DISS. ETH NO. 25146

Architecture without Applause
The Manufactured Work of João Filgueiras Lima, Lelé

A thesis submitted to attain the degree of
Doctor of Sciences of ETH Zurich
(Dr. sc. ETH Zurich)

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2018

Zusammenfassung

Diese Doktorarbeit untersucht the Arbeit und das industrielle Denken von João Filgueiras Lima – auch bekannt als Lelé (Rio de Janeiro, 1932 – Salvador, 2014) – innerhalb des Kontexts der sieben, sich in Staatsbesitz befindlichen Fabriken für vorgefertigte Bauelemente, die er in seiner dreissig Jahre währenden intensiven Tätigkeit als Fabrikant gründete (1979-2009). Die Arbeit erforscht drei ausgewählte Ebenen seiner Architektur – Fabriken, Systeme und Komponenten – da sie elementar für seinen spezifischen Konstruktionsansatz sind, sowohl was die Konzeption, als auch was die Produktion betrifft. Indem die Studie Lelé als Architekten portraitiert, der weit über seinen Fachbereich als Designer hinausging, und auch als Produzent von Bauelementen und als Bauunternehmer tätig war, zeigt sie auf, wie Lelé die Grenzen seiner Disziplin durch seine Praxis erweiterte. Mit Blick auf die inkonstante Idee der Industrialisierung der Vorfabrikation – sie schlägt sich beispielsweise darin nieder, wie seine Fabriken organisiert waren – argumentiert die Arbeit, dass Lelé eine starke manuelle Dimension in seinen *Modus Operandi* integrierte. Seine Kompromisse und Überzeugungen konzentrierten sich in (scheinbar) paradoxer Weise auf die Kombination handwerklicher und industrieller Arten der Produktion des technischen Objekts; mit dem Ziel, günstiger und effizienter zu produzieren, um dem gemeinnützigen Gebrauch der geschaffenen Gebäude Rechnung zu tragen. Schlussendlich ist diese Studie davon motiviert, Lelés Beitrag neu zu bewerten und in einen grösseren Kontext zu stellen – dies erfolgt durch das Prisma der Operationalisierung vorgefertigter Architektur; was gleichzeitig dazu dient, die politischen, ökonomischen und sozialen Dimensionen in seiner Arbeit zu hinterfragen.

Abstract

This dissertation investigates the work and industrial thinking of João Filgueiras Lima – or simply Lelé (Rio de Janeiro, 1932 – Salvador, 2014) – within the context of the seven state-owned factories for precast building elements that he founded in Brazil over the course of 30 years of intense manufacturing activity (1979-2009). It aims to explore three interrelated levels of his architecture – factories, systems and components – as they constitute the fundamentals of his constructive approach, in terms of both conception and production. From the perspective of the architect acting beyond the scope of the designer, manufacturer and builder, this study seeks to portray how Lelé broadened the discipline throughout his practice. In view of an inconstant notion of industrialization – which would affect the way his precast plants were organized – it is argued that Lelé incorporated a strong manual dimension in his *modus operandi*. Thus, his compromises and convictions were paradoxically centered upon the combination of crafted and industrial ways of producing the technical object; ways that might prove less expensive and more efficient, given the community-oriented use of the structures concerned. The reason for conducting this study on Lelé is to re-evaluate his contribution through the prism of the operationalization of prefabricated architecture in a wider context; this will bring into question political, economic and social issues as determinants in his manufactured work.

Contents

Acknowledgments

This work would not have been possible without the help of many people and institutions for whose support I remain indebted. I wish to thank my supervisor, Professor Laurent Stalder, for having carefully read my work and given appropriate comments throughout the writing process. I would also like to thank my co-supervisors, Professors Sylvia Ficher and Max Risselada, for serving as my committee members and for their contributions.

I am thankful to the Swiss Government, here represented by the Federal Commission for Scholarships for Foreign Students (FCS), not only for investing in my academic development but also for allowing me to benefit from this enriching and memorable life experience. I would particularly like to thank Walter Grossenbacher-Mansuy, Head of the International Grants Unit (SBFI/ESKAS). I express my sincere gratitude to Professor Stefano Bernasconi and Sandra Zweifel, from ETH, and Professor Johann Steurer and Claudia Meyer, from the University of Zurich, for fostering such warm, friendly and personal learning environments during our events. I extend this appreciation to both the Swiss Embassy in Brasília and the Brazilian Embassy in Bern for providing me with necessary support before and during my studies.

I would equally like to thank the Institute of History and Theory of Architecture (gta) for supporting my PhD at ETH Zurich. The advice and comments offered by Vittorio Magnano Lampugnani, Ita Heinze-Greenberg, Akòs Moravansky and Philip Ursprung have been a great help to me. Professor Lampugnani, *vouz avez raison*, *il faut du courage* (courage is needed) to ask ourselves the reasons for the paths we take in our research. I also wish to thank Elisabet Jönsson Steiner, Ursula Suter (Doctoral Office) and Julie Mogodin for their helpful suggestions in the search for the best administrative solutions.

In the Department (D-ARCH/ETH), I owe my gratitude to Professor Annette Spiro, with whom I have corresponded about Lelé's work since 2008, and Professor Christophe Girot, who I first met in Brasília in 2013 during a study trip (together with Prof. Lampugnani). I also gratefully acknowledge the constructive comments and encouragement of Professor Joseph Schwartz.

In addition, this thesis has benefited from the support given by the various institutional archives I have visited over the years. In Brasília, I owe a particular debt to the *Arquivo Público do Distrito Federal*, *Arquivo Central da Universidade de Brasília*, *Arquivo do Centro de Planejamento Oscar Niemeyer* (CEPLAN), the newspaper *Correio Braziliense,* and the Sarah Kubitschek hospital. In Salvador, I would like to express my gratitude to the *Fundação Gregório de Mattos*, the *Jornal da Bahia* and the *Centro de Tecnologia da Rede Sarah* (CTRS). In Rio de Janeiro, I am indebted to the archives of the *Casa de Lucio Costa*, the *Biblioteca Nacional*, the Sarah Rio and the *Jornal do Brasil*. In São Paulo, I would like to thank the *Fundação Bienal de São Paulo*, the *Associação Brasileira de Normas Técnicas* (ABNT) and the newspaper *Folha de São Paulo*.

I would also like to express my appreciation of the libraries that have helped me along this journey. The Swiss libraries (especially ETH-Baubibliothek, ETH-Bibliothek, ETH-

HDB, *Zentral Bibliothek* and *Sozialarchiv* in Zurich, *la Bibliothèque de l'EPFL* in Lausanne, the ZHAW *Hochschulbibliothek* in Winterthur, the HTW Chur *Fachhochschule*, *la Bibliothèque de l'Haute École Spécialisée* (HES) of Fribourg and the *Biblioteca dell'Accademia di architettura* of Mendrisio), the *Biblioteca Nacional de España*, and the libraries in Brazil at: the *Universidade Federal do Rio de Janeiro*, *Universidade de São Paulo*, *Universidade Federal da Bahia*, *Escola Politécnica de São Paulo*, *Escola de Engeharia de São Carlos* and *Universidade de Brasília*. Without the assistance of their staff, this research would not have been possible.

I am immensely grateful to all those who agreed to be interviewed and who shared with me their memories of their professional and personal involvement with Lelé. I wish to especially thank: Adriana Filgueiras, for giving me one of the most incredible opportunities of immersion in the investigation of her father's archives; Kristian Schiel, for his attention and interest during our long sessions of conversation and for having opened his invaluable archive; and Professor Dante Martinelli and his wife, Julieta P. Martinelli, for their patience and the passionate way in which they described the emergence of *argamassa armada* in Brazil and their life here in Zurich in the early 1960s.

Special thanks to João Benko, Divina Benko, Albineiar Plaza Pinto, Gil Santini Pinto, and João Evangelista, for having enhanced my understanding of the joint project in Abadiânia. I gratefully acknowledge Aires Carvalho, Fábio Savastano, Haroldo Pinheiro, Zeca Franco, Paulo Eduardo Fonseca de Campos, Maria Cecília Loschiavo, José Fernando Minho, Mariano Casañas and Luberto Moreira, for their inestimable generosity in sharing with me documents and stories that went beyond technical detail. Their perception of the facts was of key importance for the construction of this narrative, along with the insightful testimonies of Luiz Henrique Pessina and Joaquim Cambraia concerning Lelé's work and the building sector during the first years of Brasília.

Waldir Silveira, Francisco Alves Nascimento, Tomaz Bacelar, and Ana Amélia Monteiro, your meticulous comments on the CTRS and the FAEC factories were an enormous help to me. Professors João Bento de Hanai and Mounir Kalil El Debs, I thank you for your supportive conversations about *argamassa armada*, Lelé and the *Grupo de São Carlos*. I have also greatly benefited from interviews with Mário Kertész, Celso Brando, Roberto Vitorino and Dalmo Cinnanti. I thank Professor Julián Salas Serrano for giving me permission to incorporate some of his ideas in this work.

I would like to express my earnest appreciation of Professor Arthur Rüegg and Cristina Casagrande, who have offered me their continuous support and generous encouragement since our very first conversations in Brasília. I am also grateful to Marta Romero and Christina Jucá, for their permanent motivation. A big thank you to Richard Zemp for having kindly lent me his books on Sérgio Ferro and the *Grupo Arquitetura Nova*. I am deeply grateful to Andreas and Angela Graf, for having so warmly received me in their house over the years. The environment you thoughtfully created made me feel at home. My deepest thanks to all my flatmates and friends outside ETH, with whom I have shared a great experience here in Zurich.

I am indebted to friends and colleagues whose doctorate or post-doctorate research has somehow coincided with mine. I am especially thankful to Daniela Ortiz dos Santos and George da Guia for their insightful comments, exchanges and suggestions. I would also like to extend this gratitude to Rute Figueiredo, Samia Henni, Andreas Kalpakci, Maria Vrontissi, Andrea Hagn, Nicholas Drofiak, Lara Borgonovi and Marcela Hanáčková. I am particularly grateful to Jemma Dunnill for our long collaboration and her attentive reading and review of this manuscript. Finally, my heartfelt appreciation goes to my family, especially my mother, whose constant love and caring have enabled me to finish this work; Kennedy and Samira, for their patient emotional support; my brother; and those who have passed on (my father, sister and grandmother) but remain present in my life.

Although I have made every possible effort to ensure the accuracy and appropriateness of information shared in this thesis, the occurrence of errors or omissions cannot be ruled out, and any personal views I have expressed should not be attributed to the institutions with which I have been affiliated.

List of Abbreviations

ACI	American Concrete Institute
AI-5	Ato Institucional no. 5
AICA	International Association of Art Critics
AMA	Ação no Município de Abadiânia
APS	Associação das Pioneiras Sociais
AU	Arquitetura e Urbanismo
BNDES	Banco Nacional de Desenvolvimento Econômico e Social
BNH	Banco Nacional de Habitação
CAB	Centro Administrativo da Bahia
CAU	Conselho de Arquitetura e Urbanismo do Brasil
CECAP	Caixa Estadual de Casas para o Povo
CEDATE	Centro de Desenvolvimento e Apoio Técnico à Educação
CEDEC	Centro de Desenvolvimento de Equipamentos Urbanos e Comunitários
CEF	Caixa Econômica Federal
CEPLAN	Centro de Planejamento Oscar Niemeyer
CIAC	Centro Integrado de Apoio à Criança
CIEP	Centro Integrado de Educação Pública
CN	Christiani-Nielsen
CNAN	Conservatoire National des Arts et Métiers
CODEBRAS	Coordenação de Desenvolvimento de Brasília
CONESP	Companhia de Construções Escolares do Estado de São Paulo
CREA	Conselho Regional de Engenharia, Arquitetura e Agronomia
CRUSP	Conjunto Residencial da Universidade de São Paulo
CTRS	Centro de Tecnologia da Rede Sarah
DASP	Departamento Administrativo do Serviço Público
DISBRAVE	Distribuidora Brasília de Veículos S/A
EDIF	Departamento de Edificação da Prefeitura de São Paulo
EESC	Escola de Engenharia de São Carlos
EMURB	Empresa Municipal de Urbanização de São Paulo
ENAC	Faculté de l'Environnement Naturel, Architectural et Construit
ENAR	Engenharia e Arquitetura Ltda
EPFL	École Polytechnique Fédérale de Lausanne

ETH	Eidgenössische Technische Hochschule Zürich
FABES	Fábrica de Equipamentos Sociais
FAEC	Fábrica de Equipamentos Comunitários
FAU	Faculdade de Arquitetura e Urbanismo
FEBASP	Centro Universitário Belas Artes de São Paulo
FIN	Ferrocement Information Network
FNA	Faculdade Nacional de Arquitetura
HfG Ulm	Hochschule für Gestaltung Ulm
HRT	Hospital Regional de Taguatinga
IAB	Instituto de Arquitetos do Brasil
IAPB	Instituto de Aposentadoria e Pensões dos Bancários
IBGE	Instituto Brasileiro de Geografia e Estatística
IBRD	International Bank for Reconstruction and Development
IBTH	Instituto Brasileiro de Tecnologia do Habitat
ICC	Instituto Central de Ciências
IFIC	International Ferrocement Information Center
IPEA	Instituto de Pesquisa Econômica Aplicada
IPESP	Instituto da Previdência do Estado de São Paulo
ISMES	Istituto Sperimentale Modelli e Strutture
JEC	Juventude Estudantil Católica
KPD	Krupnopanelnoye Domostroyenie
LAMS	Laboratory for Systemic Modeling
LNEC	Laboratório Nacional de Engenharia Civil de Lisboa
MAIS	Movimento de Ação Integrada Social
MASP	Museu de Arte de São Paulo
MCB	Museu da Casa Brasileira
MCMV	Minha Casa Minha Vida
MEC	Ministério da Educação
MIT	Massachusetts Institute of Technology
MoMA	Museum of Modern Art of New York
NBR	Norma Brasileira
NIEC	Núcleos Integrados de Equipamentos Comunitários
OCEPLAN	Órgão Central de Planejamento da Prefeitura de Salvador
PCB	Partido Comunista Brasileiro
PEE	Programa Especial de Educação

PNAD	Pesquisa Nacional por Amostra de Domicílios
PT	Partido dos Trabalhadores
RENURB	Companhia de Renovação Urbana de Salvador
SG	Galpão de Serviços Gerais
SHRU	Seminário de Habitação e Reforma Urbana
SPHAN	Serviço do Patrimônio Histórico e Artístico Nacional
SQN	Superquadra Norte
SQS	Superquadra Sul
TCU	Tribunal de Contas da União
TRANSCOL	Transportes Urbanos de Salvador
TRT	Tribunal Regional do Trabalho
TU Delft	Technische Universiteit Delft
UCG	Universidade Católica de Goiás
UFBA	Universidade Federal da Bahia
UFRJ	Universidade Fedeal do Rio de Janeiro
UnB	Universidade de Brasília
UNESCO	United Nations Educational, Scientific and Cultural Organization
USP	Universidade de São Paulo

Fig. i.i Workers on the building site of the first *Superquadra* (SQS 108) erected in Brasília, 1957. Lelé is the one on the right.
Arquivo João Filgueiras Lima, Salvador

A certain John. João Filgueiras Lima, Lelé

This is the story about a common architect. João da Gama Filgueiras Lima (1932-2014), registered at the Brazilian Regional Council of Engineering, Architecture and Agronomy (CREA)[1] under the number 8608-D 5th Region, was a Rio de Janeiro National Faculty of Architecture graduate, class of 1955. Certified Architect in 1956 – the same year that Brazil's President Juscelino Kubitschek staged an open competition for the design of Brasília – Lelé, as he was popularly known, began his career as a draftsman at the Institute for the Retirement and Pensions of Bank Employees (*Instituto de Aposentadoria e Pensões dos Bancários*, IAPB). The same institute which, in September 1957, placed Lelé in the new capital's building sites to work among an anonymous mass of workers coming from all over the country. But what does it mean to be a common architect, an epithet which applies to Lelé, throughout the course of his practice (1957-2013)?

According to the Federal Decree no. 23.569 of December 11, 1933, architects and engineer-architects are accredited with "the study, design, direction, inspection, and construction of buildings, with all their complementary works."[2] However, while 'in practice' in the public sphere, Lelé was prevented from building his own work at the end of his life. At least this is what can be grasped through the reading of the audit[3] no. TC 010.637/2011-7 conducted by the Federal Audit Court (*Tribunal de Contas da União*, TCU) upon the unfinished works of the Regional Labor Court's head office in Salvador (*Tribunal Regional do Trabalho*, TRT), a metallic building designed by Lelé in 2009.

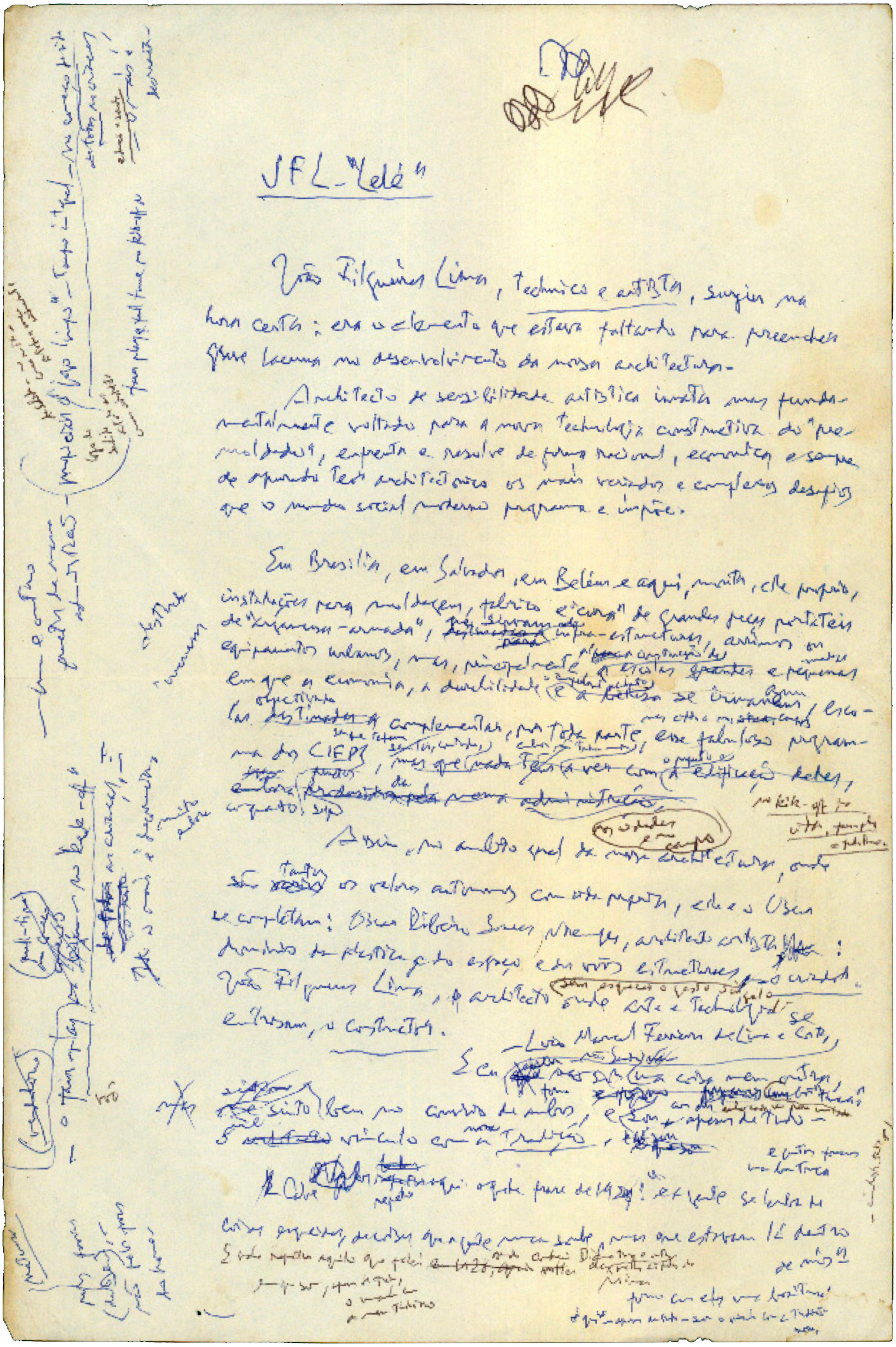
Unlike Oscar Niemeyer, who built most of the tribunals and public bodies in Brasília exempted from the legal requirements to public works – namely the obligation of holding a proceeding of bidding – Lelé was never granted the same recognition. Moreover, "as evidenced by the architect's curriculum," highlighted the Federal Audit Court, Lelé "had not produced any publication dedicated exclusively to steel structures"[4] which might have justified his expertise on this building technique and therefore waived the public bid. Ironically, between 1996 and 1998, João Filgueiras Lima was the very architect who designed and built the eight headquarters for the same Audit Court in the Brazilian states of Bahia, Rio Grande do Norte, Minas Gerais, Sergipe, Espírito Santo, Alagoas, Piauí, and Mato Grosso. All of them using metallic structures.

1 For a comprehensive picture of the educational, political and cultural framework in which the first professional associations of engineers and architects emerged in Brazil, see Sylvia Ficher, *Os arquitetos da Poli: ensino e profissão em São Paulo* (São Paulo: EdUSP, 2005), 177–190.

2 As provided for in the Decree-Law no. 23.569 of December 11, 1933, Article 30. Available at: http://www.planalto.gov.br/ccivil_03/decreto/1930-1949/d23569.htm. Accessed on February 15, 2018.

3 See audit no. TC 010.637/2011-7, p. 24, dated September 28, 2011. Arquivo Tribunal de Contas da União, TCU. Brasília, Distrito Federal.

4 Ibid. [Não se constata também qualquer publicação voltada exclusivamente à estrutura em aço] (my translation).


JFL – "Lelé"

João Filgueiras Lima, technico e artista, surgiu na hora certa: era o elemento que estava faltando para preencher grave lacuna no desenvolvimento da nossa architectura.

Architecto de sensibilidade artística inata mas fundamentalmente voltado para a nova technologia constructiva do "pre-moldado", enfrenta e resolve de forma racional, economica e sempre de apurado teor architectonico os mais variados e complexos desafios que o mundo social moderno programa e impõe.

Em Brasília, em Salvador, em Belém e aqui, montou, ele proprio, installações para moldagem, fabrico e "cura" de grandes peças portateis de "argamassa-armada", [illegible] infra-estructuras, [illegible] equipamentos urbanos, mas, principalmente, [illegible] escolas grandes e pequenas em que a economia, a durabilidade [illegible] se [illegible] ...

Assim, no ambito geral da nossa architectura, onde tantos são os valores autonomos com obra propria, ele e o Oscar se completam: Oscar Ribeiro Soares Niemeyer, architecto artista [illegible] dominado pela plastica do espaço e dos vãos estructuraes, o creador; João Filgueiras Lima, o architecto onde arte e technologia se entrosam, o constructor.

— Lucio Marçal Ferreira Ribeiro de Lima e Costa,

Fig. i.ii Lucio Costa's letter on Lelé, 1985. Arquivo Casa de Lucio Costa, Rio de Janeiro

Nevertheless, for his peers, Lelé obtained more than professional recognition. He was assigned a position among the canons of modern architecture in Brazil. In 1985, Lucio Costa wrote a tribute to Lelé soon after visiting the *Fábrica de Escolas* (School Factory) which had been built by the architect in Rio de Janeiro:

> João Filgueiras Lima, technician and artist, appeared at the right time: he was the missing element that filled the serious gap in the development of our architecture. An architect with an innate artistic sensibility, yet fundamentally directed toward new building technology in "prefabrication". Lelé confronted, with refined architectonic tenor as well as in a rational and economic manner, the most diverse and complex challenges that the modern social world programs and imposes. (…) Therefore, within the spectrum of our architecture where there are a lot of autonomous values, he and Oscar complete each other. Oscar Ribeiro de Almeida Niemeyer Soares, artist architect: mastery of form, spaces and structural leaps, without forgetting the simple gesture – the creator. João da Gama Filgueiras Lima, the architect whose art and technology meet and are intertwined – the builder. And me, Lucio Marçal Ferreira Ribeiro de Lima e Costa – who has a bit of one and the other and feels at home in their company, so much so that despite our distinct personalities we form a good gang: I represent, after all, the link to our past, our ballast – tradition.[5]

Undoubtedly, Lelé became a reference in the professional milieu. A myth of rationalized architecture, also noticed by the foreign critics. So much so that the unconditional reception of his work seemed to have drawn the attention of Max Risselada when he visited the Sarah hospital in Belo Horizonte. The architect and emeritus professor from TU Delft was touched by the way he was showed around by one of Lelé's collaborators: "Apart from admiring the relaxed intensity of this industrially produced complex around an existing building by Niemeyer, with its changing shades of light and the visible caring for its patients, I was mostly stricken and moved by the devotion of our guide to the work of Lelé."[6]

Despite Max Risselada's important effort to accommodate the architect in his context, the history of Brazilian modern architecture was built without Lelé. In his place, the most representative names, such as Niemeyer, Costa, Artigas, Mendes da Rocha, Reidy and Burle Marx were selected. In the 1980s, at a critical moment for the discipline in Brazil, once again, for ideological reasons, the names of architects who worked for the military governments during the dictatorial regime (1964-85) were overshadowed.[7] These included Sérgio Bernardes, Ícaro

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5 Lucio Costa, Lucio Costa: registro de uma vivência (São Paulo, Brasil: Empresa das Artes, 1995), 434. Translated from Portuguese by Izabel Murat Burbridge. In: Maria Elisa Costa, "Outros Caminhos," Le visiteur: revue critique d'architecture, no. 14 (2009): 172.

6 Max Risselada, "A Culture of Materials and Art of Production. The Auditor Courts of João Filgueiras Lima," in *Teatro Do Mundo*, ed. Carla Carrondo, Cristina Marinho, and Nuno Pinto Ribeiro, vol. 11 (Porto: CETUP, 2016), 161.

7 For an overview of Brazilian architecture during the military dictatorship in the country, see: Sylvia Ficher, "Censura e Autocensura: Arquitetura Brasileira Durante a Ditadura Militar," *Vitruvius* 080.14, no. 080.09 (2014), http://www.vitruvius.com.br/revistas/read/drops/14.080/5192.

de Castro Mello, Severiano Porto, Milton Ramos, and Lelé himself.

In the 1990s and 2000s, the figure of Lelé was revived under labels such as "the last of the modernists,"[8] and "unknown hero,"[9] and his work, described as sustainable or high-tech, was placed parallel to names like Jean Prouvé and Richard Neutra,[10] or Renzo Piano.[11] Taking as a starting point another methodological approach, this thesis analyzes Lelé not as a myth or "another modern," but as an architect who was part of a generation of professionals marked by the construction of Brasília and a commitment to the advancement of prefabrication.

Instead of mapping the Brazilian architects involved with building prefabrication, this thesis focuses mainly on the critical years in Lelé's production – from 1979 to 2009 – when the cycles of greatest activity in his work were observed. The reason for such peaks in the architect's productivity can be explained by the setting up of seven[12] precast factories spread across the country's four largest cities (São Paulo, Rio de Janeiro, Brasília and Salvador).

The idea of this study is not to carry out a survey of prefabricated works, nor will these critical years be perceived as a period of rupture with Brazilian architecture or the evolution of new building techniques. Instead, the period under study will be treated here as a crucial moment for an architect whose intellectual and built production did not center on technology exclusively. Technology may help us to understand what is deemed to be the contribution of Lelé's work to architecture, specifically his approach to both design and construction. However, if disconnected from a large range of variables, its role in this process may become innocuous.

By treating Lelé as a critical figure subjected to failures, successes and barely explored gaps, this thesis has entailed a close examination of diverse documents – including photos, drawings, letters, and movies – found in the architect's private archive in Salvador. In addition, 27 interviews were conducted throughout the investigation with some of Lelé's former collaborators, some of whom made their individual archives accessible to me. This careful analysis of primary sources has revealed not only a prefabrication process that went beyond the material and construction techniques, but, above all, it has disclosed an architectural practice in which mechanization[13] did not take command.

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8 Ana Gabriella Lima Guimarães, "João Filgueiras Lima: O Último dos Modernistas" (Universidade de São Paulo, 2003).

9 André A. Corrêa Lago, "Heroi Desconhecido," *Le visiteur: revue critique d'architecture*, no. 14 (2009): 21–28.

10 André Marques, "A Obra do Arquiteto João Filgueiras Lima, Lelé: Projeto, Técnica e Racionalização" (Universidade Presbiteriana Mackenzie São Paulo, 2012).

11 Marina Mange Grinover, "Laboratório de Projeto e Construção: Prática da Arquitetura na Obra de Renzo Piano e João Filgueiras Lima" (Universidade de São Paulo, 2015).

12 This work takes into account the following factories: Renurb in Salvador (1979-81), Abadiânia in Goiás (1982-84), the School Factory in Rio de Janeiro (1984-86), the *Argamassa Armada* Factory in Brasília (1985-94), FAEC in Salvador (1986-88), CEDEC in São Paulo (1990-93) and the CTRS in Salvador (1992-2009). The factories installed by Lelé in Campinas (early 1990s) and in Ribeirão Preto (FABES, *Fábrica de Equipamentos Sociais*, 2002-04) were not taken into consideration due to their minor contributions to the topic.

13 A series of scholars proved decisive in broadening the notions of mechanization, prefabrication and building technology used in this thesis, and we shall build on contributions from: Bruno Reichlin, Laurent Stalder, Kenneth Frampton, Pedro Ignacio Alonso, Ana Luiza Nobre, Roberto Gargiani, and Ana Paula Koury. For further details, see: Bruno Reichlin, "Technical Thought, Techniques of Thinking," in *Jean Prouvé: The Poetics of the Technical Object* (Weil am Rhein: Vitra Design Museum, 2006), 28–47; Moritz Gleich and Laurent Stalder, *Architecture/machine: Programs, Processes, and Performances*

Richard Sennett,[14] in this context, became a central figure in the narrative, since he allowed me to uncover the artisan behind the industrialist. In his book "The Craftsman" (2008), as well as exploring non-industrialized manual work, Sennett analyzed human work through two metaphorical figures: *Animal laborans* and *Homo faber*. The former is the craftworker absorbed in the work as an end in itself, condemned to repetitive tasks; and the latter is "the judge of material labor and practice,"[15] in other words, the worker that thinks, discusses and decides what he or she does. The author argues that this division is false, based on the notion that a disciplined hand is not devoid of thinking.

In this thesis it is maintained that Lelé assumed positions on both sides, acting either as *Homo faber* or *Animal laborans*. However, by moving through his factories, we realize that Lelé never came to be the architect who assumed the position of "master of the building industry," as expected by Walter Gropius in 1956. Contrary to the contempt with which the founder of the Bauhaus School treated the professionals who "continued thinking in terms of the old craft methods, pathetically unaware of the colossal impact of industrialization,"[16] Lelé attached himself to a hybrid career: one which swings between the ingenuity of the craftsman and the efficiency of the *Homme d'usine*.[17]

Starting from the assumption that Lelé extrapolated the role of the architect by understanding the discipline as a broader field of action, this thesis seeks to portray that, in his practice, Lelé went beyond the designer, manufacturer and builder. He somehow engaged himself in what comes before architecture, in what is necessary in order to materialize architecture, and in what follows after architecture is achieved. The remarkable contribution of Lelé's work lies in the manner in which he immensely broadened the field of architectural production.

By focusing on the studies for more than 24 systems developed by Lelé over his career, this thesis argues that the sequence of state-owned factories implemented to erect public buildings worked less as a constructive search and served more as architectural research. Put

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(Zürich: gta Verlag, 2017); Kenneth Frampton and Steven Moore, "Technology and Place," *Journal of Architectural Education* 54, no. 3 (2001): 121–122, http://www.jstor.org/stable/1425577; Pedro Ignacio Alonso, "The Architecture of Assemblage in the Rhetoric of a New Construction: Between the Expanded Meaning and the Turning Point of Building" (Architectural Association School of Architecture, 2007); Ana Luiza Nobre, "Fios cortantes: projeto e produto, arquitetura e design no Rio de Janeiro (1950-70)" (Pontifícia Universidade Católica do Rio de Janeiro, 2008); Roberto Gargiani and Alberto Bologna, *The Rhetoric of Pier Luigi Nervi: Concrete and Ferrocement Forms* (Lausanne: EPFL Press, 2016); Ana Paula Koury, "Arquitetura construtiva: proposições para a produção material da arquitetura contemporânea no Brasil" (Universidade de São Paulo, 2005).

14 Richard Sennett (1943) is an American sociologist who conducted a research project entitled *Homo Faber*, dedicated to exploring material ways of making culture. The book trilogy begins with the Craftsman (2008), and subsequent volumes are *Together: The Rituals, Pleasures, and Politics of Cooperation* (2012), and *Building and Dwelling: Ethics for the City*, published in February 2018. In this thesis, other thinkers who have explored the making of society with different case studies were also taken into consideration. Henri Focillon in his *Éloge de la Main* (1947) defended the idea that the hand is action, as it takes, creates, and sometimes also thinks. In: Henri Focillon, *Vie de Formes*, 3rd ed. (Paris: Presses Universitaires de France, 1947), 99. Gilbert Simondon explored the conflicts between the human individual and the technical individual. See: Gilbert Simondon, *Du mode d'existence des objets techniques* (Paris: Aubier, 1989), 115–119. Max Frisch in his novel *Homo Faber* (1957) somehow touched the topic, as he explored in a dramatic narrative the interface between technology and philosophy through the perspective of human conflicts.

15 Richard Sennett, *The Craftsman* (London: Penguin, 2008), 6.

16 Walter Gropius, *Scope of Total Architecture* (London: G. Allen & Unwin, 1956), 84.

17 This term was employed by Hugo Segawa and Ana Gabriella Lima Guimarães, "Lelé: The Creator, the Builder, and the Context," *Le visiteur: revue critique d'architecture*, no. 14 (2009): 83.

differently, by setting up a series of precast plants, Lelé foresaw the possibility of not only trying to find a solution for a constructive problem but also developing a systematic investigation into building prefabrication. Therefore, factories, systems and components are here defined as concepts and not merely seen as terms of Lelé's constructive syntax. Such a methodological framework investigating production, mediums and parts has served, moreover, as a central element of the thesis narrative.

Part I focuses on the period preceding the inauguration of the first factory, that is, the years between 1957 and 1979. The intention has been to show how a combination of factors (including labor, buildings and the local market) shaped Lelé's involvement with building prefabrication, at that time centered on techniques using wood and reinforced concrete. In the beginning, the architect's relationship with prefabrication is placed more at the crossroads of professional circumstances than at the hands of coincidence and fate, as Lelé claimed. In this sense, the works at the University of Brasília (1962-65) and the building companies operating within the new capital's construction sector played a pivotal role.

Part II offers a detailed view of important building systems and components used by Lelé in his work, such as sanitation channels, prefabricated schools, bus shelters, sheds, and marquees. From *argamassa armada*[18] to steel structures – two of the most widespread materials in question – the chapters of the second part reposition the development of constructive systems and their elements in the most fruitful phase of Lelé's activity (1979-2009). By questioning the pertinence of certain constructive precepts defined by the architect as orienting both the production and assembly of precast unities, Part II has reinterpreted certain constraints on Lelé's systems and components, such as the role of weight and quality control for the *argamassa armada* components.

Part III invites the reader to explore the precast factories set up and managed by Lelé (1979-2009), when his investigation into building prefabrication extrapolated the material and constructive limits to reach sociopolitical and economic dimensions. A careful look at the primary sources combined with oral evidence has revealed that the precast plants changed over time – whether in terms of machinery, lay-out or production methods – as the notion of industrialization itself gradually changed for Lelé. In the end, this last part shows the complexity, contradictions and multiple facets of the architect's industrial production.

18 Here, and throughout this dissertation, "argamassa armada" (reinforced mortar) is defined and understood as a variation of Pier Luigi Nervi's ferrocement. The material is constituted by the addition of cement, sand and water applied over a layer of metal mesh, woven expanded-metal or metal fibers and closely spaced thin steel rods such as rebar. Due to Lelé's substantial changes to the material composition and production process, the term in Portuguese will be adopted throughout the narrative. This may lead to a clear distinction between *ferrocemento* and *argamassa armada*. This understanding is also supported by Campos (2002), who asserted that, while *ferrocemento* was considered a composite and synergetic material, *argamassa armada* was classified as a special type of reinforced concrete, an associated material. In: Paulo Eduardo Fonseca de Campos, "Da Argamassa Armada Ao Microconcreto de Alto Desempenho: Perspectivas de Desenvolvimento Para a Pré-Fabricação Leve" (Universidade de São Paulo, 2002), 8.

Placed within a larger framework, Lelé may also be seen as part of a group of Latin American builders,[19] with whom he shared a constructive activity-oriented approach to urgent themes in response to the growing trend of rapid urbanization in Argentina, Brazil, Chile, Uruguay, Colombia, Mexico, Peru and Venezuela. By undertaking works that overcame the lack of urban infrastructure and poor living conditions in which much of the population of those countries lived, the practice of Lelé and his peers was underpinned by a notion that might be called of the 'non-spectacle'. Indeed, their accomplishments did not seem to attract widespread critical attention. In this sense, I tend to agree with Julián Salas Serrano,[20] when he says that "the applause in architecture is given in small and exclusive circles."[21]

Confronted with a particular definition of technological development – in which the optimization of production was not always preceded by the mechanization of the processes – Lelé showed, in the final analysis, the challenges and unsavory aspects involved in the decision to produce an industrial-tailored approach to a socially-oriented architecture. It now remains for us to examine more attentively the legacy inherited from this choice and how it came to be.

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19 With regard to the Latin American builders referred to in this study, the following names illustrate the subject matter under discussion: the Uruguayan engineer Eladio Dieste (1917-2000), the Chilean architect Fernando Castillo Velasco (1918-2013), the Peruvian engineer Julio Vargas Neumann, the Colombian architects Alvaro Ortega (1920-1991) and Oscar Hidalgo-Lopez (1930-2014), the Mexican architect Carlos Gonzáles Lobo, and the Venezuelan engineer José Adolfo Peña.

20 Julián Salas Serrano is a Spanish industrial engineer who graduated in Industrialized Construction from the CSTB (Paris) and holds a PhD from the *Universidad Politécnica de Cataluña* (1983). During the course of more than 30 years of research and teaching activities, Salas Serrano was a head of the *Instituto de Ciencias de la Construcción Eduardo Torroja* and the School of Architecture of the *Universidad Politécnica de Madrid*, where he founded the Chair *UNESCO de Habitabilidad Básica*, later renamed ICHaB, *Instituto de Cooperación en Habitabilidad Básica.*

21 Julián Salas Serrano, "Arquitectura sin aplausos," *Architecto Hektor Saavedra*, last modified 2009, accessed November 28, 2017, http://arqhsaavedra.blogspot.ch/search?q=lelé. [*los aplausos en la arquitectura se dispensan en círculos reducidos y excluyentes*] (my translation).

Part I

Lelé's involvement with standardized construction methods

Fig. 1.1 Rabello building company's advertisement showing a big "não" (no) as part of its campaign to promote prefabrication in view of the material waste produced by traditional construction methods. Building site of a Superquadra in Brasília, late 1950s. Catalog *Construtora Rabello S.A* (Brasília: Rabello, 1969)

"Linear time is a Western invention, time is not linear, it is a marvellous tangle, where, at any moment, points can be selected and solutions invented, without beginning or end."

Lina Bo Bardi

1. Building the knowledge base

In this section, I propose to discuss the origins of Lelé's involvement with building prefabrication and standardized construction in Brazil. It will be argued that his *savoir faire* is the result of an extensive and oriented process towards rationalized construction methods. By observing how the architect's interests permeated through this field, one might see that his works and thinking were not at all guided by mere coincidence – as the architect himself claimed[1] – but by a solid constructive understanding acquired from a variety of sources which have so far not been adequately explored. These references are introduced to the narrative for their wide range of possibilities and impact on Lelé's mind, rather than their specific contribution to the architect's technical knowledge. In seeking to understand the origins of Lelé's involvement with prefabrication we cannot proceed without associating his work with significant contributions coming from a wide range of actors. Their influence on Lelé proved to be much stronger than previously assumed.

In 1951, Pier Luigi Nervi (1891-1979) offered a series of lectures in Brazil at the São Paulo Museum of Art (MASP), located at that time on the first floor of the *Diários Associados*[2] headquarters. Invited by his friend Pietro Maria Bardi to "spend a few weeks"[3] with them, Nervi delivered his talks and presented works like the prefabricated airplane hangars built for the Italian Air Force in Orvieto, Orbetello and Torre del Lago Puccini (1939-42) and the *Salone Agnelli* at the Turin Exhibition Hall (1947-49). These two projects earned him the international architecture prize at the 1st Biennial[4] in São Paulo the same year. Inside the auditorium where

1 In his texts and interviews Lelé invariably attributed to "coincidences" the experiences he had with prefabrication throughout his career.

2 Diários Associados or "Associated Daily Press" was the largest media and press group in Brazil at that time. Its founder, the Brazilian journalist and diplomat Assis Chateaubriand, took an active part in the national moves toward the country's modernization.

3 In addition to the lectures, Nervi also worked as Lina Bo Bardi's engineering consultant for the construction of the new São Paulo Museum of Art (MASP) at Paulista Avenue. See: Annette Condello, "Pietro Maria Bardi – The Vicarious Architect: The Importation of Italian Futurism to Brazil," in 15th International Planning History Society Conference (São Paulo, 2012), 10.

4 The first edition of the São Paulo Biennial took place in the city of São Paulo from 20 October to 23 December 1951 against the vehement opposition of Vilanova Artigas, who accused the event of being a vehicle for American imperialism and an obstacle for local artists. The jury composed by Sérgio Milliet and René d'Harnoncourt (MoMA) also awarded Max Bill the international sculpture prize for his "Tripartite Unity" (1948-49) and Le Corbusier the international architecture prize for his work on reinforced concrete carried out at the *Unité d'Habitation de Marseille* (1946-52). For more information on the polemic involving Artigas, see the article *A Bienal é contra os artistas brasileiro*s [The Biennial is against Brazilian Artists], in: Vilanova Artigas, *Caminhos da arquitetura*, ed. Rosa Artigas and José Lira (São Paulo: Cosac Naify, 2004), 30-34. For an overview of the São Paulo Biennial, see: Agnaldo Farias, *50 anos Bienal de São Paulo* (São Paulo: Fundação Bienal de São Paulo, 2001).

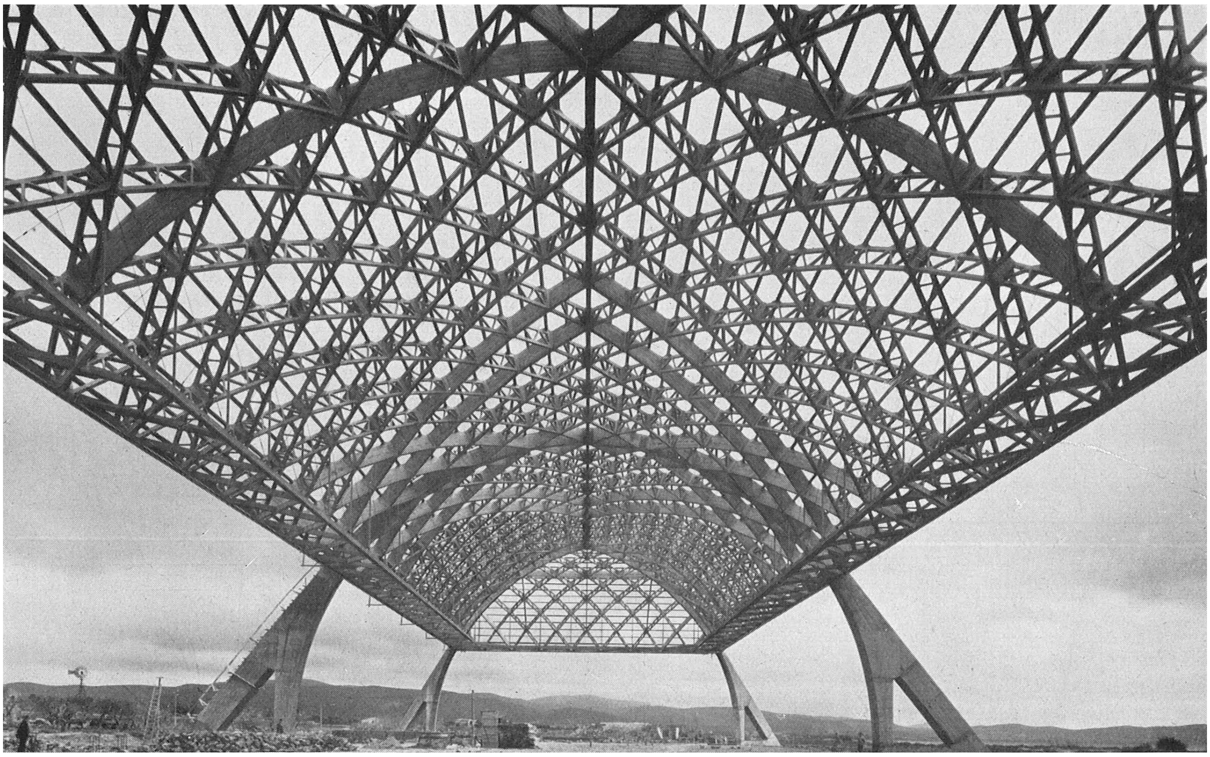

Fig. 1.2 Hangar in Orvieto, Italy, 1939-42. Pier Luigi Nervi, *Construire Correttamente* (Milano: Ulrico Hoepli, 1955), XIX

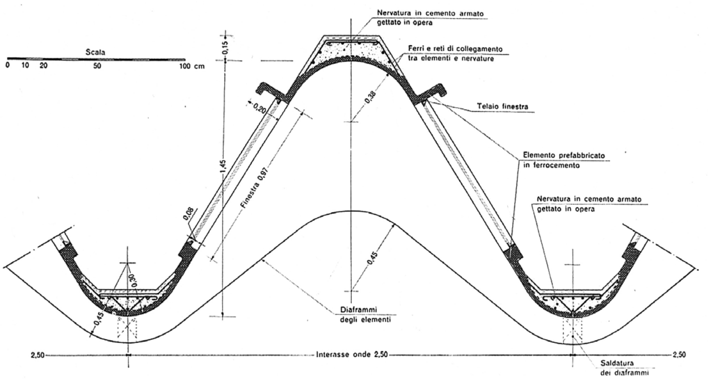

Fig. 1.3 Drawing of wave segment. Turin Exhibition Hall, 1947-49. C. Olmo and C. Chiorino, Pier Luigi Nervi: Architecture as Challenge (Milano, Brussels: Silvana, Civa, PLN Project, 2010), p. 127

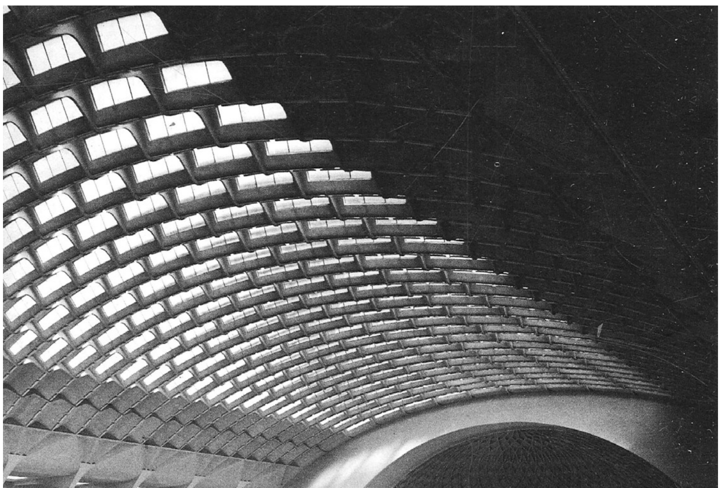

Fig. 1.4 View of the interior. Turin Exhibition Hall, 1947-49. C. Olmo and C. Chiorino, Pier Luigi Nervi: Architecture as Challenge (Milano, Brussels: Silvana, Civa, PLN Project, 2010), p. 127

Nervi gave his speech, a young engineering student followed the presentation, amazed by the concepts and images discussed by the Italian guest. Dante Martinelli,[5] who years later would transplant Nervi's ideas and approaches from the Italian context to Brazil, certainly changed the course of light prefabrication in the country over the following decades. The engineer recalled 40 years later:

> But, alongside these great works – large and beautiful ones – re-emerged small boats in "fer-ciment" of Lambot, enhanced by Nervi's boats in "ferro-cemento". And the idea of Lambot-Nervi grew as it was applied to multiple projects, large and small, ranging from the warehouse for his own company to the restaurant in Ostia, or from the Lanificio Gatti to the Turin Exhibition Hall and the salt warehouses in Tortona. It is something that needs to be transplanted.[6]

Together with the decisive contributions of the engineers Frederico Schiel[7] and later Lafael Petroni,[8] Martinelli initiated the first experiments concerning the technical implementation of *ferrocemento* in Brazil between 1960-65 at the Structures Laboratory of the São Carlos School of Engineering. In one of their first studies regarding the use of *argamassa armada* in structural elements, Schiel and Martinelli clarified that:

> Based on Nervi's results, and motivated by a real problem to solve, we proceeded to the re-elaboration of the construction technique (of *ferrocemento*) at the EESC (São Carlos School of Engineering) Structures Laboratory. We sought to adapt it to our reality both in terms of execution and the need to cut production costs. For this purpose, we reduced the consumption of cement, trying to ascertain the minimum quantity of wire mesh that, combined with the material, would still ensure greater resistance to cracking.[9]

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5 Dante Ângelo Osvaldo Martinelli studied civil engineering at the Polytechnical School of the University of São Paulo (1951), where he received his PhD in 1961. He taught at the São Carlos School of Engineering (EESC-USP) from 1960-86, working as guest researcher in Lisbon (LNEC, 1961-62) and Zurich (ETH, 1969-70). He collaborated in relevant infrastructure projects in Brazil, such as the São Paulo subway (1968) and the binational Itaipu power plant (1975-81).

6 Dante Martinelli. Preface to the First Edition of: João Bento de Hanai, *Construções de argamassa armada: fundamentos tecnológicos para projeto e execução* (São Paulo: Pini, 1992). [Mas, ao lado dessas grandes obras – grandes e belas –, ressurgiam os pequenos barcos de "fer-ciment" de Lambot, ampliados nos barcos de "ferro-cemento" de Nervi, e a ideia de Lambot-Nervi multiplicava-se em aplicações, pequenas e grandes, desde o armazém para a própria empresa, ao restaurante em Ostia, ao Lanifício Gatti, até o Salão do Automóvel de Turim e o Depósito de Sal de Tortona. É algo que precisa ser transplantado] (my translation).

7 Friedrich Schiel (1905-2000) was an engineer and important member of the *Grupo de São Carlos*. Born in Brasov, Romania (then Kronstadt, Hungary) – a city in the historical region of Transylvania – he studied in Vienna from 1924 to 1927. In 1931, he graduated in Dresden, Germany, where years later he received his doctorate in engineering. In 1948 he moved to France, staying in the country for two years before emigrating to Brazil in 1950, where he lived in Petrópolis, in the state of Rio de Janeiro. In 1954, Dr. Schiel was admitted to the São Carlos School of Engineering (USP) as a full professor, teaching material resistance. There, he and his group carried out research in *argamassa armada*, expanding the work of the Italian engineer Pier Luigi Nervi with *ferrocemento*.

8 Lafael Petroni (1918-2015) was vice director of the São Carlos School of Engineering (1980-84), where he taught at the Architecture and Urban Planning Department from 1954 to 1987. The engineer played an important role in the development of the technological basis of *argamassa armada* in Brazil.

9 Frederico Schiel and Dante Martinelli, "Argamassas Armadas em Elementos Estruturais," *Forum de Engenharia, Técnica e Equipamentos* 1, no. 4 (1964): 21. [À partir desses resultados de Nervi, e com a motivação de um problema real a resolver, procedeu-se no Laboratório de Estruturas da EESC à reelaboração da técnica construtiva, procurando adaptá-la às

The efforts promoted by the group of engineers that would later become known as *Grupo de São Carlos*[10] were fundamental for the industrialization of the material in Brazil twenty years later. Renamed as *argamassa armada* and subsequently modified (see table 1 on page 9), ferrocement would not enter the production chain in Brazil until 1980, through the works of Lelé and his team.

Fig. 1.5 Gatti Wool Factory, Roma, 1951. Pier Luigi Nervi, Construire Correttamente (Milano: Ulrico Hoepli, 1955), tavola XLV

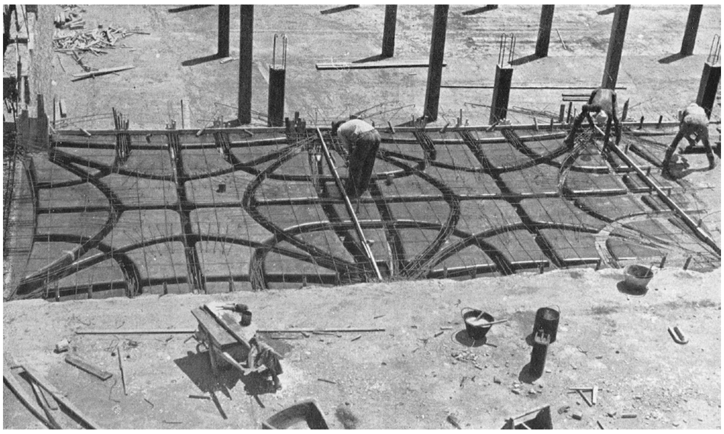

Fig. 1.6 The formwork of Gatti Wool Factory, Roma, 1951. Pier Luigi Nervi, Construire Correttamente (Milano: Ulrico Hoepli, 1955), XLIV

When analyzing the impact of Nervi's techniques with *ferrocemento* on Lelé's practice one can see that besides inspiring shapes and refined technical solutions, the Italian engineer also laid the foundation for further innovative use of the material. The possibility of incorporating reusable *ferrocemento* formwork into construction – observed for instance in Rome at the Gatti Wool Factory with its ribbed roof slab – is a clear demonstration of its great diversity of uses.[11]

It seemed that Lelé had learned the lesson when he came to put it into practice in his fruitful collaboration with Lina Bo Bardi during the recovery project for the historic center of Salvador[12] (1987-88). As we are reminded by Marcelo Ferraz:

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nossas possibilidades quer quanto aos processos de execução quer quanto à necessidade de baratear o material, reduzindo-se o consumo de cimento e, especialmente, procurando averiguar qual a mínima quantidade de telas compatível com a necessidade de material que ainda apresentasse elevada resistência à fissuração] (my translation).

10 The activities of the *Grupo de São Carlos* (São Carlos Group) – based at the São Carlos School of Engineering (EESC-USP) – were not restricted to design projects and the execution of works. They also carried out research on material properties, components and construction systems, as well as professional training and technology dissemination. The group was responsible for the first experiments with *argamassa armada* in Brazil.

11 For further constructive details concerning the use of *ferrocemento* within the work of Nervi and Lelé, see: Yopanan Rebello and Maria Amélia d'Azevedo Leite, "Architekton Lelé: O mestre da arte de construir," *Arquitetura e Urbanismo*, no. 175 (2008): 72–77.

12 In 1986, the mayor of Salvador, Mário Kertész, decided to tackle the restoration/reconstruction of the city's historic center, abandoned for many decades. Lina Bo Bardi and her team were in charge of a master plan, partially rejected by the local institute of historic and cultural heritage (SPHAN). Even so, the restoration of the *Casa do Benin* (Benin House) museum, accomplished in 1988, and five buildings from colonial times at Ladeira da Misericórdia (Misericórdia Slope) were carried out successfully. For more details, see: Cecília Rodrigues dos Santos, "Assim, nas bordas e por dentro, os ratos foram roendo toda nossa cidade da Bahia." *Projeto*, no. 133 (1990): 47–48.

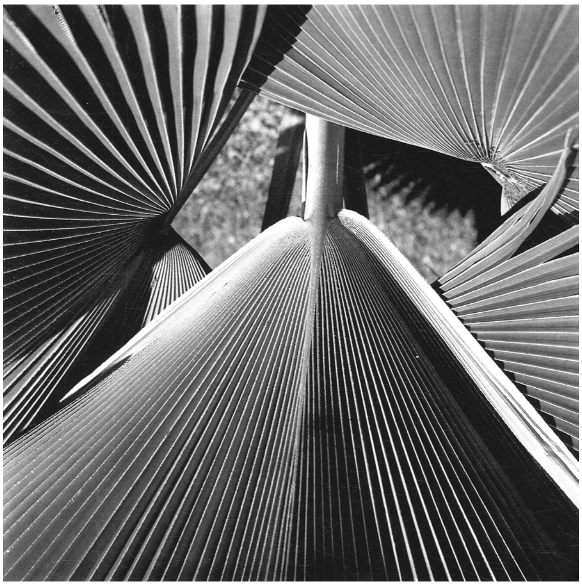

Fig. 1.7 Capim-palmeira leaf. *Marcel Gautherot: Die Monografie* (Zürich: Scheidegger & Spiess, 2016), p. 251

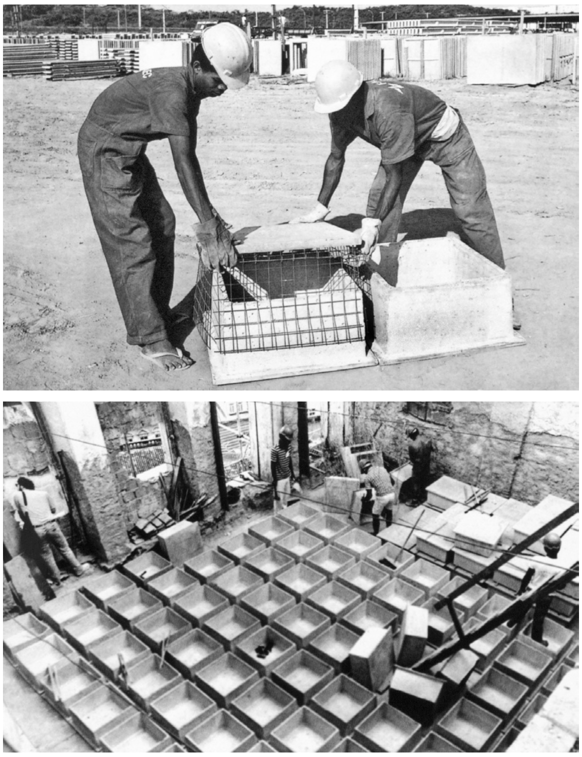

Fig. 1.8 Prefabricated slab molds. G. Latorraca, *João Filgueiras Lima, Lelé* (Lisboa: Blau, 2000), p. 167

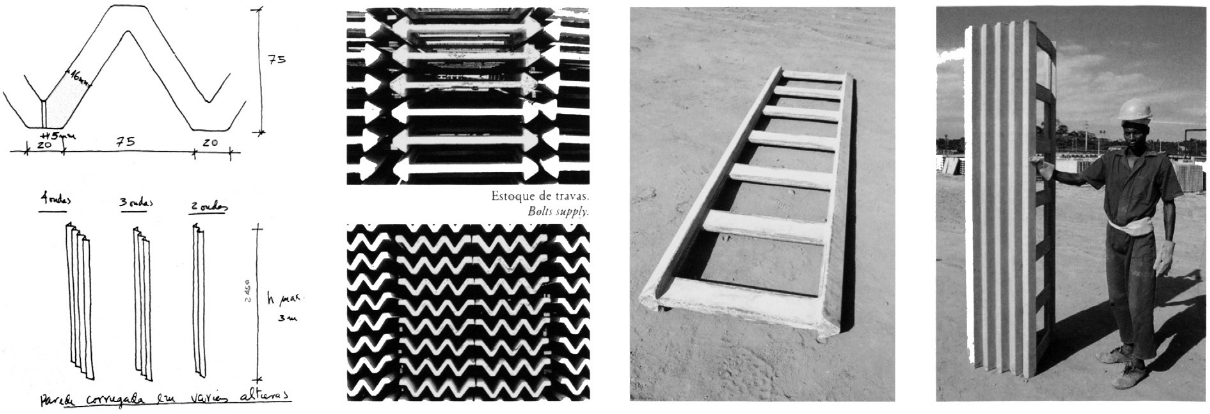

Fig. 1.9 Prefabricated pleated walls (buttress) in argamassa armada, Salvador, 1988. Giancarlo Latorraca, *João Filgueiras Lima, Lelé* (Lisboa: Blau, 2000), p. 168

> The first professional meeting between Lina Bardi and Lelé to discuss the use of reinforced mortar in the recuperation of Salvador's historical center, should have happened in the "*Fábrica de Escolas*", in Rio de Janeiro. When Lina's collaborators went to her house to take her to the airport, she asked for a leaf of "*capim-palmeira*" from her garden in Morumbi (São Paulo). She put it in a shoebox and said: take this to Lelé and tell him I am thinking of a structure like this. He will understand. Tell him I couldn't go to Rio, but that we will meet in Salvador.[13]

In his letter replying to Lina Bo Bardi's suggestion of using the old buildings' external walls as buttresses, Lelé presented his studies of some prefabricated components in *argamassa armada* based on a thoughtful analysis of Nervi's *ferrocemento* molds: "it was very important to examine the material you showed me about Nervi."[14] Amongst other elements for this project, Lelé designed a pleated wall component – in reference to the leaf of *capim-palmeira* (*Curculigo capitulata*) – and a system of ribbed slab. Curiously, the architect inverted the position of the prefabricated molds in *ferrocemento* proposed by Nervi by mounting then upside-down in Salvador. In this way, a precast plate closed the void between the turned up ribs, acting as the ground surface of a hollow-ribbed floor slab. If the result does not provide the same graceful ribbed pattern found at Nervi's projects,[15] it offers, in return, a cost-saving solution that requires less concrete pouring. In addition, the voids inside the slab provide the necessary acoustic isolation while working as a space to embed the sanitary sewage and lighting systems.

The reduced thickness of the pleated wall component in *argamassa armada* (16 mm) and its double-arrow-shaped bracing studs – both prefabricated in different heights with a limit of 3m – allowed the necessary adjustments for stabilizing the existing structures. Cut or bent with relative ease, the pleated components[16] not only favored Lina Bo Bardi's curved creations, but they also contributed to obtaining the desired free spaces inside the restored colonial buildings from the 18th century. This made the plans for a new interior layout possible.

The range of prefabricated elements and systems proposed for the historic center of Salvador should be regarded as a project that captured the quintessence of Lelé's architectural design over the previous two decades. In keeping with Yopanan Rebello and Maria Amélia Leite, the architect "tackles the issue of the increasing cross-section inertia by folding the elements

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13 Giancarlo Latorraca, *João Filgueiras Lima, Lelé*, ed. Marcelo Carvalho Ferraz (Lisboa, São Paulo: Editorial Blau, Instituto Lina Bo e P.M. Bardi, 2000), 166.

14 João Filgueiras Lima. Letter to Lina Bo Bardi in March 20, 1987. The content of the presented material might be related to the basement of the Gatti Wool Factory in Rome (Nervi, 1951). Ibid. See also: Marcelo Carvalho Ferraz, "Ladeira da Misericórdia: Plano Piloto." *Projeto*, no. 133 (1990): 49–55.

15 For further information, see: Alberto Bologna, "Structural Art in Nervi & Bartoli's Industrial Architecture (1949-1971)," in *Space of Production: Projects and Essays on Rationality, Atmosphere, and Expression in the Industrial Building*, ed. Jeannette Kuo (Zürich: Park Books, 2015), 90–97.

16 For a detailed view of Lelé's prefabricated components for the restoration plan of Salvador historic center, see: "This is not a tourist city". In: Zeuler R. M. de A. Lima, *Lina Bo Bardi* (New Haven and London: Yale University Press, 2013), 185-201.

in a fantastic exercise in which Joaquim Cardozo[17] – the memorable structural engineer – denominated 'symbiosis between static and aesthetics'."[18] Comparatively speaking, Lelé's dramatic reduction of Nervi's ferrocement composition – as presented in the table below – can be understood in terms of necessity, rather than a specific drive to exploit the available means in a more economical way. Only through a more fluid argamassa mixture and a minimum amount of steel mesh could Lelé materialize his components and thereby enhance the chance of success for his building systems.

	Cement content Kg/m³	**Wire mesh content Kg/m³**
Nervi's *ferrocemento* (1)	1,000	500
Grupo de São Carlos' *argamassa armada* (2)	700	200 – 250
Lelé's *argamassa armada* (3)	650	150

Table 1. Ferrocement composition changes. Sources: (1) Hanai, João Bento de. *Construções de argamassa armada: fundamentos tecnológicos para projeto e execução*. São Paulo: Pini, 1992, p. 43. (2) Ibidem. (3) Lima, João Filgueiras, and Cynara Menezes. O que é ser arquiteto: memórias profissionais de Lelé, João Filgueiras Lima. Rio de Janeiro: Editora Record, 2004, p. 61.

The first reasonable explanation for the observed discrepancy concerning the usage of cement and wire mesh under Nervi (ratio 1:2) and Lelé (ratio 1:4) is directly related to the structurally demanded parts found at their works.[19] Given the relatively modest spans with which Lelé produced his buildings in *argamassa armada*,[20] one can say that Nervi's constructive strategy consisted of employing more material in his ferrocement components in order to combine them with reinforced concrete, therefore achieving large-span structures. This is the case with works such as the Turin Exhibition Center (1947-54) and the *Palazzetto dello Sport* (1956-57).

A second reason for the use of less material in Lelé's *argamassa armada* has undoubtedly to do with the malleability of the concrete mix. It was only by using a doughy concrete mix that the architect could advance towards a vertical pouring phase. A concrete mix with the same levels of cement and steel mesh, as favoured by Nervi, would make unviable Lelé's plans of using

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17 Joaquim Maria Moreira Cardozo (1897-1978) was a Brazilian structural engineer, poet, professor and writer. He was responsible for the calculations of Oscar Niemeyer's main works, from Pampulha (1940) to the Palaces of Brasília (1958-1970).

18 Yopanan Rebello and Maria Amélia d'Azevedo Leite, "Architekton Lelé: O mestre da arte de construir," *Arquitetura e Urbanismo*, no. 175 (2008), 76. [Ele assume a questão do aumento de inércia da seção pelas dobraduras em um exercício fantástico do que o memorável engenheiro de estruturas Joaquim Cardozo denominava de 'simbiose entre estática e estética'] (my translation).

19 I am indebted to Laurent Stalder for helping me with Nervi and Lelé's structural analysis.

20 On average, Lelé's works in argamassa armada were designed with spans of up to 5 m. However, his auditoriums in Rio de Janeiro (1984) and Camaçari, Bahia (1987), together with the CIAC gymnasiums (1990), all reached spans of over 20 m.

sophisticated metallic formwork to combine quality in long-term reuse and greater freedom at the component's design level. The fluid characteristic of the moisture was fundamental for obtaining a homogeneous distribution of the material within the forms.

But Lelé's own perception of his work as being more fortuitous than deliberate further diffused the mistaken idea that external factors were responsible for the orientation of his architecture towards rationalized construction methods. In his auto-biographical testimony, Lelé provided an account which clearly associates his career with circumstantial elements:

> My professional story is most peculiar. It may seem incredible, but there is nothing at the start of my biography to indicate that one day I would become an architect. In fact, I almost got to become a musician. What happened was that some coincidences over the years helped me to follow certain paths, to improve, by pure chance. Why did I go to Brasília? Why did I become friends with Oscar Niemeyer? These facts are coincidental, not achievements. It happened to me as it could happen to anyone else. If it had not been for these coincidences, I would not have done anything that I did. My professional life is due to a series of eventualities.[21]

The apparently fallible and potentially revisable claim of the architect is rooted in the belief that any technological progress made within his work is attributable to minor accidental factors that shaped his practice. The question arising here is not whether these events[22] may have affected Lelé's professional trajectory, but how the architect took advantage of them to build and validate his constructive knowledge and, therefore, shape his way of thinking and producing architecture as a technical object. It is well known that Lelé's first endeavor towards rationalization of construction methods took place at the building sites of Brasília, where he arrived in September 1957 at the age of 25. Part of the staff board of the Institute for Retirement and Pension of Bank Employees [*Instituto de Aposentadoria e Pensões dos Bancários*, IAPB], Lelé oversaw the construction of the first Superquadras in the new capital. Upon being asked by the journalist Ledy Valporto Leal, whether he started practicing his architecture in Brasília Lelé answered: "I went there to build, not to design."[23]

This clear and unusual defined role delegated to a young architect in those conditions of overwhelming construction demands seemed to have echoed the matter of works execution

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21 Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes*, 11. [A minha é uma história professional das mais peculiares. Pode parecer incrível, mas não há nada no início da minha biografia indicando que um dia eu ia me tornar arquiteto. Na verdade, quase cheguei a me tornar músico. O que houve foram coincidências ao longo dos anos que me ajudaram a seguir certos caminhos, a melhorar, por pura casualidade. Por que fui para Brasília? Por que fiquei amigo de Oscar Niemeyer? São coincidências, não são conquistas. Aconteceu comigo como poderia acontecer com qualquer outra pessoa. Se não fossem essas coincidências, não teria feito nada do que fiz. Minha vida professional se deve a uma sucessão de acasos] (my translation).

22 The car accident Lelé had with his wife in 1963 is also taken by the architect as an example of eventuality that modified the path of his life. On that occasion, the accident put the architect in contact for the first time with the team that created the Sarah hospital in Brasília in 1976.

23 João Filgueiras Lima, "Nunca Pensei Em Ser Arquiteto [Entrevista a Ledy Valporto Leal]," *Finestra* 8, no. 33 (2003).

Fig. 1.10 Superquadra 108 South (SQS 108) under construction. Brasília, 1959. Photograph by Mario Fontenelle, Arquivo Público do Distrito Federal, Brasília

beyond the building site. In 1959, the relationship between architects and engineers was at the core of the debates at the Extraordinary International Congress of Art Critics,[24] held inside the Supreme Court Palace in Brasília. Meanwhile, not far from there, João Filgueiras Lima accomplished an ensemble of prefabricated temporary buildings under poor working conditions to support the works in progress of the Superquadras 108 and 109 in the new capital. The two main reasons that explain Lelé's early contact with building rationalization are often associated with the tremendous amount of work undertaken during Brasília's first years and their very tight deadlines. Keeping in mind the urgency that dictated the rhythm of the works in the new city – the symbol and motor of Brazilian modernization prompted by President Juscelino Kubitschek national industrialization plan[25] – it is totally comprehensible that new methods of construction should have been adopted.

24 The Extraordinary AICA International Congress of Art Criticism was held in Brasília, São Paulo and Rio de Janeiro from 17 to 25 September, 1959. Organized by the art critic Mario Pedrosa to celebrate the forthcoming inauguration of the new capital (21 April 1960), the event was carried out with the participation of names such as Giulio Carlo Argan, Bruno Zevi, Richard Neutra, Oscar Niemeyer, Charlotte Perriand, Jean Prouvé, Eero Saarinen, Israel Pinheiro, Tomás Maldonado, Stamo Papadaki, André Bloc, and Alberto Sartoris, among others. In its third session, held on 19 September, the subject was "technique and expressiveness", and Jean Prouvé delivered an expressive talk about building industrialization. For futher information, see: Maria da Silveira Lobo, Congresso Internacional Extraordinário de Críticos de Arte. Cidade nova: síntese das artes, ed. Maria da Silveira Lobo and Roberto Segre (Rio de Janeiro: UFRJ/FAU, 2009).

25 The mandate of President Juscelino Kubitschek (1956-1961) was underpinned by a great industrial appeal, with emphasis on automobile industry. With the motto campaign "fifty years of progress in five" the president led the country to an economic boom in the first years, but later inflation and huge debts due to Brasília's construction were felt by the population in subsequent decades.

Fig. 1.11 Wooden pavilion at the building site of the Superquadra 108 Sul. Brasília, 1959. Photograph by Mario Fontenelle, Arquivo Público do Distrito Federal, Brasília

Nevertheless, besides Lelé's early concerns related to the indiscriminate use of wood in construction[26] and considering the urgent needs, there are reasonable grounds to believe that the architect drew on a logistic condition to promote his first rationalized experiments at Brasília's building sites. According to the architect:

> During the construction of Brasília, I had to develop some timber systems for building the workers' camps. As there were no material suppliers, everything came from outside, sometimes by plane, and thus I designed some parts that arrived ready to use. Industrialization on site was needed more as a matter of logistics than economy. The nearest building supply shop was located a 5-day trip away from Brasília. And each of those building sites was a town with 2,500 workers, who needed to eat, sleep ...[27]

26 João Filgueiras Lima. "During the construction of the superquadra there was no industrialization experience to draw from. Huge amounts of wood were wasted on the concrete casting. Ten years later the pine from the state of Paraná was endangered as a result of the indiscriminate use of wood in concrete forms, which led to intense deforestation." In: Hugo Segawa and Ana Gabriella Lima Guimarães, "Lelé: The creator, the builder, and the context," *Le visiteur: revue critique d'architecture*, no. 14 (2009), 196.

27 João Filgueiras Lima, "Mestre da Surpresa [Entrevista a Marcos de Sousa]." *Arquitetura e Urbanismo* 15, no. 82 (1999), 27. [Durante a obra de Brasília tive que desenvolver alguns sistemas com madeira para a construção dos canteiros de obras. Como não havia fornecedores de materiais, tudo vinha de fora, às vezes de avião, e assim projetei algumas peças que já chegavam prontas. A industrialização na obra era necessária mais por uma questão de logística do que de economia. A loja de materiais mais próxima ficava a 5 dias de viagem. E cada canteiro daqueles era uma cidade, com 2.500 operários, que precisavam comer, dormir …] (my translation).

Lelé understood from the very beginning the importance of working collectively. This was already true when the architect designed a series of provisional buildings in prefabricated wooden components for the Superquadras in Brasília. Built with certain technical refinements, these small pavilions unquestionably provided a solution which, on the one hand resolved construction problems like the alignment of wooden slats and joints, and on the other revealed an evident structural change towards rationalization in Lelé's approach. The wooden pavilions – which counted on the expertise of two German carpenters[28] also employed by the IAPB – were erected to tackle the housing issue for workers, engineers and their families, as well as provide essential services during the Superquadras' construction. The dormitory, refectory, kitchen, laundry, and storeroom were imperative facilities at that time.

> I was in charge of designing and building that small town in a short period and, at the same time, start the construction of the buildings. This forced me to get immersed in intensive study selecting the technical information necessary to the exercise of my duties. I sought to harness the few hours that were left to study structural calculation, electrical and hydraulic installations, foundations, etc. The eventual technical assistance that could come from the offices in Rio only occurred precariously through a radio receiver once a week and for about half an hour (reserved by Novacap to IAPB). To save time in construction, I developed with the support of two excellent German workers – Werner Grumpich and Walter Reinicke – prefabrication technologies in wood. We set up a large carpentry workshop which later also performed all services involving wood for the eleven buildings.[29]

When Lelé made his first incursions into the field of prefabricated constructions, the formal imagery dominating the architectural scene at that time was encapsulated in emblematic buildings in Brasília such as the Catetinho (Oscar Niemeyer, 1956) and the Júlia Kubitschek primary school at Candangolândia (Oscar Niemeyer, 1957). One can see few parallels between these and Lelé's wooden pavilions. Despite the modern linearity and volumetry that characterize all of them, a wealth of detail is visible on the façade of Lelé's provisional accommodation. This is reached through the serialization of components (which is not the case for Niemeyer's buildings) and the clearest aspect of constructive modulation. The interaction of skills that was evident in the Superquadras' building sites was definitely essential to awake in Lelé the notion

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28 For further information see interview with Lelé in Adalberto Vilela, *A Casa na obra de João Filgueiras Lima, Lelé* (Brasília: Editora Universidade de Brasília, 2017), 277-278.

29 João Filgueiras Lima, "Crônicas de Brasília, 1957/1961." *Arquitetura e Urbanismo*, no. 192 (2010): 69. [Minha função de projetar e executar aquela pequena cidade em um curto período e, ao mesmo tempo, iniciar a construção dos edifícios, obrigou-me a um estudo intensivo selecionando as informações técnicas indispensáveis ao exercício de minhas funções. Aproveitava as poucas horas que sobravam para estudar cálculo estrutural, instalações elétricas, hidráulicas, fundações etc. A eventual ajuda técnica que poderia vir dos escritórios do Rio só ocorria precariamente pelo rádio, uma vez por semana e durante cerca de meia hora (reservada pela Novacap ao IAPB). Para ganhar tempo na construção, desenvolvi com o apoio de dois excelentes operários alemães (Werner Grumpich e Walter Reinicke) tecnologias de pré-fabricação em madeira. Montamos uma grande oficina de marcenaria que mais tarde executou também todos os serviços em madeira dos onze prédios] (my translation).

Fig. 1.12 Júlia Kubitschek primary school. Brasília, 1957. Photograph by Mario Fontenelle, Arquivo Público do Distrito Federal, Brasília

Fig. 1.13 Catetinho, the first residence of President JK in the new capital. Brasília, 1956. Photograph by Mario Fontenelle, Arquivo Público do Distrito Federal, Brasília

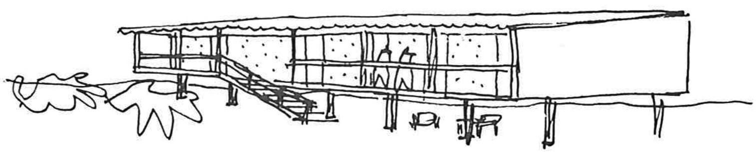

Fig. 1.14 Catetinho sketch. Oscar Niemeyer, 1956. Ettore Mocchetti, *Oscar Niemeyer* (Milano: Mondadori, 1975), p. 142

of work as a collaborative undertaking. The immediate result of this perception is a better understanding of how building knowledge could eventually merge with his practice. In the long term, this way of working would be converted into a real and industrial division of labor experience.

2. The University years (1961 – 1965)

The construction of the University of Brasília[30] represented one of the most significant milestones for prefabrication in Brazil. The emergence of Brasília as the new capital, allied to a sense of renewal and an urge for innovation on the part of those involved in its construction, made the UnB campus a place where rationalized production techniques were employed on an unprecedented scale in the country.

> The desire for creating a new possibility for the Brazilian architectural panorama was so emphatic that all the UnB construction process was documented. This material became a didactic documentary named *Universidade de Brasília: Primeira experiência em pré-moldado, 1962-70* [University of Brasília: First experience in precasting, 1962-70] carried out by Heinz Forthmann, alongside João Filgueiras Lima as technical advisor.[31]

Lelé's immersion in the field of prefabrication during the construction of the university was only possible because Oscar Niemeyer enabled there what David Underwood called "a centralized plan that made use of prefabricated elements."[32] The following statement by Niemeyer makes clear that this decision was taken bearing in mind questions like agility and costs:

> It was at the University that we came to work in the field of prefabrication, therefore eliminating small building elements which could lead to a high labor cost. This system was implemented at the construction of Ceplan offices, the Faculty of Sciences, the student residences, the Faculty of Theology and, later, the Ministry of Defence, erected with 17m height columns and 25m long slabs of 15x5m each.[33]

30 The University of Brasília (UnB) was created in 1961 by the federal law no. 3.998 (15 December, 1961) with direct influence of the Brazilian anthropologist Darcy Ribeiro.

31 Klaus Chaves Alberto, "Formalizando o ensino superior na década de 1960: A Cidade Universitária da UnB e seu projeto urbanístico." Universidade Federal do Rio de Janeiro, 2008, 243. [O desejo de se criar uma nova possibilidade para o panorama da arquiteura no país era tão enfático que todo o processo de construção da UnB foi documentado. Esse material tornou-se um documentário didático chamado Universidade de Brasília: Primiera experiência em pré-moldado (1962-70), realizado por Heinz Forthmann, tendo como assessor técnico João Filgueiras Lima] (my translation).

32 David Underwood, *Oscar Niemeyer and the Architecture of Brazil* (New York: Rizzoli, 1994), 157.

33 Oscar Niemeyer, *Niemeyer* (Paris: Alphabet, 1977), 229. [C'est pour l'Université de Brasília que nous avons entrepris de travailler dans le domaine de la pré-fabrication, éliminant des éléments de petite taille et une main-d'oeuvre trop coûteuse. Ce système fut repris pour le Ceplan, la Faculté des Sciences, les maisons afférentes, la Faculté de Théologie et, plus tard, le Ministère de la Défense pourvu des colonnes de 17m, de poutres de 25m et de dalles de 15x5m] (my translation).

With Max Bill and other European architects' criticism still fresh in his mind, Niemeyer set sail for a trip to Venezuela and Europe in 1954. The trip had an enormous impact on his production, starting with the Caracas Art Museum (1954-55), an unbuilt project singled out as a turning point in the architect's career.[34] From 1955 onwards, one notices in Niemeyer a professional attitude and thinking aimed at building simplification, valuing the pure and geometric forms. These are the precepts that would orient the conception of the palaces in Brasília, designed from 1956 onwards, and the first works at the university, such as the *Praça Maior* (unexecuted), the Institute of Theology, the Central Institute of Sciences building (*Instituto Central de Ciências, ICC)* and the Ceplan offices. All these buildings were designed by Niemeyer between 1962 and 1963 and constructed by Rabello, a building company that had a fundamental role in the construction of Brasília, mainly because of its expertise in prefabrication.

Lelé relates that "Oscar [Niemeyer] always wished to act in the area of prefabricated casts. He has invited me many times. At the time of the University he said: Now we'll make pre-fabricated stuff."[35] However, Niemeyer's interest in prefabrication did not arise from the works at UnB. In fact, his adherence to the new technology may be understood as a step ahead towards the architect's research based on frame structure systems with fixed ends.[36] Niemeyer's study on porticos for previous projects already pointed to a clear change within the architect's career, where structure assumed special emphasis.

Fig. 1.15 The Central Institute of Sciences building. University of Brasília, aerial view, 1972. Arquivo Público do Distrito Federal, Brasília

At the turn of the second half of the century, Niemeyer's new approach toward frame structure systems in architecture was already visible in projects such as the Twin Theaters for the Ministry of Education in Rio de Janeiro (1948), the Duchen Factory in Guarulhos (1950), the Aerospace Technical Center in São José dos Campos (1950) and the Annex to Yacht Club in Belo Horizonte (1962).[37] When

34 According to Niemeyer's testimony published in Módulo in 1985: "The works in progress in Brasília, together with my project for the Caracas Museum, mark a new stage in my professional work, a stage characterized by a constant search for consciousness and purity, and greater attention to the fundamental problems of architecture. This stage, which constitute a change in my method of design and principally in my way of developing a project, did not arise without reflection. It did not emerge as a new formula answering to new problems; rather, it sprang from a cool and frank review of my work as an architect." In: Underwood, *Oscar Niemeyer and the Architecture of Brazil*, 92-93.

35 João Filgueiras Lima. In: Latorraca, João Filguieras Lima, Lelé, 17.

36 To know more about the classification of section-active structure systems, see: Heino Engel, *Tragsysteme. Structure Systems* (Ostfildern: Hatje Cantz, 2013), 50-51.

37 For a wider panorama of constructive architecture in Brazil, see:

Ana Paula Koury, "Arquitetura construtiva: proposições para a produção material da arquitetura contemporânea

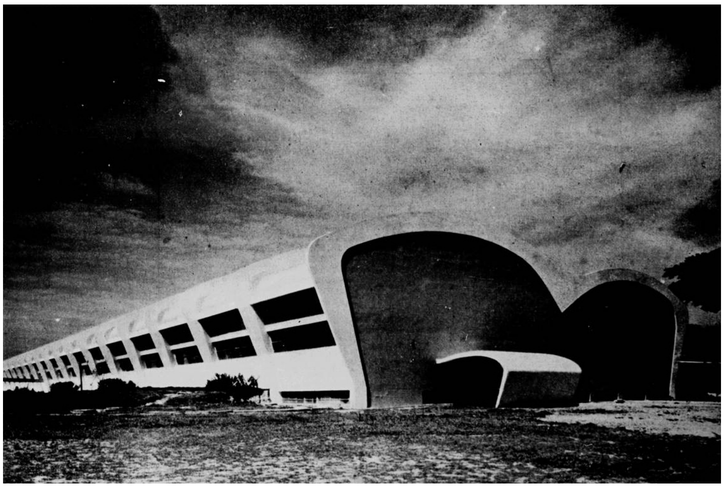

Fig. 1.16 The Duchen Factory. Oscar Niemeyer, Guarulhos, São Paulo, 1948. Módulo, no. 26 (1961): 49

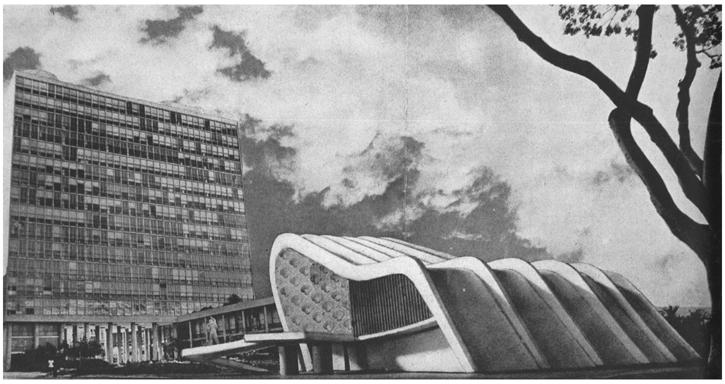

Fig. 1.17 Twin Theaters for the Ministry of Education in Rio de Janeiro. Oscar Niemeyer, 1948. Stamo Papadaki, *The work of Oscar Niemeyer* (New York: Reinhold, 1950), p. 190

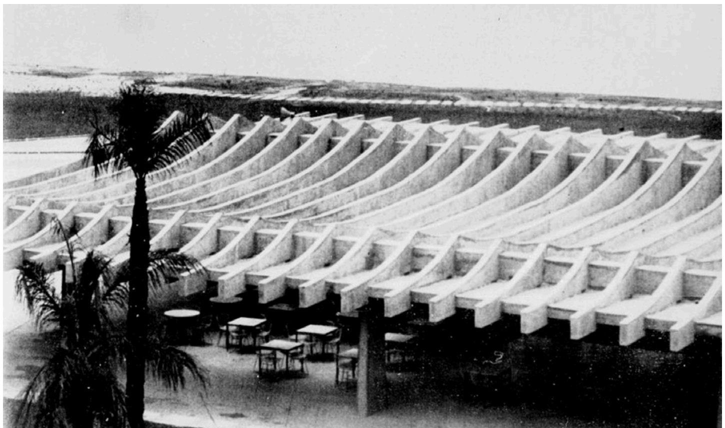

Fig. 1.18 Pampulha Yacht Club Annex. Oscar Niemeyer, Belo Horizonte, Brazil, 1962. Módulo, no. 27 (1962): 9

talking about his new more disciplined mode of working, Oscar Niemeyer stated:

> I have become interested in compact solutions, simple and geometric, in problems of hierarchy and architectonic character, in the harmony and unity between buildings, and in expressing these qualities not through secondary elements, but rather through the structure itself, appropriately integrated within the original plastic conception.[38]

These are precisely the characteristics that describe an important building in our narrative: The University Planning Center [*Centro de Planejamento da Universidade*, CEPLAN]. Portrayed in the aforementioned documentary at each stage of its construction – which took only 45 days – the small and elegant pavilion was the first attempt of a team of professionals to realize a prefabricated building in reinforced concrete at the university. Tomás Maldonado[39], former dean of the Ulm School of Design, once said that "Brasília is a tremendous opportunity for modern city planning. It is a great opportunity and at the same time a great responsibility. The failure of Brasília would be one of the biggest traumas of culture of our times."[40] Indeed, it is no exaggeration to affirm that

no Brasil" (Universidade de São Paulo, 2005). For Niemeyer's structuralist approach in architecture, see: Ruth Verde Zein, "A arquitetura da escola paulista brutalista 1953-1973" (Universidade Federal do Rio Grande do Sul, 2005), 82-85.

38 Underwood, Oscar Niemeyer and the Architecture of Brazil, 95.

39 Tomás Maldonado (born 1922) is an Argentine painter, industrial designer, teacher and theoretician of the so-called Scientific Design Movement. Between 1954 and 1967 he was head of the Ulm School of Design (*Hochschule für Gestaltung, HfG Ulm*) in Germany.

40 "Opiniões dos críticos de arte" in: Brasília, ano 3, setembro de 1959, p.7. Apud Ana Luiza Nobre, "Fios cortantes: projeto e produto, arquitetura e design no Rio de Janeiro (1950-70)" (Pontifícia Universidade Católica do Rio de Janeiro, 2008), 208. [Brasília é uma tremenda oportunidade para o moderno planejamento de cidades. É uma grande possibilidade e ao mesmo tempo uma grande responsabilidade. O fracasso de Brasília seria um dos maiores traumas da cultura de nossos tempos] (my translation).

Fig. 1.19 Lelé and part of the CEPLAN team. From left to right: Virgílio Ernesto Souza Gomes, Luiz Henrique Gomes Pessina, Lelé, Carlos Bittencourt and Oscar Borges Kneipp. Brasília, 1964. Arquivo João Filgueiras Lima, Salvador.

the failure of CEPLAN would have represented a complete loss of faith in prefabrication as the symbol of a new technique which catalyzed all efforts to erect the University of Brasília.

The CEPLAN building offered Lelé the opportunity to experience for the first time the issues and procedures of prefabrication *in loco* – as he was in charge of the executive project and the building's construction – and its importance was proven by the fact that it remained a reference for his future works.[41] The same simplicity and elegance with which Niemeyer designed the CEPLAN offices were harnessed by Lelé during the construction of two buildings in the nearby area: the General Services Building[42] [*Galpão de Serviços Gerais*], also

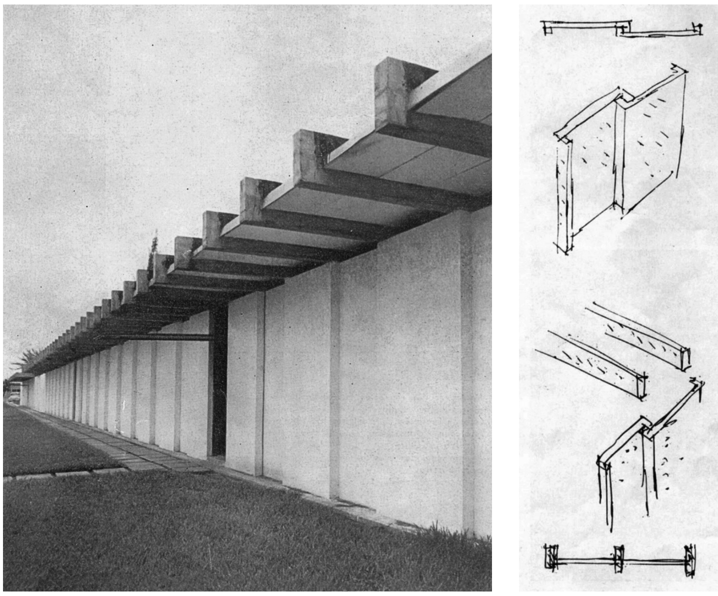

Fig. 1.20 The CEPLAN building. Oscar Niemeyer, Brasília, 1962. Acrópole, especial UnB, ano 31, n. 369/70, jan/fev 1970, p. 32

41 The CEPLAN building may be seen as a pre-eminent reference for Lelé during the development of his argamassa armada schools in the 1980s.

42 As reported by the architect and retired professor (UnB) Luiz Henrique Pessina, one of the three pavilions built at the University according to Lelé's project (SG-9, SG-11 and SG-12) was not executed using prefabrication. The SG-9 building

Fig. 1.21 Friar Mateus' residence and chapel at the University of Brasília (UnB). João Filgueiras Lima, Brasília, 1962. Arquivo Central da Universidade de Brasília

known as the SG building, and the provisory wooden residence designed for friar Mateus Rocha[43] in September 1962. However, unlike Niemeyer's concrete pavilion built with only two precast components – a U-shaped panel for the walls and a prestressed concrete beam for the roof – Lelé opted for the mixed technique of wooden and brick masonry construction. Incidentally, the architect's decision to combine such distinct materials was echoed at Sérgio Rodrigues' OCA building (1962).[44]

Beyond the immediate objectives set for CEPLAN – to prepare the plans for all the

erected by ENAR in the late 1960s was constructed using the traditional technology of concrete and brick masonry. The reason for this shift, he said, was that the building company had offered a lower price during the public bidding. Luiz Henrique Pessina. Interview with Adalberto Vilela on February 12, 2015 in Brasília.

43 Dominican friar, Mateus da Rocha (1923-1985) was dean of the University of Brasília between 1962 and 1963 and a close friend of Lelé. The small buiding designed by Lelé to serve as chapel and residence for friar Mateus within the UnB campus preceded the university's decision of constructing the Institute of Theology in the same area. "Initially, there was only the proposed project for a provisional construction characterized by a small chapel and a wooden residence for him [Friar Mateus]. I did this project and Oscar designed the big one for the Institute of Theology, which was partially accomplished. [A princípio existia somente a proposta de um projeto provisório que constava de uma capelinha e uma residência de madeira para ele. Eu fiz esse projeto e Oscar concebeu o grande projeto para o Instituto de Teologia, que se realizou parcialmente] (my translation). In: Ana Gabriella Lima Guimarães, "João Filgueiras Lima: o último dos modernistas" (Universidade de São Paulo, 2003), 34.

44 Conceived by the architect and designer Sérgio Rodrigues, the OCA 1 and OCA 2 buildings were the first edifices to be built within the university (1962). They hosted the first branch courses, namely: Law, Economics and Administration / Architetcure and Urban Planning / Brazilian Letters. Built using an industrialized wooden system called SR2, the only remaining pavilion (OCA 2) will soon accommodate the University Museum for Modern Furniture. For further information see: Oscar Luís Ferreira and Marco Aurélio da Silva Máximo. "O Pavilhão OCA 2 da Universidade de Brasília: a adaptação do patrimônio moderno às exigências de acessibilidade universal," In *Congresso Latinoamericano REHABEND* (Santander, España, 2014).

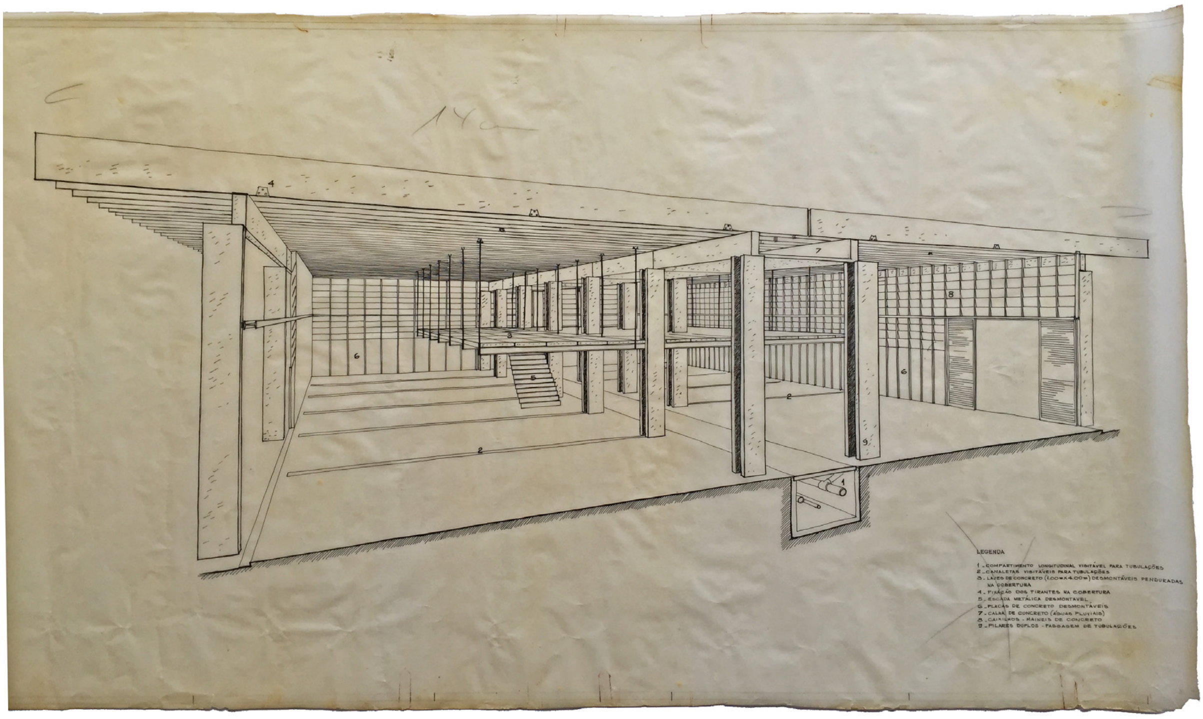

Fig. 1.22 Section of the General Services building (SG building) at the University of Brasília. João Filgueiras Lima, Brasília, 1962. Arquivo João Filgueiras Lima, Salvador

buildings comprising the university and to orient and conduct the courses at the Faculty of Architecture – "it was [also] conceived to become a major design center of international renown, capable of responding to other Latin American countries' demands."[45] The long-term and ambitious plan was part of Darcy Ribeiro's initiatives to speed up the process of creating a university, which represented the renewal of higher education in Brazil, as well as the promotion of scientific development.[46] It was in this context that Darcy Ribeiro[47] decided to send a scientific mission to Eastern Europe in 1963. Among the technicians and scientists that were in charge of evaluating potential technological purchases, Lelé and another architect from the CEPLAN team (Sabino Barroso) were appointed to visit and assess the facilities where industrialized construction offered more widespread employment. Their greatest motivation was to work towards the goal of creating a great factory at UnB upon their return.

Over more than two months travelling through Russia, East Germany, Poland, France and Czechoslovakia, the architects came across one of the most popular and commercially

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45 Koury, "Arquitetura construtiva: proposições para a produção material da arquitetura contemporânea no Brasil," 33. [O Ceplan foi pensado para se tornar um grande centro de projetos com reconhecimento internacional, capaz de atender demandas de outros países da América Latina] (my translation).

46 During the initial planning of the University of Brasília (1960-1962) the question was raised of creating an institution on the basis of the Jesuit Order. For more information about this episode, see: Alberto, "Formalizando o ensino superior na década de 1960: A Cidade Universitária da UnB e seu projeto urbanístico," 251-252.

47 Darcy Ribeiro (1922-1997) was a Brazilian anthropologist, writer and politician. He was Minister of Education for Brazil during the period 1962-63. After leaving the country due to the military state coup in 1964, his studies on Latin America and his propositions for renewing the higher education system had a great impact on university reforms in many other Latin American countries. For further reading, refer to: Javier Ocampo López, "Darcy Ribeiro: sus ideas educativas sobre la universidad y el proceso civilizatorio de América Latina" (Universidad Pedagógica y Tecnológica de Colombia Sociedad de Historia de la Educación Latinoamericana, 2006).

successful prefabricated systems in operation at that time: the Camus processes. Having acquired enough technical information *in situ* about the procedures developed by the engineer Raymond Camus – "symbol of the architectural mediocrity and failure of the big housing complexes built during the 1950s and 1960s"[48] – Lelé gave the impression that such visits were not true eye-opening experiences: "At that time, a very developed system of loading walls in France – the Camus system – was extensively used. But what interested me, say, was not the process per se, but to discover how prefabrication was utilized, the scope of its potential, and how it might be employed."[49]

Industrialized architecture from Eastern Europe would not attract Lelé's attention as expected, although the architect had expressed his esteem for the prefabricated works he found in Czechoslovakia: "Among all of those countries, who dominated the industrial technology of construction, the best was indeed the Czechs, because of the quality. In terms of quantity, it was undoubtedly the Soviet Union. Poland also dealt with prefabricated construction, but slightly worse than the Czechs."[50] Further on we will see that Lelé's apparent lack of interest in the French system remained more at the discourse level than in practice.

In any case, it is more than likely that the architect had learnt about the large-scale panel technology *Panelák* when he was in Czechoslovakia in 1963. His impressions concerning the Czech production of high-quality panelized architecture are confirmed by Kimberly Zarecor when treating the question of structural panel technology discrepancies within the Soviet Bloc:

> The well-developed building industry in Czechoslovakia, which operated on a much smaller scale than in the Soviet Union, proved more capable of responding to the technical challenges and production needs of the new technology. In the late 1950s, architects from the Soviet Union and other Eastern Bloc countries looked to Czechoslovakia for guidance in this area, sending delegations to tour research facilities, panel factories, and *panelák* construction sites.[51]

Despite this promising contact, Lelé's involvement with prefabricated panel construction never assumed a role of great importance in his career. Since his early projects at the university,

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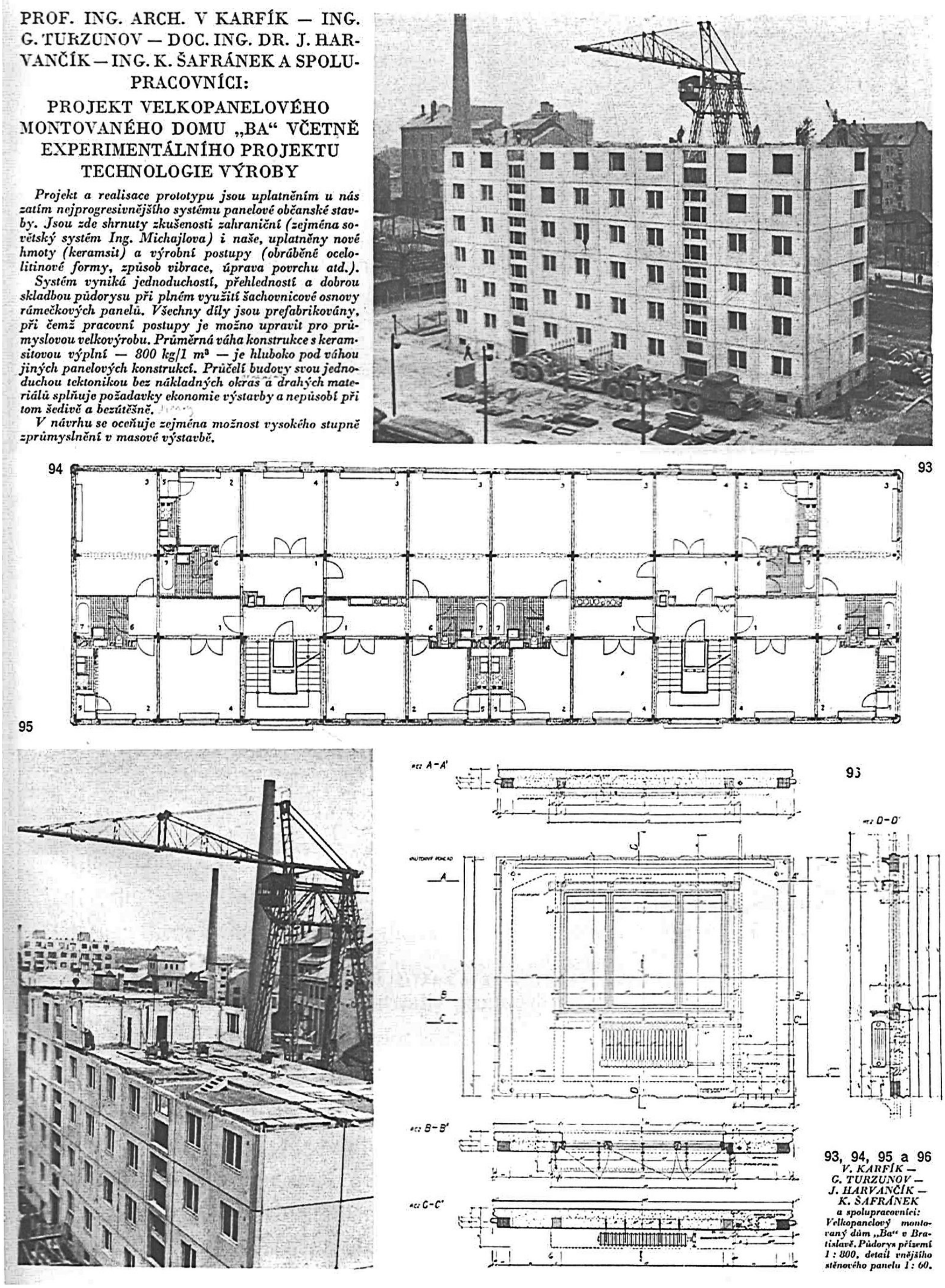
48 Yvan Delemontey, *Reconstruire la France: l'aventure du béton assemblé, 1940-1955* (Paris: Éditions de la Villette, 2015), 254. [symbole de la médiocrité architecturale et de la faillite des grands ensembles de logements construits durant les années 1950 et 1960] (my translation).

49 Otavio Leonídio, "Eu vivo numa ilha. Entrevista Com João Filgueiras Lima, Lelé," *Vitruvius* 15, no. 058.01 (2014), accessed September 15, 2016. http://www.vitruvius.com.br/revistas/read/entrevista/15.058/5170. [Na época, se usava muito um sistema muito desenvolvido na França, o processo Camus, de paredes portantes. Mas o que me interessava não era, digamos, o processo propriamente dito; era saber como a pré-fabricação era utilizada, quais suas possibilidades, como poderia ser empregada] (my translation).

50 "De Praga a Abadiânia" [From Prague to Abadiânia]. In: Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes*, 53. [Desses países todos, quem melhor dominava essa tecnologia industrial de construção eram mesmo os tchecos, por causa da qualidade. Em termos de quantidade, sem dúvida era a União Soviética. A Polônia também fazia construção industrializada, mas um pouco pior que os tchecos] (my translation).

51 Kimberly Elman Zarecor, *Manufacturing a Socialist Modernity: Housing in Czechoslovakia, 1945-1960* (Pittsburgh: University of Pittsburgh Press, 2011), 226.



PROF. ING. ARCH. V KARFÍK — ING. G. TURZUNOV — DOC. ING. DR. J. HARVANČÍK — ING. K. ŠAFRÁNEK A SPOLUPRACOVNÍCI:

PROJEKT VELKOPANELOVÉHO MONTOVANÉHO DOMU „BA“ VČETNĚ EXPERIMENTÁLNÍHO PROJEKTU TECHNOLOGIE VÝROBY

Projekt a realisace prototypu jsou uplatněním u nás zatím nejprogresivnějšího systému panelové občanské stavby. Jsou zde shrnuty zkušenosti zahraniční (zejména sovětský systém Ing. Michajlova) i naše, uplatněny nové hmoty (keramsit) a výrobní postupy (obráběné ocelolitinové formy, způsob vibrace, úprava povrchu atd.).

Systém vyniká jednoduchostí, přehledností a dobrou skladbou půdorysu při plném využití šachovnicové osnovy rámečkových panelů. Všechny díly jsou prefabrikovány, při čemž pracovní postupy je možno upravit pro průmyslovou velkovýrobu. Průměrná váha konstrukce s keramsitovou výplní — 800 kg/1 m³ — je hluboko pod váhou jiných panelových konstrukcí. Průčelí budovy svou jednoduchou tektonikou bez nákladných okras a drahých materiálů splňuje požadavky ekonomie výstavby a nepůsobí při tom šedivě a bezútěšně.

V návrhu se oceňuje zejména možnost vysokého stupně zprůmyslnění v masové výstavbě.

93, 94, 95 a 96
V. KARFÍK — G. TURZUNOV — J. HARVANČÍK — K. ŠAFRÁNEK a spolupracovníci: Velkopanelový montovaný dům „Ba“ v Bratislavě. Půdorys přízemí 1 : 800, detail vnějšího stěnového panelu 1 : 60.

Fig. 1.23 BA System prototype (identical to early *paneláks*). V. Karfíg, J. Harvančik, K. Šafránek, and team. Bratislava, 1955. Kimberly Elman Zarecor, Manufacturing a Socialist Modernity (Pittsburgh: University of Pittsburgh Press, 2011), p. 275

the concept of panel had always been associated to an element designed to work as internal partition or at least as a façade component, destitute in all cases of any structural demand. When asked about the prefabrication techniques he learned during the trip to Europe and Eastern Europe, the architect was emphatic:

> This experience was very important, though it did not play a decisive role in my education. I brought this knowledge with me to try and establish a factory at the university, in a Brazilian style that had nothing to do with the European. We appropriated technical aspects, but created spaces in accordance with our climate and our social reality. We did not incorporate techniques, so much so that my projects rendered in concrete presented results that were different from the European versions. In fact, the trip served for me to check their solutions for technical problems and construction, which were not exactly aspects of architecture.[52]

Back in Brazil during the administration of President João Goulart (December 1962 – March 1964), Lelé continued to work and teach at the university. By that point, the architect already enjoyed the reputation for being a good builder, so much that Niemeyer asked him to occupy the following positions: executive chief of the CEPLAN Offices, coordinator of the postgraduate course in architecture and professor of the course of technique and construction technology. "I started as associate professor, although quite young – I was 30 years old. I recognize that I had a position far beyond my capacity,"[53] Lelé recalled many years later.

It is interesting to note how the professional relationship between Lelé and Niemeyer became established at this point in the erection of the University of Brasília. The successful construction of the Superquadra 108 some years before – conceived by Niemeyer and constructed under Lelé's direction – might have influenced the decision to invite the young architect to join his team at UnB.[54] The fact is that Lelé's attibutions were all related to the executive part of architecture, as if an expert condition was already assigned to him. In fact, considering that prefabrication was taking great strides to consolidate a culture of building industrialization at the university, one can say that both Lelé and Niemeyer were learning by making.

However, unlike his prominent friend, Lelé devoted himself more especially to technical subjects and to solving construction problems often neglected by Niemeyer. When commenting on his duties at the university, Lelé recalled that the famous architect stated the following:

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52 Segawa and Guimarães, "Lelé: the creator, the builder, and the contex," 197.

53 Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes*, 51. [Comecei já como professor associado, embora muito jovem – tinha 30 anos. Reconheço que tinha uma função muito além da minha capacidade] (my translation).

54 The CEPLAN team was composed of a group of architects working in two sections divided as follows: [Urban section] Lucio Costa, Jayme Zettel and Italo Campofiorito. [Architecture section] Oscar Niemeyer, João da Gama Filgueiras Lima, Sabino Barroso, Glauco Campello, Virgilio Sosa Gomes, Evandro Pinto Silva, Carlos Bittencourt, Hilton Gerson Costa, Abel Accioly, Darcy S. Pinheiro and Oscar B. Kneipp. In: Luiz Henrique Gomes Pessina, "Aspectos gerais da pré-fabricação: estudo de cronograma de obra com pré-fabricados" (Universidade de Brasília, 1964), 30.

"when one speaks about technique, one should refer to Lelé."[55] Thus, the growing collaboration between the two architects led Lelé to adopt an integral role in the assembly design of all Niemeyer's prefabricated projects.

As a graduate school professor, Lelé supervised two master theses[56] whose subjects were precisely related to prefabrication. A reading of Pessina's dissertation reveals that Lelé was not only aware of the development of prefabrication in both Brazil[57] and abroad,[58] but it also shows that the architect – in his capacity as supervisor – acted as protagonist at a moment when prefabrication started to gain more defined contours in Brazil with the endorsement of a growing number of architects. The interest Lelé maintained in applied research in the field of building precasting would also foster the adoption of this technology in agreements and contracts between CEPLAN and public entities.

Two projects emerged from this model of cooperation: the apartment building for the French Embassy in Brasília (Glauco Campelo, 1963) and the São Miguel Unity of Neighborhood [*Unidade de Vizinhança São Miguel*] (Mayumi and Sérgio Souza Lima, 1963). Both residential projects were designed at a point when Brazilian architects were discussing the industrialization of construction and technological development as a combined alternative to tackle the great housing problem[59] faced by the county. The issue has its origins in the complexity of defining effective urban planning actions for the big Brazilian cities during the country's modernization process. In July 1963, the Urban Reform and Housing Seminar [*Seminário de Habitação e Reforma Urbana*, SHRU][60] took place in Rio de Janeiro and São Paulo with major political, economic and social implications. It seems that the subject reverberated across the Capital,

55 Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes*, 51. [Negócio de técnica é com o Lelé] (my translation).

56 For further information, see: Pessina, "Aspectos gerais da pré-fabricação: estudo de cronograma de obra com pré-fabricados"; Mayumi Watanabe Souza Lima, "Aspectos da habitação urbana: projeto de habitação coletiva para a unidade de vizinhança São Miguel" (Universidade de Brasília, 1965).

57 "In Brazil, the first impactful experiments of prefabrication that we know of are currently under development. The construction of several buildings for the Petrobras oil refinery in Porto Alegre, six of the twelve student lodgment blocs of the University of São Paulo and the buildings of the University of Brasília." [No Brasil, as primeiras experiências de vulto com pré-fabricados que conhecemos encontram-se em fase de desenvolvimento. Trata-se da construção de diversos prédios da refinaria da Petrobrás, em Porto Alegre; de seis dos doze blocos de alojamento para estudantes da Universidade de São Paulo e dos edifícios da Universidade de Brasília] (my translation). In: Luiz Henrique Gomes Pessina, "Aspectos gerais da pré-fabricação: estudo de cronograma de obra com pré-fabricados" (Universidade de Brasília, 1964), 25. Besides the works undertaken at the University of Brasília, Pessina mentioned a further two pioneering and remarkable experiences with prefabrication in Brazil: the first, the student residence at USP (Universidade de São Paulo, 1961), designed by the architects Eduardo Kneese de Mello, Joel Ramalho Jr. and Sidney de Oliveira, published at: Eduardo Kneese de Mello, Joel Ramalho Jr., and Sidney Oliveira, "Setor Residencial da Cidade Universitária," *Acrópole* 26, no. 303 (1964): 93–101. See also: Roberto Alves de Lima Montenegro Filho, "A Pré-Fabricação na Trajetória de Eduardo Kneese de Mello" (Universidade de São Paulo, 2012). The second work is the Alberto Pasqualini oil refinery in Canoas, metropolitan area of Porto Alegre (1962-68). For further information, see: Viviane Villas Boas Maglia, "Refinaria Alberto Pasqualini: aplicação dos paradigmas modernistas à tipologia industrial no Rio Grande do Sul" (Universidade Federal do Rio Grande do Sul, 2001).

58 The widespread use of prefabrication and its respective images were shown in Pessina's dissertation – Volume 2. The famous projects and systems cited included: La Citté de la Muette (Lods and Beaudouin, 1932-34), Nervi's hangars in Orvieto and Orbetello (1939), la Cité Pierre Collinet in Meaux, France, along with the systems Hebel (USA), Airey Nemavo (Netherlands), Ciarlini (Italy), Camus (France), Linköping (Sweden) and S-3 (Not identified).

59 The housing deficit in Brazil at that time surpassed 3.5 million units.

60 The Seminar's impact is described in detail in: Ana Paula Koury, "Arquitetura construtiva: proposições para a produção material da arquitetura contemporânea no Brasil" (Universidade de São Paulo, 2005).

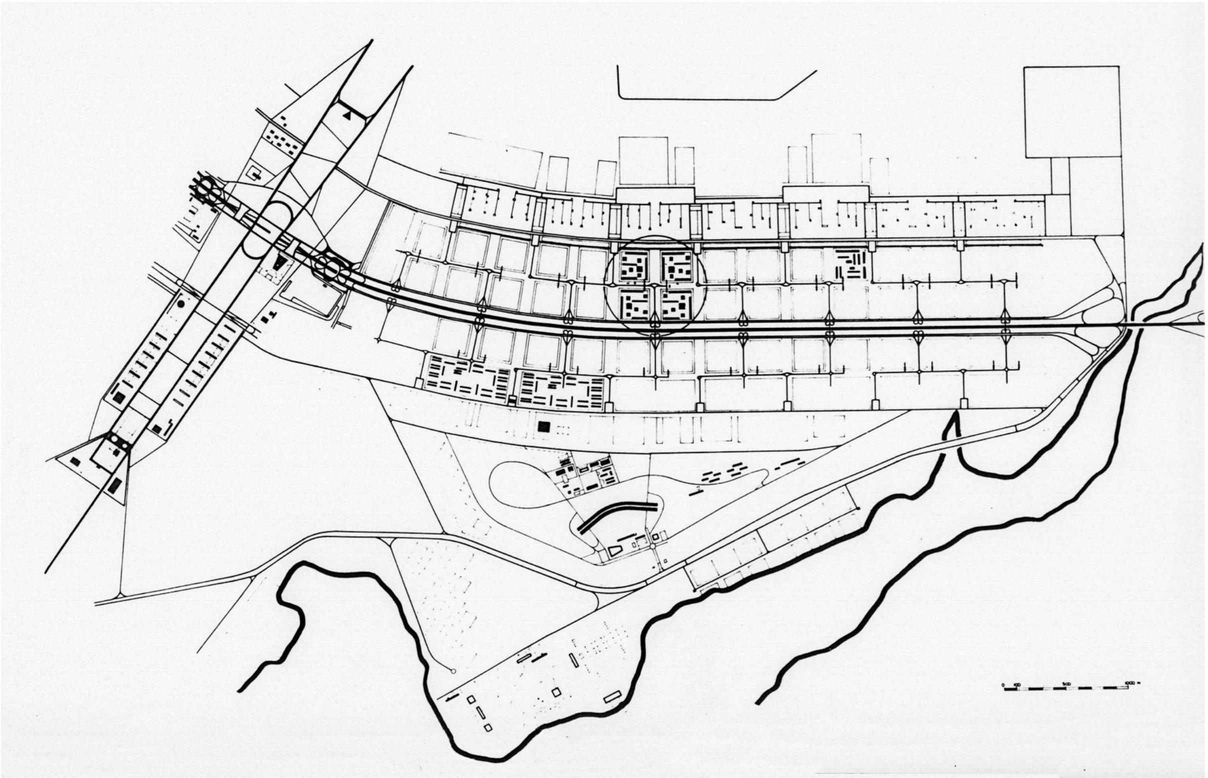

Fig. 1.24 General location of the São Miguel Neighborhood Unity within Brasília's *Plano Piloto*. Mayumi and Sérgio Souza Lima, Brasília, 1963. Mayumi Watanabe, master thesis, University of Brasília, 1965, volume 2

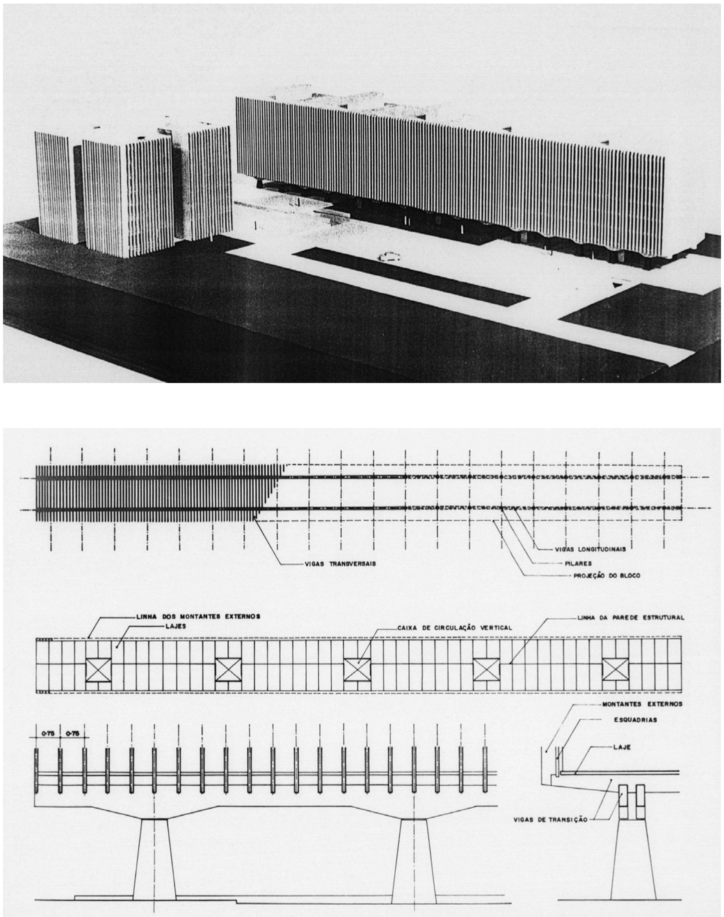

Fig. 1.25 São Miguel Neighborhood Unity's scale model (above) and drawings (below). Mayumi and Sérgio Souza Lima, Brasília, 1963. Mayumi Watanabe, master thesis, University of Brasília, 1965, volume 2

Fig. 1.26 Prototype of a prefabricated student housing unit at the University of Brasília. Oscar Niemeyer, Brasília, 1962. Luiz Henrique Pessina, master thesis, vol. 2, University of Brasília, 1964, p. 65

especially among the CEPLAN team.

In the previous year, Niemeyer had published an article where the architect presented two types of prefabricated housing: an unexecuted seven-story block with a kindergarten on the fifth floor, and an entirely prefabricated unit to be used in a variety of stacked combinations. He recalled:

> The housing problem is becoming increasingly serious in Brasília. It is not merely a question of providing a home for those who are still without one, living in the numerous shanties that disfigure that city so badly, but also of accommodating the public servants who will have to come to live in Brasília as the various ministries are moved to the new capital.[61]

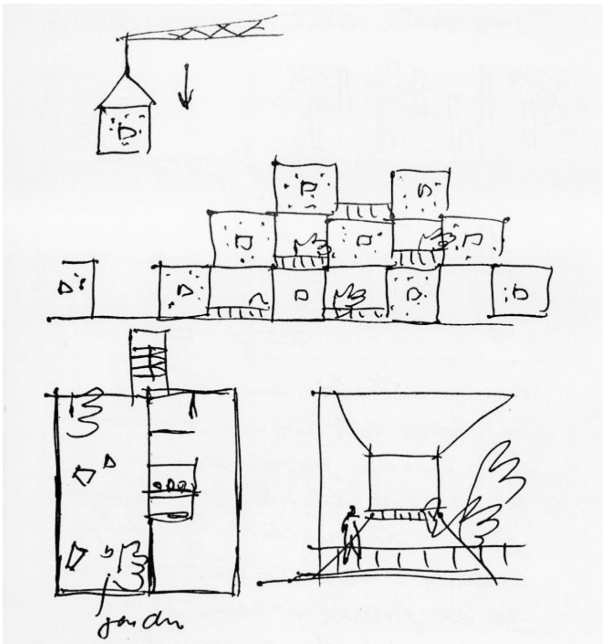

Fig. 1.27 Sketches for a student housing complex at UnB. Oscar Niemeyer, Brasília, 1962. Módulo, ano 8, n. 27, mar 1962, p. 34

With the purpose of serving as student accommodation for the University, a prototype was produced at UnB in 1962, anticipating in 5 years the typology of stackable boxes used by Moshe Safdie[62] at one of the most emblematic housing complexes built around this concept:

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61 Oscar Niemeyer, "Prefabricated Housing in Brasília," Módulo, no. 27 (1962): 28.

62 Moshe Safdie (Born 1938) is a Canadian/American/Israeli architect. He is still best known for his first major


Fig. 1.28 Colina prefabricated housing complex built for the University of Brasília's staff. João Filgueiras Lima, Brasília, 1962. Arquivo Público do Distrito Federal, Brasília


Fig. 1.29 Prefabricated housing proposition by Lelé for the MCMV federal housing program, Salvador, 2011. Arquivo João Filgueiras Lima, Salvador

the Habital '67 in Montréal.[63] However, the overweight unit of 45m² and 42 tons led to a complex transport plan, which ended by making its mass production impossible at that time.

The same Niemeyer who had justified the widespread use of prefabrication in 1962 by showing the huge demand for housing after the advent of Brasília, seemed to be skeptical now in relation to the present technology. In another article written in 1979, he pointed out the limitations intrinsic to precast architecture: "Of course, prefabrication embodies a limitation and should only be applied when economic problems and rapidity require them. Otherwise it would be unnecessary fantasy, an obstacle to the architect's own imagination."[64] The failure of Niemeyer's collective housing project at UnB – with the costs of having sacrificed the benefits of a more flexible solution – led Lelé to an understanding of the crucial equation to be solved as a prerequisite for a feasible prefabricated system, based on the binomial component's weight/

architectural work: the Habitat '67 in Montréal (1967), Canada.

63 I am indebted to Sylvia Ficher for this information. For further material concerning box-unit structures using concrete, see: Kay Louise Ting, "Concrete Box-Units for Housing" (Massachusetts Institute of Technology, 1975).

64 Oscar Niemeyer, "Problemas da Arquiteura 4: o Pré-Fabricado e a Arquiteura," Módulo, no. 53 (1979): 58. [É claro que o pré-fabricado representa uma limitação e só deve ser aplicado quando problemas de economia e rapidez o reclamam. De outra forma seria fantasia desnecessária, um obstáculo à própria imaginação do arquiteto] (my translation).

transportation.

Curiously, by means of his first collective housing project for the university staff (Colina, 1962) – a building that might connect the architect to the main concerns and expectations shared by the SHRU group concerning the use of prefabrication on a large scale – Lelé distanced himself from housing questions for almost 50 years. It was only in 2011 that the architect came up with a new proposal in the field, elaborated for a mass housing program *Minha Casa, Minha Vida*[65] (My House, My Life), which aimed, unsuccessfully, to build 3.4 million housing units by the end of 2014.

Therefore, it would not be true to say that Lelé abandoned the theme (of collective housing projects) and its potential new constructive approaches at all. At least four more unexecuted (and unpublished) projects of a similar nature were found in his archives, as we will see later. What matters to us is that the refusal of Lelé's project for the federal housing program (MCMV) explicits a permanent incongruity between the architect's attempt to gradually implement methods of building industrialization throughout his practice and the economical interests ruled by the sturdy construction sector in Brazil. Old building methods applied to a large-scale housing program would surely be more profitable than the adoption of rationalized processes, where the prices were kept under strict control. This situation contributed to sustaining the professional isolation in which Lelé found himself at the end of his life:

> I think I live on an island and therefore cannot generalize the experience I have, which is very isolated. So, I do not know how professional practice is being exercised by other colleagues. Yet, I think that in Europe, where I know large architecture offices, there is a tendency to build large companies. The offices of Norman Foster, who is super organized, Renzo Piano, and Santiago Calatrava, are examples of this: they have a very good structure, which is fundamental in order for them to work. They are architects who operate with great professional integration. As for us, here in Brazil, we work completely disintegrated. This is perhaps the worse thing.[66]

Yet there was a problem that contributed further to Lelé's isolation on a professional level. In 1964 the emergence of the authoritarian military dictatorship in Brazil ruined Darcy Ribeiro's plans of creating an innovative, autonomous and leading institution. The UnB's invasion by the military troops on April 3, 1964 signaled the decline of both the prefabricated

65 For further information, see Cláudia Estrela Porto, "Nossa Casa, Nossa Vida," Arquitetura e Urbanismo 26, no. 208 (2011): 38–45.

66 João Filgueiras Lima. In: Otavio Leonídio, "Eu vivo numa ilha. Entrevista com João Filgueiras Lima, Lelé," *Vitruvius* 15, (2014), accessed September 15, 2016, http://www.vitruvius.com.br/revistas/read/entrevista/15.058/5170. [Eu acho que vivo numa ilha e portanto não posso generalizar uma experiência que eu tenho e que é muito isolada. Então, não sei bem como a prática profissional está sendo exercida por outros colegas. Agora, acho que na Europa, onde conheço grandes escritórios, há uma tendência no sentido de se ter grandes estruturas. Os escritórios do Norman Foster, que é super organizado, do Renzo Piano, do Santiago Calatrava, são exemplo disso: têm uma estrutura muito boa, fundamental para que possam atuar. São arquitetos que atuam com grande integração profissional. Quanto a nós, aqui no Brasil, estamos completamente desintegrados. Isso é talvez o que há de pior] (my translation).

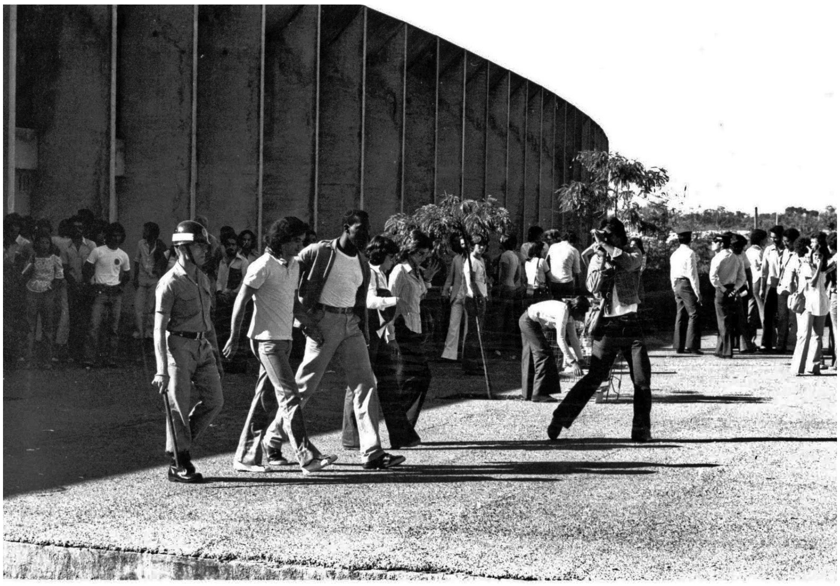
Fig. 1.30 Military invasion at the University of Brasília, 1964. Google Images, 2016

experiments in the campus – which included the envisioned factory – and the quality of the academic staff. According to Klaus Chaves Alberto, "In the following year, on October 18, 1965, Niemeyer and another 223 professors forwarded a resignation request to the Rectorate acting in solidarity with the 15 professors removed from their functions in June 1964 by the then Rector Zeferino Vaz. This marked Niemeyer's definitive rupture with the University of Brasília."[67] Although Niemeyer was not in the country at the time of these events,[68] he was kept informed about the political crisis undermining Brazil.

Lelé, however, was for many years one step ahead of the military authorities, and he described the CEPLAN Offices as 'a center of subversion within a subversive university'. If on the one hand the image and prestige of Niemeyer had somehow preserved him from a tendency towards isolation, both socially and politically, the same did not apply to Lelé. "Just for you to have an idea, when I left the University, I worked for one year at a building company, but this was nevertheless very difficult. The military interfered, trying to convince the company not to hire me. After my resignation from UnB, the persecution continued, and I only came to obtain a new commission in 1968, four years later."[69]

The 1964 coup d'état left deep marks not only on the young Brazilian democracy, but on the careers of many professionals who, like Lelé, had disclosed in a clear and unequivocal fashion their ideological left-wing political orientation.[70] If on the political side it had been

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67 Klaus Chaves Alberto, "Formalizando o ensino superior na década de 1960: a Cidade Universitária da UnB e seu projeto urbanístico" (Universidade Federal do Rio de Janeiro, 2008), 286–287. [No ano posterior, em 18 de outubro de 1965, Niemeyer e mais 223 professores encaminharam à Reitoria um pedido de desligamento em solidariedade aos 15 docentes afastados em junho de 1964 pelo então reitor Zeferino Vaz. Esse foi o rompimento definitivo de Niemeyer com a Universidade de Brasília] (my translation).

68 "Niemeyer received the news of the military coup of 1964 in a hotel in Lisbon. Deeply depressed by the turn of events, he proceeded to Israel, where, at the expense of a businessman named X. Federman, he closed himself off in a hotel room in Tel Aviv for six months. During this time, he worked on several projects, the most important of which were the Ideal City of Neguev and the University of Haifa." In: David Underwood, *Oscar Niemeyer and the Architecture of Brazil* (New York: Rizzoli, 1994), 157.

69 João Filgueiras Lima. In: Ana Gabriella Lima Guimarães, "João Filgueiras Lima: o último dos modernistas" (Universidade de São Paulo, 2003), 34. [Só para se ter uma ideia, quando me desliguei da universidade, eu trabalhei durante um ano numa empresa construtora, mas mesmo assim os militares não queriam deixar que a empresa me contratasse, foi difícil. Depois que pedi demissão da UnB, a perseguição continuou e eu só consegui fazer um projeto em 1968, quatro anos mais tarde] (my translation).

70 Lelé mentioned his political orientation many times. "I was not a party activist, but I attended the Brazilian

a time of persecution, from an economic perspective the Brazilian Miracle[71] would favor the enhancement of civil construction in the country, encouraging the growth and emergence of new building companies. However, Brasília's new market also appeared to have attracted pioneering firms on concrete structures, which overlapped Lelé's practice and brought further implications, as discussed in the next section.

3. Lelé, the engineers and building companies

The dissatisfaction with which Lelé reports a feeling of professional isolation should not obscure the fact that he worked in close collaboration with important building companies that strongly promoted and boosted the diffusion of prefabrication in Brazil, especially in Brasília.[72] From the mid-1960s until the end of 1970s, Lelé's career was marked by a sequence of important propositions, some of them unexecuted but of significant value in terms of enhancements in rationalized construction methods. The core of the question is to what extent did the collaboration between Lelé, the engineers and building companies contribute to the assimilation of ideas about prefabrication (its potential and limits) that would later inform his designs?

Issues and disagreements were rife and decisive in Lelé's professional life. Technical misunderstandings between Lelé and the engineers working on behalf of building companies led the architect and his team to adopt a particular stance on the prefabrication matter, which was sharply opposed to the economic interests[73] of certain companies. In practice, these problems were reflected throughout Lelé's entire career to a greater or lesser extent. The intention here is to demonstrate that Lelé took from these confrontations what was most useful for him in order

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Communist Party (PCB) meetings with Oscar at UnB. As student, I did not become involved with the party at the university. What happenend was that the architect Italo Campofiorito and I acted as a kind of designated representative for Oscar during his absence. I was somewhat like the PCB agent within UnB, although not a member." [Não era militante, mas participava das reuniões do PCB com o Oscar, na época da UnB. Como estudante, na faculdade, não tinha me envolvido, mas o que aconteceu é que ficamos, eu e o arquiteto Ítalo Campofiorito, sendo uma espécie de representantes de Oscar na Universidade, quando ele estava ausente, nas discussões que havia. E fiquei um pouco como representante do PCB na UnB, embora não-filiado] (my translation). In: João Filgueiras Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes* (Rio de Janeiro: Editora Record, 2004), 105–106.

71 In the period from 1969 to 1973, the Brazilian economy reached extraordinary levels due to the military's massive investments in infrastructure. At that time, the perilous state of the economical situation attracted many multinational companies from the US and Europe, which acted side by side with the empowered state-owned enterprises. This moment became known as the *Milagre Econômico* (Brazilian Miracle). On the social level, in contrast, salaries were squeezed, trade unions subjected to interference and repression, university staff exposed to police investigation, student organizations outlawed, liberal churches raided, civil rights suspended, and opponents of the coup were imprisoned, tortured and assassinated. See: Pedro Fiori Arantes, "Reinventing the Building Site," in *Brazil's Modern Architecture* (London: Phaidon, 2004), 186.

72 The first building company Lelé worked with was called "Architec Ltda." On the recommendation of the architect Aldari Toledo (1915-2000) Lelé, still an undergraduate student, found a position as technical designer in the company, where he stayed from 1950-52. According to Lelé, this coincided with the Rio de Janeiro real estate boom. For further details, see: Muriel Emanuel and Dennis Sharp, Contemporary Architects (New York: St. Martin's Press, 1980), 249; Lima, O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes, 32–33.

73 Among all the projects where economic interests proved to be more evident, the CIAC educational program (1991) represents a special episode. Marked by a great corruption scandal, the federal schools were discussed and written about daily in the Brazilian media.

to formulate his own propositions, drawing from a broad body of technical knowledge.

This is the case, for instance, with the Central Institute of Sciences building [*Instituto Central de Ciências,* ICC][74] and its foundation design and construction. The decision of the Rabello[75] construction company to erect the university's main building on raft foundations ruffled Lelé, who was in charge of the project development. When commenting on the importance of the ICC building for Lelé's career, Pessina recalled:

> The ICC was built on piled raft foundations on gravel, compacted, as is the case with road construction… The building does not have deep foundations. They absolutely take the form of a raft, built over this *radier*. Lelé, by the way, was against the construction of the *radier* because it modified, and people do not know this, but it modified the ICC design. The building ended up with a huge underground area, and the construction of the elements planned for the space between the two blocks was not realized. Lelé knew this would happen. Today many classrooms are located underground.[76]

The experience with the ICC building foundations seems to have given Lelé the necessary structural perception to adopt the *radier* as an ordinary technical solution where the building plot characteristics allowed him to do so[77] and when the situation imposed a faster and cheaper solution. Therefore, this kind of foundation became quite consistent in Lelé's later designs, incorporated as part of the architect's *savoir faire.* This example clearly illustrates an important feature of his practice, which consists in learning lessons from experiences on the construction level and making amendments in order to create new solutions.

This can be seen when the architect – drawing on the basic principles of shallow

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74 The ICC building was designed by Oscar Niemeyer in 1962 and its construction started in June 1963 at the University of Brasília. The 720m long building is constituted by two parallel blocks, separated 15m from each other. The two-story blocks also present a basement designated to services. After the long period of construction (1963-71) the ICC is still an unfinished building. After the military took power in March 1964, the team responsible for the development of the building was forced to resign, which had a prejudicial effect on the outcome of the construction.

75 Founded by the Brazilian engineer Marco Paulo Rabello (1918-2010) in 1945, the building company Rabello S/A was responsible for erecting major infrastructure works in Brazil, such as important roads (Transamazônica, Presidente Dutra, Castelo Branco, Rio-Santos), bridges (Rio-Niterói, etc.) and viaducts. The company acted in close collaboration with Oscar Niemeyer, from Pampulha (1940) to the architect's projects for Algeria (1970). In Brasília, Rabello played a crucial role, mainly because of their expertise in reinforced concrete and structural calculations. Works executed by Rabello in Brasília include: The Alvorada Palace (official residence of the president), the Banco do Brasil headquarters, the main station platform, the National Theater, the university, the stadium, the international airport, Brasília's cathedral and the Supreme Court. For further details about Rabello and prefabrication in concrete, see: Construtora Rabello S/A (Brasília: Construtora Rabello, 1969). In: Arquivo Lucio de Costa, Rio de Janeiro.

76 Luiz Henrique Pessina. Interview with Adalberto Vilela on 12 February, 2015 in Brasília. [A fundação do ICC é um radier de cascalho, como você faz numa estrada, compactada…. Ele não tem fundação profunda. É absolutamente rasa, em cima desse radier. O Lelé inclusive foi contra a construção desse radier porque alterou, a gente não sabe disso, mas alterou o projeto do ICC. O ICC ficou com subsolo demais e as construções previstas para o espaço entre os dois blocos não foram feitas. Lelé previa que ia aconter isso. Hoje você tem salas de aula ali] (my translation).

77 The structural engineer and Lelé's former collaborator Roberto Vitorino explains that Brasília's soil is very inconstant, which often requires specific evaluations before defining the foundation type to be adopted in construction. In contrast, Salvador has very stable and resistant soil. Telephone interview with Adalberto Vilela on September 28, 2016.

Fig. 1.31 Aerial view of the argamassa armada footbridge in Duque de Caxias, Rio de Janeiro. João Filgueiras Lima, 1985. Arquivo Zeca Franco, Rio de Janeiro

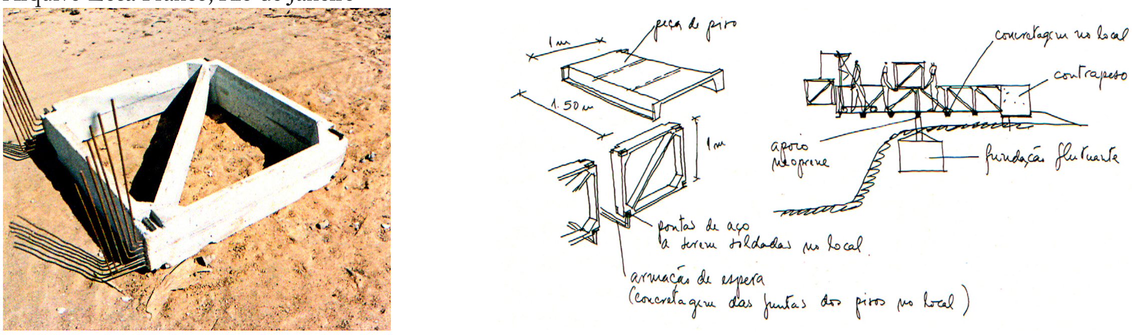
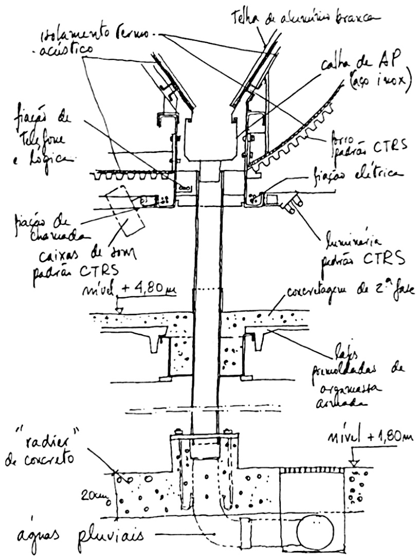


Fig. 1.32 Prefabricated footbridge component in argamassa armada. João Filgueiras Lima, Duque de Caxias, Rio de Janeiro, 1985. Giancarlo Latorraca, *João Filgueiras Lima, Lelé* (Lisboa, São Paulo: Blau, Instituto Lina Bo e P. M. Bardi, 2000), p. 152

Fig. 1.33 Technical galleries/foundation of the Sarah hospital in Salvador. João Filgueiras Lima, Salvador, 1991. Photograph by Akemi Tahara, 2017

Fig. 1.34 Children's Rehabilitation Center (Sarah hospital) at Pombeba Island. João Filgueiras Lima, Rio de Janeiro, 2001. M. Risselada and G. Latorraca, A arquitetura de Lelé: fábrica e invenção (São Paulo: Imprensa Oficial de SP/MCB, 2010), p. 152



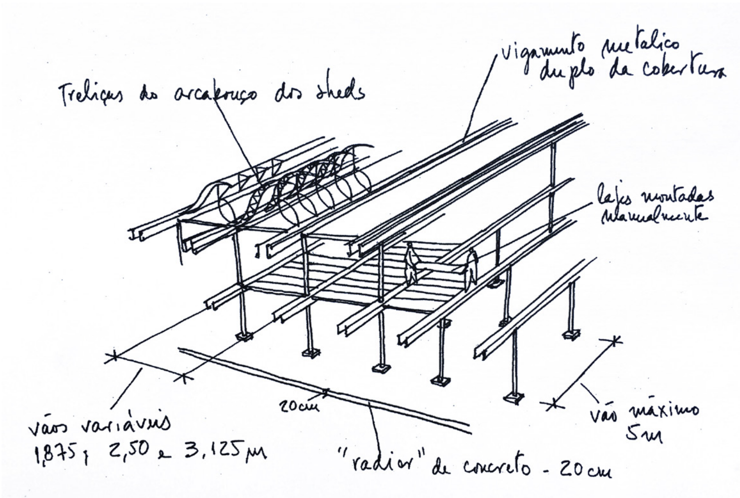


Fig. 1.35 Children's Rehabilitation Center Drawings. Risselada and G. Latorraca, A arquitetura de Lelé: fábrica e invenção (São Paulo: Imprensa Oficial de SP/MCB, 2010), p. 153 / Arquivo João Filgueiras Lima, Salvador

foundations – proposed the use of floating footings for his *argamassa armada* pedestrian bridge[78] in Duque de Caxias (Rio de Janeiro state, 1985) and the Sarah Kubitschek hospital in Salvador (1991). Unlike the conditions of the swamped area in Rio de Janeiro (in terms of scale and the instability of the soil), Lelé adopted a solution in Bahia where a sequence of underground technical galleries for hospital installations also acquired a major role in building stabilization. Designed and oriented to capture the ocean breeze, these big air intake ducts also worked as foundations, responsible for the distribution of the building loads to the compacted soil underneath.

Returning to the construction companies in Brasília, there are some converging points between Lelé's constructive knowledge-based practice and the operations conducted by some of the building firms in the new capital. I would argue that beyond their relevant role in the city configuration, they strongly contributed to informing Lelé's practice in the sense that the architect brought together much of their know-how as a merged and transmuted source of technical references. At the time, Lelé was in private practice, and the *Construtora Rabello S/A* (Rabello building company) had already set up a factory[79] in Brasília for prefabricated panels in concrete, based on the Camus[80] system. The political connections between Rabello and President Juscelino Kubitschek were strengthened after the conclusion of major works in the newly installed capital, carried out by the company. At the University, Rabello was in charge of the construction of its main building, the ICC (*Instituto Central de Ciências*), the CEPLAN Offices and also Lelé's prefabricated General Services building (1962).

During the transitional period between Lelé's early departure from the University (1965) and his first commission as an autonomous architect – the Taguatinga hospital (1968) – Lelé was employed by the Christiani-Nielsen[81] building company. For one year, the architect carried

78 The architect Zeca Franco, who collaborated with Lelé during the works in Rio de Janeiro (1984-1986), recalled: "that masterpiece (the pedestrian bridge) was assembled over a sewage canal alongside the river Sarapuí, in the municipality of Duque de Caxias, Rio de Janeiro state, in 1985. The canal was later grounded and the argamassa armada bridge demolished." Email interview with Adalberto Vilela on September 29, 2016.

79 Following Luiz Henrique Pessina's ideas, the Rabello factory was installed in the Industrial Sector of Brasília (*Setor de Indústria e Abastecimento*, SIA) in 1967. Telephone interview with Adalberto Vilela on September 16, 2016.

80 The Camus system, patented in 1948 by the French engineer Raymond Camus, was one of the most widely exported prefabricated concrete systems for housing in Europe. For more information, see: Raymond Camus, "Fabrication Industrielle de Huit Logements Par Jour Dans La Région Parisienne," *Annales de l'Institut Technique du Bâtiment et des Travaux Publics* 9, no. 101 (1956): 427–454; Yvan Delemontey, *Reconstruire la France: l'aventure du béton assemblé, 1940-1955* (Paris: Éditions de la Villette, 2015), 254–292.

81 Christiani & Nielsen was originally a Danish building company founded in 1904 in Copenhagen by Rudolf Christiani, a Danish civil engineer, and Aage Nielsen, a captain in the Royal Danish Navy. The international expansion started early in 1908 (Hamburg, Germany). The first subsidiary installed outside Europe was in Brazil (Rio de Janeiro) in 1917. Rudolf Christiani's career was marked by the internship years at the Hennenbique office in Paris, where he developed his knowledge for making calculations for concrete structures. The building company had a strong presence in Brazil during the first half of the 20th century, with offices operating in three cities – Rio de Janeiro, São Paulo and Salvador. The fourth bureau in Brazil was housed in Brasília after the inauguration of the new capital. For further information about CN (Christiani-Nielsen), see: Chr. Ostenfeld, *Christiani & Nielsen: Jernbetonens Danke Pionerer* (Lyngby: Polyteknisk Forlag, 1976); Maria Luiza de Freitas, "A Christiani & Nielsen e a arquitetura do concreto armado no Brasil: indagações em torno da relação entre arte e técnica," in *8. Seminário Docomomo Brasil* (Rio de Janeiro, 2009); H. S. Kaarsberg, *Christiani & Nielsen: Twenty Five Years of Civil Engineering, 1904-1929* (Copenhagen: Christiani & Nielsen, 1929); Christiani & Nielsen, *50 Years of Civil Engineering, 1904-1954* (Copenhagen: Christiani & Nielsen, 1954); Christiani & Nielsen, *60 Years of Civil Engineering, 1904-1964.* (Copenhagen: Christiani & Nielsen, 1964).

on the works for the *Disbrave* workshops, a Volkswagen maintenance shop and car dealership in Brasília. It was not the first time Lelé collaborated with Christiani-Nielsen. The renowned and multinational Danish corporation had already constructed the university apartment buildings (Colina) designed by Lelé in 1962.[82] However, the short period as employee[83] during the construction of the *Disbrave* building did not prevent Lelé from struggling against technical decisions regarding the concrete structure and prefabrication in general. Commenting on the works of the Disbrave building in Brasília, Lelé stated:

> Christiani Nielsen was in charge of the *Disbrave* workshop construction, mostly because they had the know-how on premolded systems. However, only part of the works was carried out using prefabrication. The halfway execution has left much to be desired. There was no equipment to assemble prefabricated parts and the building owner also had no money to face all the construction problems. They did not respect the entirely proposed industrialization method because of the production process and also because of the deadlines. It is clear that if you intend to keep a crane at the building site for a long time, the high costs will wipe out the economic benefits.[84]

The fact that Lelé's first project, completed after the establishment of the dictatorship, was not published by *Módulo*[85] magazine but rather by a French journal printed in Switzerland, is highly curious to say the least. In 1970, in an article entitled "*Les progrès de Brasília",*[86] the *Disbrave* headquarter was registered through the lens of Marcel Gautherot,[87] in which

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82 In order to clarify the chronology involving Lelé's first buildings at the University of Brasília and their construction method – whether partially or totally prefabricated – it seems necessary to highlight some facts taken from primary sources. A careful analysis of the CEPLAN archives reveals the preliminary draft dates concerning the Colina and General Services (SG) buildings, showing their position on the timeline of Lelé's early projects. Dated from February 1962, the Colina apartment building was indeed Lelé's first relevant project at UnB. In its construction, Lelé adopted heavy prefabrication in prestressed and reinforced concrete (columns, beams, slabs and even the jambs and lintels of the window frames), except for the cast-in-place staircases and windowless façade pillars. Unlike Colina, the SG building, designed in September 1962, had all of its structural components prefabricated, which includes pillars, slabs, beams and the underground's retaining wall.

83 From 1965 to 1966, Lelé worked as an engineer at the Pederneiras S/A building company. See Edgar Graeff et al., *Arquitetura Brasileira Após Brasília. Depoimentos* (Rio de Janeiro: IAB/RJ, 1978), 218.

84 João Filgueiras Lima. Interview with Ana Gabriella Guimarães on February 20, 2001 in Salvador. In: Guimarães, "João Filgueiras Lima: o último dos modernistas," 61. [Quem contruiu a Disbrave foi a Christiani Nielsen porque ela estava aparelhada para fazer sistemas pré-moldados, mas ela só fez uma parte da obra pré-moldada. Então foi feito pela metade, de modo que deixou muito a desejar sob o ponto de vista da execução. Não havia equipamentos para montar as peças e o proprietário também não tinha dinheiro para enfrentar todo o problema da construção. Eles não respeitaram todo o processo de industrialização por causa do processo de produção e também por causa do prazo. É claro, se você vai manter um guindaste numa obra durante muito tempo, o custo do aluguel desse guindaste é muito grande, anulando assim a vantagem econômica] (my translation).

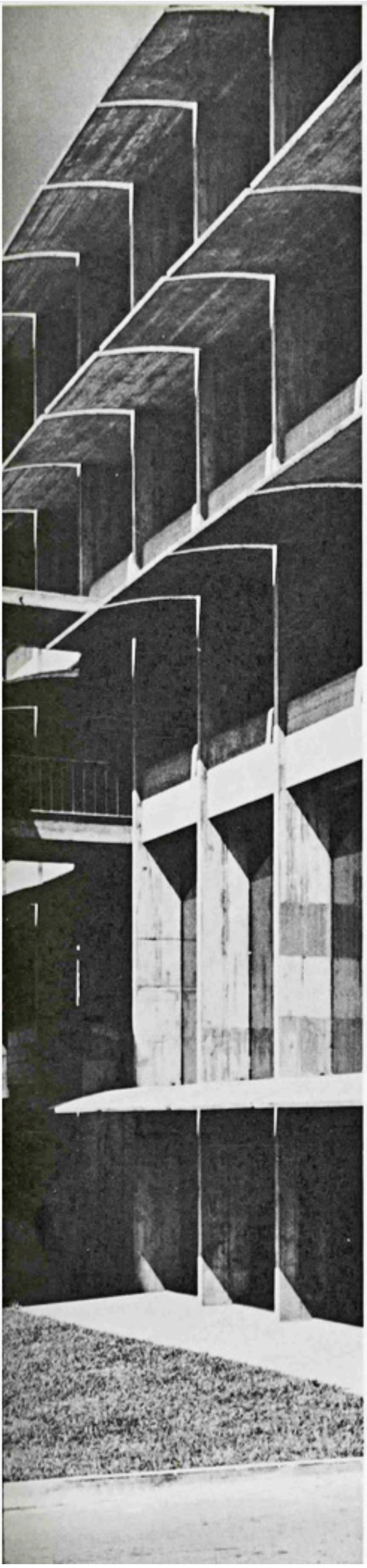
85 Edited by Oscar Niemeyer, Módulo was one of the most important architectural journals founded in Brazil. The periodical publication that also covered arts and design was discriminated against during the military dictatorship, having being prohibited for some years. Módulo was published from 1955 to 1989.

86 François Loyer, "Les Progrès de Brasilia," L'Oeil, no. 184 (1970): 8–15.

87 Marcel Gautherot (1910-1996) was a French photographer who lived in Brazil from 1939 until the end of his life. Gautherot had easy access to important names of Brazilian modernism, such as Mario de Andrade, Rodrigo Melo Franco de Andrade, Carlos Drummond, Lucio Costa, Oscar Niemeyer and Burle Marx. The famous photographer collaborated with Lelé during the registration of the *Disbrave* workshops (1965), and during a session that was to illustrate an article for Módulo magazine dedicated to Lelé. In: "João Filgueiras Lima, Arquiteto: Pensamento e Obra," Módulo, no. 57 (1980): 78–93. Further readings on Marcel Gautherot, see: K. Frampton, S. Burgi, and S. Titan Jr., *Building Brasilia* (London; New York: Thames & Hudson, 2010); Samuel Titan and Sergio Burgi, *Marcel Gautherot: Die Monografie* (Zürich: Scheidegger & Spiess, 2016).

1 Chaque quartier d'habitation est organisé en « quadras » dont la construction est confiée à divers architectes brésiliens. Les immeubles implantés en quinconce donnent sur de vastes jardins intérieurs. Les façades sont protégées par de larges brise-soleil. **2** *Dans cette autre « quadra », on aperçoit au premier plan une petite école primaire alternant murs-écrans et claustra. L'architecte en est W. Reis Netto, récemment installé en France où il a été l'auteur d'un projet pour l'aménagement du quartier des Halles de Paris. Brasilia, l'une des expériences architecturales les plus spectaculaires du monde, est une pépinière d'architectes.* **3** *Le siège de la Société Volkswagen a été confié à l'architecte João da Gama Filgueiras, de Lima. La construction en béton brut souligne l'opposition des plans par le jeu des voiles perpendiculaires à la façade, des allèges basses en léger retrait et des grands brise-soleil faiblement incurvés qui protègent les panneaux de verre directement enchâssés dans le béton. Le bloc amandiforme de l'escalier extérieur s'oppose à ces minces panneaux emboîtés.* **4** *Vue d'avion, la construction comporte deux éléments distincts : un bâtiment de bureaux et un vaste hangar pour les voitures. Le bâtiment de bureaux est sur plan carré, l'horizontalité du système des dalles débordantes étant ici très apparente. A l'arrière-plan, le quartier des ministères.* **5** *La couverture du hangar à voitures est assurée par de longues poutres en béton armé : leur profil en « y » dissymétrique, avec des branches incurvées, permet l'emboîtement et donne à l'ensemble un très beau mouvement. Dans la partie de chaque poutre protégée par le débordement de la poutre voisine sont pratiqués des alignements de petites lucarnes qui diffusent un éclairage indirect à l'intérieur de l'édifice. La hauteur de la poutre lui assure une plus grande largeur de franchissement ; la forme en tunnel permet l'aération et la protection contre les grosses chaleurs. Enfin, le porte-à-faux extérieur délimite un parking couvert pour les visiteurs.*

Fig. 1.36 Disbrave building at L'Oeil. Article '*Les Progrès de Brasília*.' Photographs by Marcel Gautherot. L'Oeil, n. 184, avril 1970, p. 14-15



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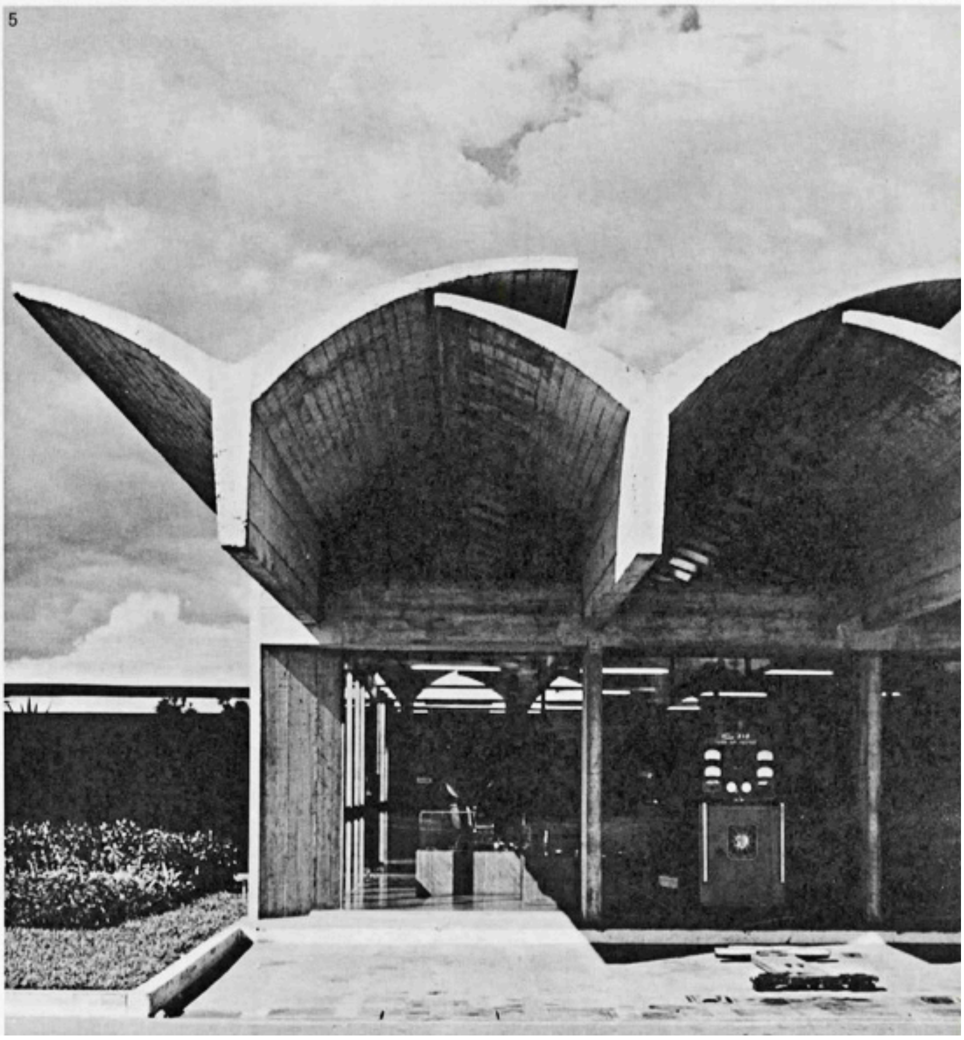

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Fig. 1.37 Disbrave building. View of the Office Block. João Filgueiras Lima, 1965. Photograph by Marcel Gautherot. Arquivo João Filgueiras Lima, Salvador

the pioneering building is depicted occupying the incipient north region (*Asa Norte*) of the new capital. Perhaps the evidence that the edification of refined plastic and constructive characteristics – which acquired the status of a work of art for its architectonic qualities[88] – was not accomplished as expected might have caused in Lelé a feeling of frustration,[89] partially

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88 In one of his texts the architect, professor and theoretician Edgar Graeff (1921-1990) highlighted the importance of the *Disbrave* workshops: "It is worth emphasizing two works in Brazil with outstanding architectural qualities: The *Duchen* Factory, designed by Oscar Niemeyer in 1950 and built in the outskirts of São Paulo; and the *Disbrave* workshops, designed by João Filgueiras Lima in 1965 and built in Brasília. Although destined for industrial activities, both buildings are perfectly qualified as authentic works of art. In any of them, the concerns with aesthetics and form meant functional and utilitarian loss. Quite conversely, at both edifices the space created has turned out to be more favourable for the expected operating activities. Edgar Albuquerque Graeff. Edifício. Cadernos Brasileiros de Arquitetura. São Paulo: Projeto, 1979, v. 7, p. 37 apud Guimarães, "João Filgueiras Lima: o último dos modernistas," 57. [No Brasil, cumpre destacar, graças às suas excepcionais qualidades arquitetônicas, a Fábrica Duchen, projetada por Oscar Niemeyer em 1950 e construída nos arredores de São Paulo; e o prédio para as oficinas da Disbrave, projetado por João Filgueiras Lima em 1965 e construído em Brasília. Embora destinados a atividades industriais, os dois edifícios são perfeitamente qualificáveis como autênticas obras de arte. Em nenhum deles a preocupação com a beleza e o apuro da forma significou prejuízo de ordem funcional-utilitária. Ao contrário, em ambos o ambiente criado revela-se mais favorável ao exercício das atividades programadas] (my translation).

89 The frustration attributed to the final result of the *Disbrave* works does not imply that the architect had neglected the project. In 1973, Lelé was selected to participate at the São Paulo 1st Architecture Biennial with three works: The *Disbrave* workshops (Brasília, 1965), the Taguatinga hospital (Brasília, 1968) and the Residence of the Minister of Planning (Brasília, 1970). In 1998, Lelé was awarded a Special Room at the São Paulo 4th Architectural Biennial, at this time with a different range of projects, which covered the period from the Renurb factory (1978) to the latest achievements produced by the

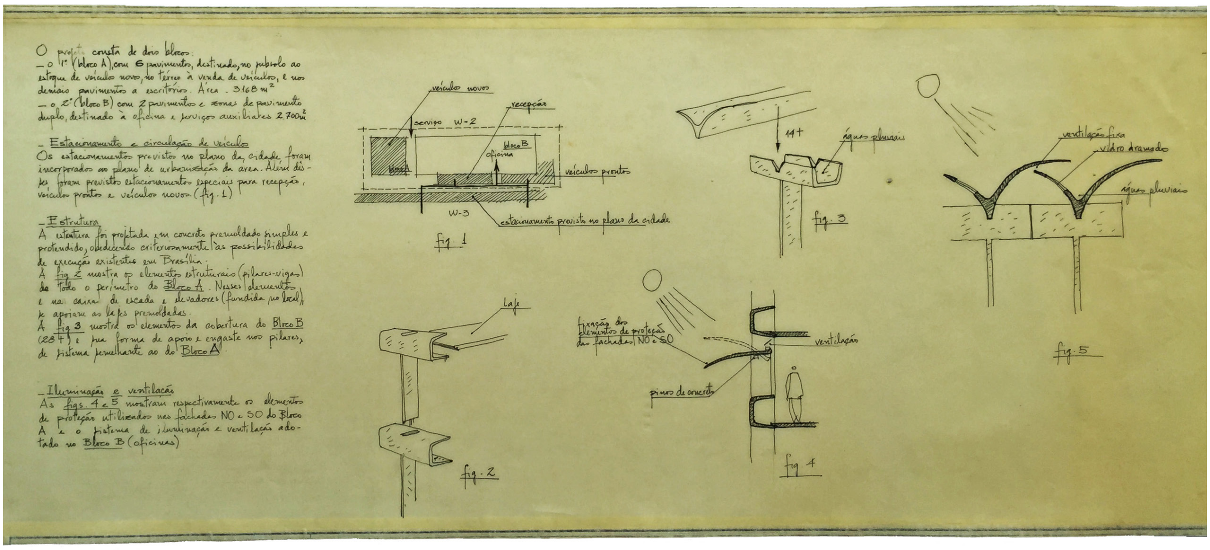

Fig. 1.38 Disbrave building. Drawings featuring the precast structural solution adopted by Lelé. João Filgueiras Lima, 1965. Arquivo João Filgueiras Lima, Salvador

Fig. 1.39 Disbrave building under construction. João Filgueiras Lima, 1965. Arquivo Disbrave. Source: Audrey Migliani, *Clássicos da Arquitetura: Disbrave*. Archdaily, January 2015

attributed to the problems faced during the construction. According to Lelé:

> Furthermore, at the entrance of the Disbrave building there is a long roof beam with a span of 25m, to which was calculated an excessive counterweight by the engineer. As that structure is submitted to huge vertical loads, the pillars were pushed down by the beam's bending deflection, which provoked serious deformation at the column's base. These concrete pillars had no suppleness due to their huge inertia towards thrust forces. Thus, they became really deformed. There is no way to keep the load in the air, because it is a force that dislocates the ground. What else could I do? The works have been done and the building was finished with several signs of cracking. I tried to invent some solutions, but they did not allow me to do so.[90]

Technology Center of the Sarah Chain (CTRS). The *Disbrave* building finally returned to one of Lelé's publications, now as a full entry in his Complete Works, published in 2000. However, the terms "prefabrication", "premolded" or "precast" are curiously not mentioned in the building's construction description. For more details, see: Giancarlo Latorraca, *João Filgueiras Lima, Lelé*, ed. Marcelo Carvalho Ferraz (Lisboa, São Paulo: Editorial Blau, Instituto Lina Bo e P.M. Bardi, 2000), 40–41.

90 João Filgueiras Lima. Interview with Ana Gabriella Guimarães on February 20, 2001 in Salvador. In: Guimarães, "João Filgueiras Lima: o último dos modernistas," 61. [Além disso, logo na entrada da Disbrave tem uma grande viga de cobertura com 25 m de vão, a qual o calculista previu um excesso de contrapeso. Como aquela estrutura sofre a ação de enormes cargas verticais, a flecha desceu empurrando os pilares e todos eles foram abrindo na parte de baixo. Eles não tinham

There is no doubt that Lelé conceived the structure of the *Disbrave* complex using prefabrication in concrete as the main element and that he was aware of the possibilities of actually implementing the technique in the new capital. The basic project, dating back to 12 March 1965, confirms the architect's intention to rationalize the heavier part of the construction process. Following the project description (based on Fig. 1.38) :

> The structure was designed using reinforced and prestressed concrete components, strictly obeying the implementation possibilities available in Brasília. Fig. 2 shows the structural elements (pillars and beams) of the whole perimeter of Block A [*Bloco A*]. Over these elements and on the staircase and elevators (cast in place) lean the premolded slabs. Fig. 3 displays the building covering elements of Block B [*Bloco B*] (28 tons) and its supporting and attaching system to the pillars, in a similar way to Block A.[91]

The *Disbrave* complex was originally composed of two blocks: a six-story building destined for car sales and administrative offices (Block A) and a long two-story pavilion for repair and maintenance services for vehicles (Block B). With or without Lelé's consent, the building has undergone several changes.[92] More relevant, however, than the building modifications over the years is the origin of its design. The *Disbrave* workshops represent the architect's effort to give continuity to the on-site prefabrication technique learned at the University of Brasília. By means of a sequence of elegant roof components, Lelé dramatically shifted the building configuration, bringing rhythm and movement to the façades and making a clear distinction between load bearing and non-load bearing materials.

The image Lelé created of the building as a technical object emerging out of precasting methods was dismantled by a range of interventions, all of them legitimated by Christiani-Nielsen engineers and endorsed by the owner. In response to the limitations imposed by the situation, and considering the major drawbacks at the building site, Lelé was forced to adapt his idea to reality. Here, the architect's unstinting commitment to prefabrication becomes evident.

In this case, Lelé managed to retain an important prefabricated component, that is to say built precisely as specified,[93] and this was the *brise-soleil* for the office block, which was composed

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flexibilidade porque eram pilares com uma inércia muito grande no sentido do empuxo. Então ele abriu mesmo. Não há como você segurar o peso no ar, pois é uma força que desloca a terra. O que eu podia fazer? A obra já estava pronta e o prédio ficou cheio de rachaduras. Tentei inventar umas soluções, mas eles não deixaram] (my translation).

91 João Filgueiras Lima. Disbrave Basic Project [Agência Volkswagen – Disbrave], descriptive memorial [memória], drawing board 1 [prancha 1]. Brasília, 12.03.1965. Arquivo João Filgueiras Lima. [A estrutura foi projetada em concreto premoldado simples e protendido, obedecendo criteriosamente às possibilidades de execução existente em Brasília. A fig. 2 mostra os elementos estruturais (pilares-vigas) de todo o perímetro do Bloco A. Nesses elementos e na caixa de escada e elevadores (fundida no local), se apoiam as lajes premoldadas. A fig. 3 mostra os elementos da cobertura do Bloco B (28 t) e sua forma de apoio e engaste nos pilares, de sistema semelhante ao do Bloco A] (my translation).

92 Lelé was in charge of *Disbrave* expansion projects on two occasions: in 1975, when the remarkable gas station was added to the ensemble, and in 1985, when the 6-meter-long prefabricated marquee was introduced at the workshop's main entrance. Today the building looks different; in fact, it has been modified so much in the last few years that it has come to lose many of its original characteristics.

93 Although the *Disbrave* brise-soleil was prefabricated, its fixation system was also modified. One clear example is the four fixing pins responsible for the component stabilization at the façade. Designed to be casted in concrete directly

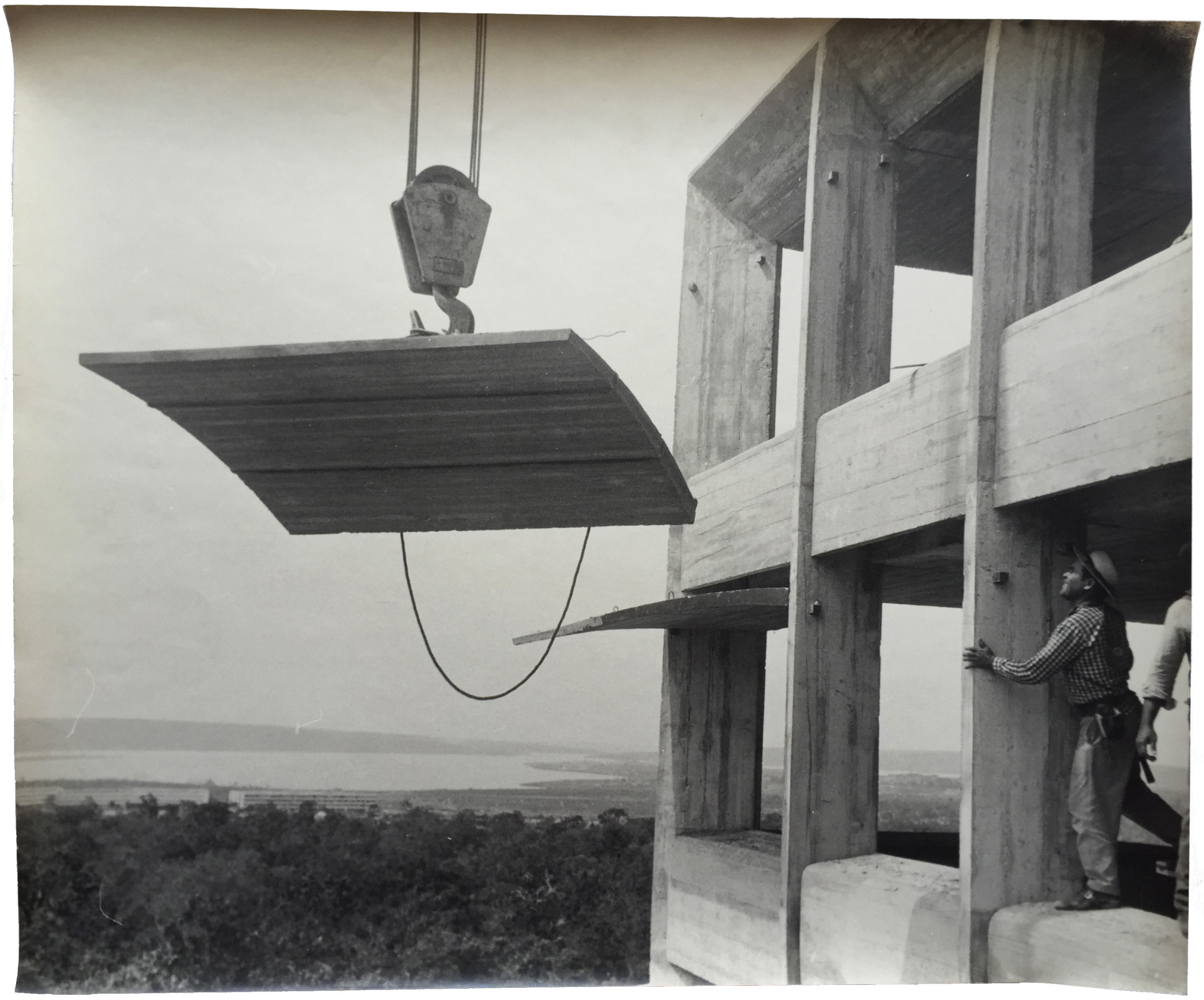

Fig. 1.40 Brise-soleil assembling process, Disbrave building. João Filgueiras Lima, 1965. Photograph by Marcel Gautherot. Arquivo João Filgueiras Lima, Salvador

of a cantilevered concrete blade. The symbolic meaning of the element's lifting operation (Fig. 1.40) using a crane – photographed by Marcel Gautherot – stands as an achievement for the architect, given the professional environment that he was immersed in. Lelé's subsequent major works show his willingness to adhere to the entire rationalization of the construction process, in the same way as he had experienced at the university. Nevertheless, some of his buildings from this phase were built in accordance with traditional techniques, despite sustaining a precast appearance. This confirms the mismatch between the construction sector in Brasília and the architect's aspirations at that time.

Hence, the question that naturally arises here is: could the *Disbrave* building – and the constructions that followed – be deemed a backward step in Lelé's movement towards the global rationalization process? In other words, why were the fully precast experiences at the UnB campus (driven by a desire to implement innovative means of construction) somehow foresaken in later projects (e.g. VW *Disbrave*, 1965; Taguatinga hospital, 1968; Ford *Planalto*

attached to the columns, they were replaced by a sequence of metal pins.

Headquarters, 1972; and the Sarah Hospital, 1976)? It could be argued that besides the clients' financial contingencies, and considering the intrinsic differences between the public and private status of the projects, the building companies and their engineers played a decisive role in the disruption to the continuity of Lelé's rationalized construction methods.

When recalling an interview made with the architect and theorist Edgar Graeff, Kristian Schiel[94] explains the reason why the pioneering construction of *Colina* (the apartment building for the staff of the University of Brasília, 1962) did not lead to any tangible results shortly after Lelé's departure from UnB:

> He (E. Graeff) explained to us that the University of Brasília was an experimental building site created to support an ambitious and far-reaching proposal. The idea was to equip Brasília's Superquadras with prefabricated collective housing projects, which seemed reasonable at the time because one and the same project could be repeated many times. Thus, the *Colina* building was a pilot project within this urbanization concept.[95]

From the construction company's point of view, this was also regarded as a great business opportunity. Christiani-Nielsen may have built the four blocks of the *Colina* complex strictly according to Lelé's propositions, believing that large-scale prefabrication could be employed during the construction of the Superquadras (most of them yet to be erected), although this did not happen. In fact, this technology was used in the residential sector of the new capital, mostly by the architect and skilled builder Milton Ramos,[96] author of the famous apartment block R2 constructed by *Rabello* in 1969.

Not only did Lelé endorse the idea that prefabrication could be a solution for the faster urbanization of the Superquadras, but he proposed similar projects for two of them in the early 1970s: the SQS 311 and the SQS 204.[97] At the most visible level, a structural element is strongly emphasized in both projects: the Vierendeel beam. Since the project for the Residence of the Minister of Planning in Brasília was realized in 1970, Lelé seemed to adopt an approach that acknowledges his personal enthusiasm for the power of concrete. This willingness signals

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94 Kristian Schiel (1942), Brazilian architect born in Germany and retired professor at the University of Brasília. Schiel worked in close collaboration with Lelé from 1968 to 1998, especially during the works for the hospitals in Taguatinga, Brasília and Fortaleza. His position as technical manager at Renurb factory (1978-1982) had a great impact on his further practice as architect and teacher.

95 Kristian Schiel. Telephone interview with Adalberto Vilela on September 23, 2016. [Ele (E. Graeff) explicou que a UnB foi um canteiro experimental para uma proposta bem maior e audaciosa que previa a construção de moradias coletivas totalmente pré-fabricadas para as Superquadras de Brasília. A ideia pra época era pertinente, uma vez que um mesmo projeto poderia ser repetido muitas vezes nas quadras. Então a Colina foi um projeto piloto dentro desse conceito de urbanização] (my translation).

96 Milton Ramos (1929-2008) was a Brazilian architect from Rio de Janeiro who worked with Oscar Niemeyer on some important projects in Brasília, such as the Ministry of Foreign Affairs (1962) and the National Theater (1958). From 1967 onwards, he started a fruitful collaboration with the *Rabello* construction company. His prefabricated buildings R2 (1969) and R3 (1972) stand as important contributions in the field. For further information see: Carlos Henrique Magalhães Lima, Milton Ramos (Brasília: IAB, 2011).

97 At both projects Lelé was commissioned by public institutions. For the Bank of Brazil (SQS 204), Lelé previewed three types of apartments distributed over 12 six-story prefabricated blocks, and for the Ministry of Transports (SQS 311), two types of apartments shared out between six buildings conventionally built (in concrete) with six floors.

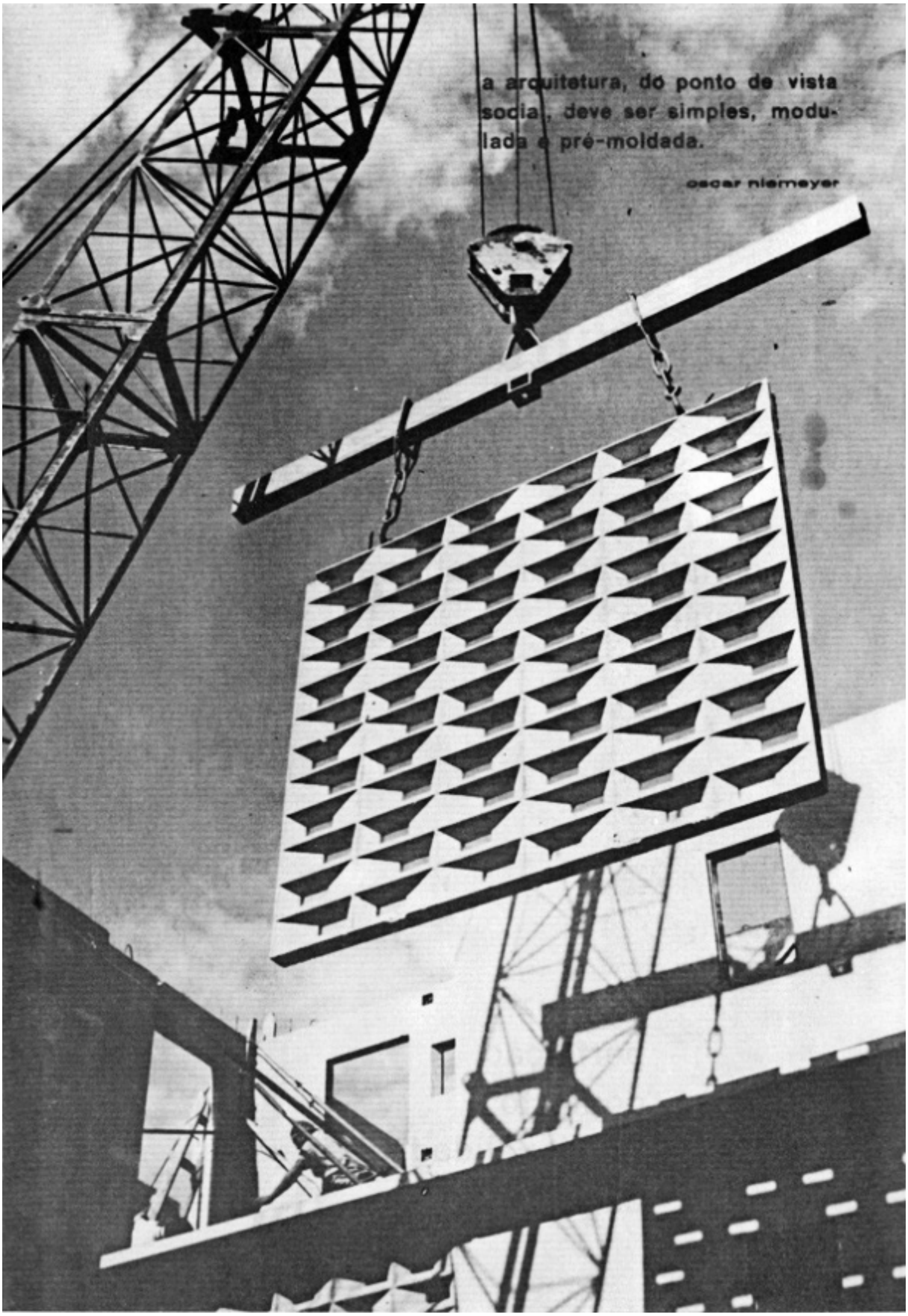

Fig. 1.41 Assembling process. Brise-soleil panel. R2 building. Milton Ramos, Brasília, 1969. Catalog *Construtora Rabello S.A.* (Brasília: Rabello, 1969). Quotation at the top: "Architecture, from a social point of view, must be simple, modulated and prefabricated." Oscar Niemeyer (my translation). Casa de Lucio Costa, Rio de Janeiro

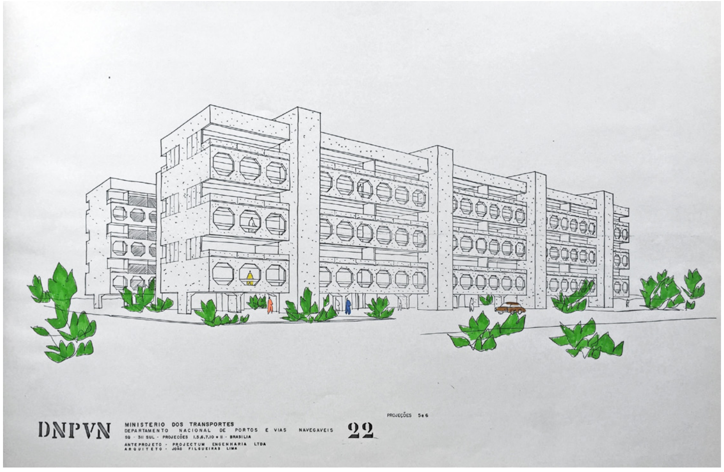

Fig. 1.42 Superquadra 311 Sul (SQS 311). João Filgueiras Lima, Brasília, 1974. Unexecuted. Arquivo João Filgueiras Lima, Salvador

Fig. 1.43 Superquadra 204 Sul (SQS 204). João Filgueiras Lima, Brasília, 1974. Unexecuted. Arquivo João Filgueiras Lima, Salvador

Fig. 1.44 Residence of the Minister of Planning in Brasília. Lelé, 1970. Published at *Módulo*, no. 49 (1978). Arquivo João Filgueiras Lima, Salvador

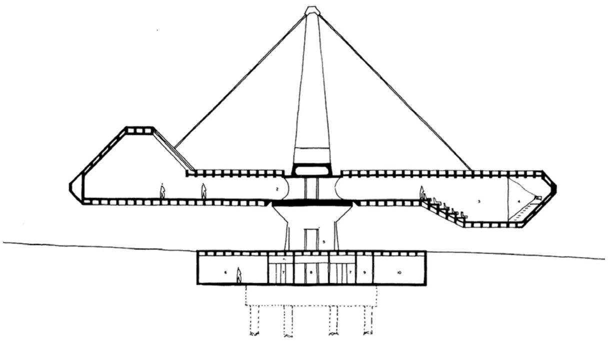

Fig. 1.45 CAB Exhibition Center. João Filgueiras Lima, Salvador, 1974. Photograph by Marcel Gautherot. *João Filgueiras Lima, arquiteto: pensamento e obra*. Módulo, no. 57 (1980): 85

a shift in his designs, propelled by the clear demonstration of his conviction about massive building technology, which is best exemplified by the Exhibition Center in Salvador (1974).

But, if on the one hand, Lelé's trajectory gains unprecedented contours with the expression of an aesthetic value associated with Brutalism (with a dose of obsession with geometrical openings in the buildings' façades), on the other it reflects his concerns while seeking for the final formal solution for the Sarah rehabilitation hospital in Brasília (1976). Inaugurated in 1980, this first unit of the Sarah Chain (Rede Sarah)[98] was signed up to a breakthrough project concerning the implementation of the enhanced healthcare program created by the orthopedist Aloysio Campos da Paz.[99] Enabled by the introduction of the *cama-maca*[100] (mobile bed) as the core equipment of the new patient's mobility concept, the program envisioned the gradual displacement of patients throughout the hospital according to the evolution of their clinical conditions.

But the point that brings the narrative closer to the chapter's main inquiry precedes all the innovative approaches to treatment launched by the Sarah hospital in Brasília. Lelé's concerns

98 The Sarah Chain of Rehabilitation Hospitals was created in 1976 by Eduardo Kertész (IPEA), Lelé and Dr. Aloysio Campos da Paz, in collaboration with the architect Alex Chacon and the anthropologist Roberto Pinho. Originally entitled "Health Subsystem in the Motorial Apparatus Area" [Subsistema de Saúde na área do Aparelho Locomotor], the Sarah Chain today comprises the following units: Brasília (1976-1980), São Luís (1988-1993), Curitiba (unexecuted, 1988), Salvador (1989-1994), Fortaleza (1991-2001), Belo Horizonte (1993-1997), Recife (unexecuted, 1995), Brasília Lago Norte (1995-2003), Natal (unexecuted, 1996), Macapá (2000-2005), Belém (2001-2007), and Rio de Janeiro (2000-2009).

99 Aloysio Campos da Paz (1934-2015) was a Brazilian orthopedist founder of the Sarah Chain of Rehabilitation Hospitals (*Rede Sarah de Hospitais de Reabilitação*). Campos da Paz initiated his post graduation studies at the University of Oxford when he was 26 years old. Later, we would hold a PhD in orthopaedics and traumatology by the Federal University of Minas Gerais (UFMG), in Brazil. The physicist was ahead of the Sarah hospital in Brasília since the early 1960s.

100 "Cama-maca" is an automated hospital bed created by the designer Alex Chacon in collaboration with Lelé in 1976. The equipment has been produced and improved over the decades by a specific department within the Sarah Chain of Rehabilitation Hospitals (Rede Sarah) called Equiphos. Responsible for carrying on research in the orthopedic field and producing medical equipment and furniture for the Sarah hospitals all over Brazil, the Equiphos department became an essential aspect of the Sarah philosophy based on the mobility of patients undergoing treatment. For further details about cama-maca and Equiphos, see: Adalberto Vilela, "João Filgueiras Lima: uma ponte entre a arquitetura e o design," in Mobiliário Moderno: das pequenas fábricas ao projeto da UnB, ed. Alex Calheiros, Marcelo Mari, and Priscila Rufinoni (Brasília: Editora Universidade de Brasília, 2014), 126–145.

Fig. 1.46 Sarah rehabilitation hospital in Brasília. João Filgueiras Lima, 1976-80. Photograph by Leonardo Finotti. João Filgueiras Lima, Lelé, *Arquitetura: uma experiência na área da saúde* (São Paulo: Romano Guerra, 2012), p. 91

Fig. 1.47 Solarium and the *cama-maca* (mobile bed). Sarah rehabilitation hospital in Brasília. João Filgueiras Lima, 1976-80. Arquivo João Filgueiras Lima, Salvador

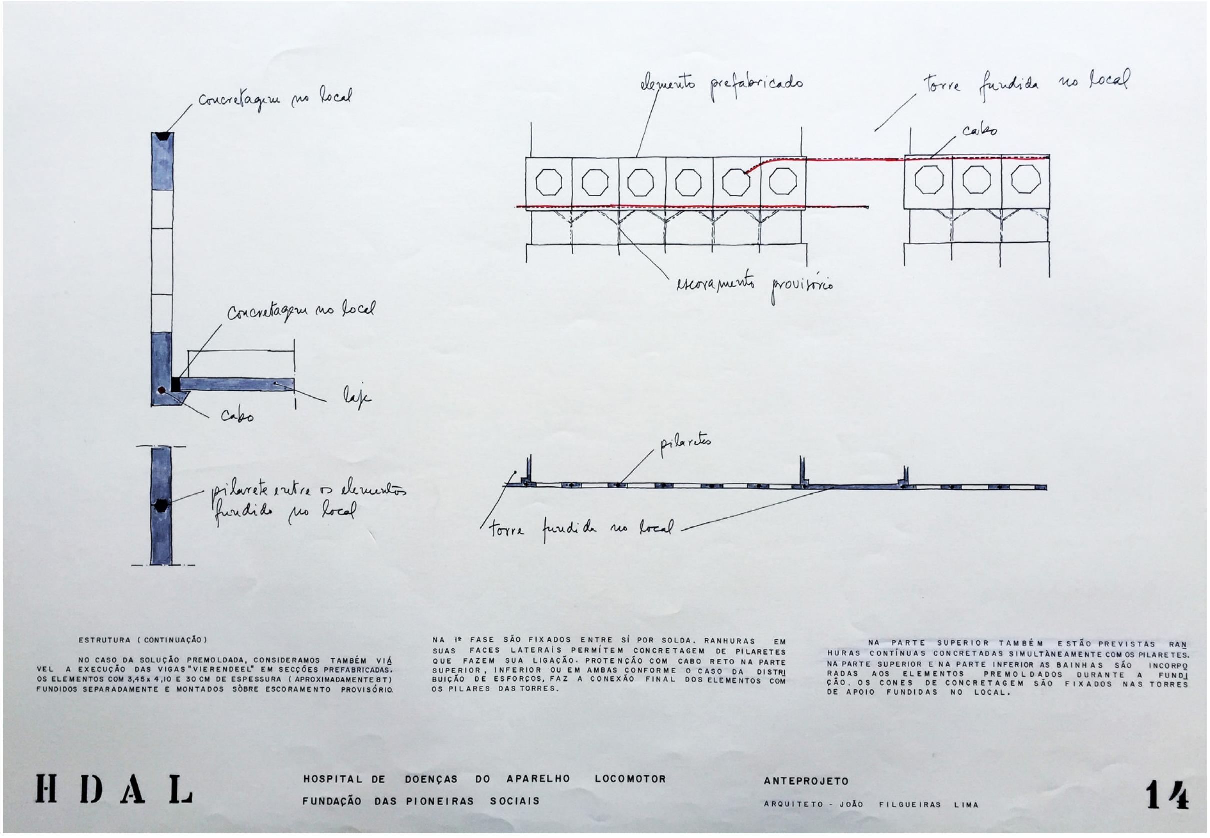

Fig. 1.48 Lelé's prefabricated proposition for the Vierendeel beam of the Sarah hospital in Brasília. João Filgueiras Lima, 1976. Arquivo João Filgueiras Lima

for rationalized construction methods reveal, again, a disjunction between the architect's aims and the final constructive solution. The building designed to adopt prefabricated components in both reinforced concrete and *argamassa armada* was erected on the traditional basis. The efforts made to ensure the adequacy of the project for the use of prefabrication are expressed by the standardization of construction elements, which include the structure, internal partitions, fixed or movable equipment, ceiling luminaires and so on. Among these elements, the case of the Vierendeel beam is of particular interest because of its unexpected technical withdrawal involving the architect and the company in charge of the calculations: *Projectum Engenharia Ltda*.

When Lelé designed this structural element for the Sarah hospital, he gave a reason for his choice and described in detail the assembly process (based on Fig. 1.48):

> We also consider the execution of the Vierendeel beams in prefabricated sections a feasible solution. 3.45m long x 4.10 m high and 30 cm thick, the elements (weighing approximately 8 tons each) will be cast in place separately and assembled over temporary propping. At the first stage, they will be fastened together by means of welding. Side grooves enable the pouring of concrete in order to cast small pillars between the elements responsible for attaching them. Prestressed straight cables positioned on top, at the bottom or both – depending on the distribution of efforts – connect all the components

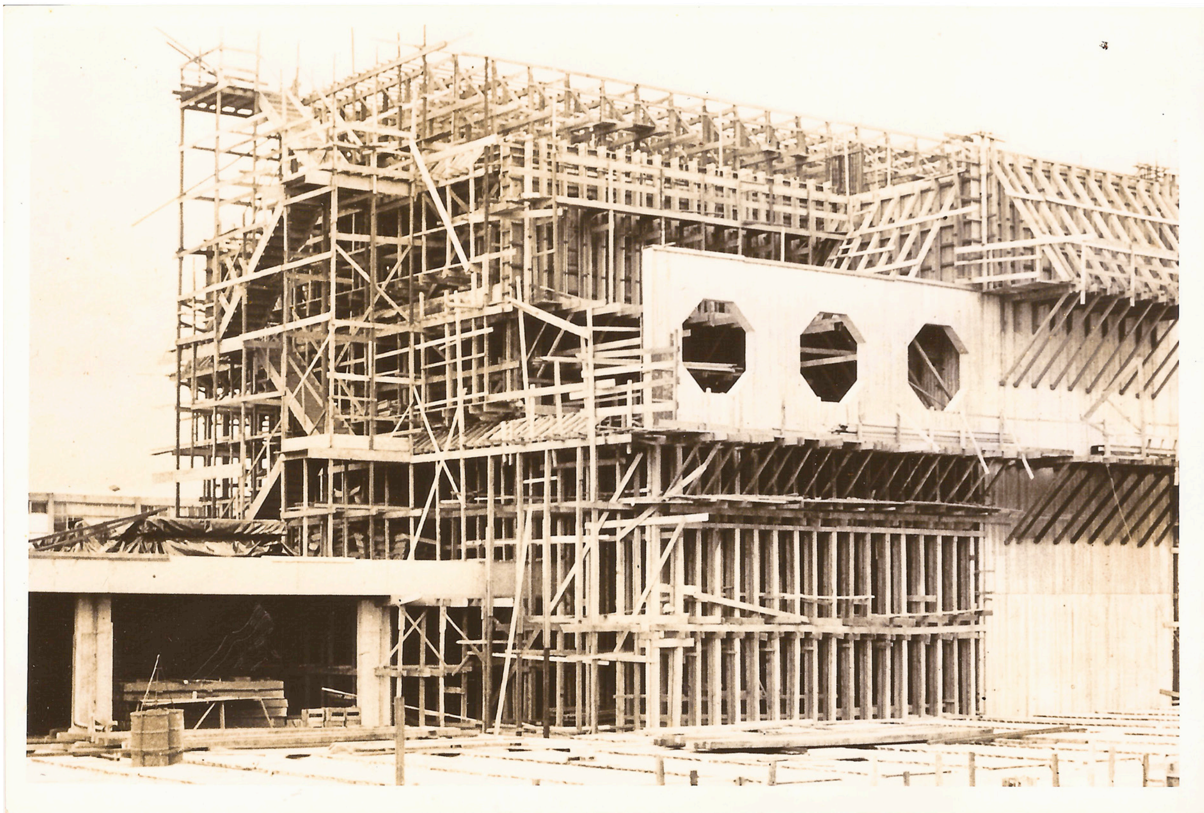

Fig. 1.49 Sarah rehabilitation hospital in Brasília under construction ca. 1978. Arquivo Kristian Schiel, Brasília

to the pillars of the towers.[101]

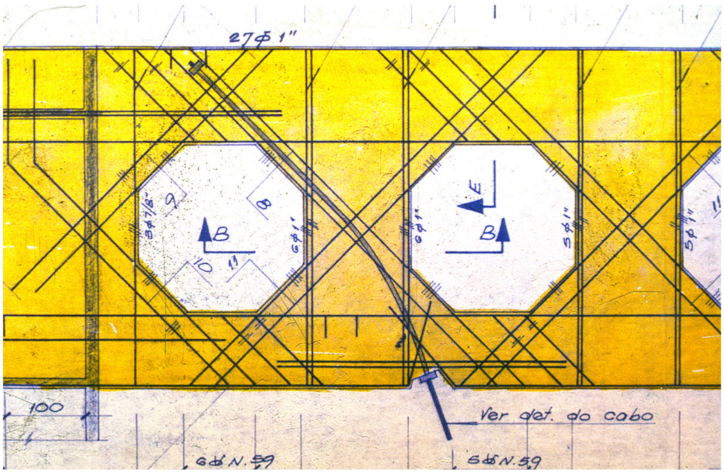

Fig. 1.50 Detail of the prestressed concrete structure calculation (Vierendeel beam). Sarah hospital. Brasília, 1976-80. Arquivo Kristian Schiel, Brasília

Although only two components remained prefabricated as originally planned – the shed cover and the external walls – a combination of apparently unrelated facts encouraged Lelé's further research exploring the possibility of moving from heavy to light prefabrication. If the Sarah hospital in Brasília on the one hand closes a period in which concrete structures reached their highest expression, on the other hand the way in which the project was interfered allows us to understand that Lelé's intensive adoption of *argamassa armada* thenceforth was not disconnected from major administrative, political and technical issues.

Inevitably, we are left to wonder how much further Lelé might have advanced in the field

101 João Filgueiras Lima. HDAL, Hospital de Doenças do Aparelho Locomotor, Fundação das Pioneiras Sociais, Anteprojeto, Prancha 14, 1976. Arquivo João Filgueiras Lima. [Consideramos também viável a execução das vigas Vierendeel em seções pré-fabricadas. Os elementos com 3,45 x 4,10 e 30 cm de espessura (aproximadamente 8 t) fundidos separadamente e montados sobre escoramento provisório. Na 1a fase são fixados entre si por solda. Ranhuras em suas faces laterais permitem concretagem de pilaretes que fazem sua ligação. Protensão com cabo reto na parte superior, inferior ou em ambas conforme o caso da distribuição de esforços, faz a conexão final dos elementos com os pilares das torres] (my translation).

of light prefabrication with *argamassa armada* had it not been for some politicians' involvement in the creation of factories as part of public companies (RENURB, FAEC, *Fábrica de Escolas*, etc.) within the scope of their administrations. In all cases, their government plans for cities like Rio de Janeiro (governor Leonel Brizola, first term 1983-87; second term 1991-94), Brasília (governor José Aparecido, 1985-88) or Salvador (mayor Mário Kertész, first term 1979-81; second term 1986-88) were strongly linked with large-scale investments – on different levels – in urban infrastructure (schools, hospitals, transportation, kindergartens, basic sanitation, etc.). In addition, there were many technical conflicts and much friction between Lelé and certain building companies in charge of the public constructions. However, in order to ensure his works were built, the architect needed to think of ways of making the use of prefabrication more flexible by adjusting it to suit the alterations preferred by the building companies. The introduction of new materials and the weight reduction on precast components are further proof that it was a clever decision.

At the end of the 1960s, Lelé and Milton Ramos were the two most prominent architects in Brasília dealing with prefabrication. Niemeyer's exile[102] favored somewhat the autonomous work of his two former collaborators. Regardless of their own merit and competence, the work alongside the master brought Lelé and Ramos a certain prestige in the capital's professional circle. This represented a great opportunity for both of them. Lelé knew how to use these contacts to promote his architecture, without exempting him from ethical responsibilities or benefiting him financially. On the contrary, the architect showed on several occasions his lack of business savvy.[103]

The case of the Taguatinga Hospital seems to be a good example of how this relation between *patronage* and technical matters furthered Lelé's rationalized production. The architect's questioning of the authorship of the new hospital planning in the outskirts of Brasília – the first to be built according to the Health Secretary guidelines[104] – already shows the critical role of this friendship network in his work:

> Therefore, it is fair to ask why he [Oscar Niemeyer] would have referred me and not Milton Ramos, another architect from his team who had developed, with unquestionable talent and ability, Oscar's first hospital in Brasília [District Hospital, 1959]? I believe that two accidental factors had a significant influence on his decision: firstly, without doubt, the generosity with which Oscar continued to help me, at that time a jobless architect. Secondly, the perception that my relationship with the three doctors from the

102 Oscar Niemeyer stayed abroad for twelve years. From 1962 to 1974, he worked and travelled in many countries in Europe, the Middle East and North Africa. For more details about this period, see "Niemeyer Abroad", in: Underwood, Oscar Niemeyer and the Architecture of Brazil, 152–181.

103 Lelé is far from being considered a businessman. His attitudes towards and interest in public architecture would hardly qualify him as a marketing innovator.

104 The guidelines set out by Oscar Niemeyer with the Brasília Health Secretary aimed for the building's flexibility, extensibility and the alleviation of the internal spaces by incorporating green areas. More information can be found in: Lima, "João Filgueiras Lima, Arquiteto: Pensamento e Obra," 80.

Fig. 1.51 Taguatinga Hospital's internment block under construction. The cast-in-place rigid central core is distinguished by a great amount of propping. Arquivo Kristian Schiel, Brasília

executive committee – Wilson Sesana, Carlos Gonçalves Ramos and Aloysio Campos da Paz – would facilitate the project's elaboration.[105]

Fig. 1.52 Taguatinga Hospital. João Filgueiras Lima, 1968. Arquivo João Filgueiras Lima, Salvador

A third fact should be included in this sequence of coincidences enumerated by Lelé: the then mayor of Brasília was a former engineer during the construction of the new capital. Wadjô Gomide was nominated by the president Costa e Silva as city manager, in charge of approving projects. As reported by the architect: "Hence, there was a certain degree of easiness between us."[106] It is certain that all these factors contributed to the decision of the local government in Brasília to commission Lelé to design the new building. Nevertheless,

105 João Filgueiras Lima, Arquitetura: uma experiência na área da saúde (São Paulo: Romano Guerra Editora, 2012), 22–23. [Cabe aqui, sem dúvida, indagar por que ele [Oscar Niemeyer] teria indicado a mim e não ao Milton Ramos, também arquiteto da sua equipe, que havia desenvolvido com indiscutível talent e competência o projeto do primeiro Hospital Distrital de Brasília, de autoria do próprio Oscar. Nesse caso, creio que houve a interferência de dois fatores acidentais relevantes: o primeiro, sem dúvida, foi a generosidade de Oscar tentando ajudar este seu amigo que na ocasião estava sem trabalho. O Segundo, suponho, foi a precepção de que a realização daquele projeto seria bastante facilitada por minha amizade com os três médicos da comissão que lhe solicitou o tal estudo: Wilson Sesana, Carlos Gonçalves Ramos e Aloysio Campos da Paz] (my translation).

106 João Filgueiras Lima. Interview with Adalberto Vilela on May 4, 2011 in Salvador. In: Adalberto Vilela, *A casa na obra de João Filgueiras Lima, Lelé* (Brasília: Editora Universidade de Brasília, 2017), 304. [Então houve aí uma certa facilidade no relacionamento] (my translation).

the old technical problems that were faced during the Disbrave construction had not yet been clearly overcome. The construction works of the Taguatinga Hospital still left much to be desired.

Fig. 1.53 Taguatinga Hospital under construction, 1972. João Filgueiras Lima, 1968. Arquivo Público do Distrito Federal, Brasília

> Unfortunately, due to the lack of technical know-how and financial problems from the side of the building company, the quality standards of construction did not correspond to the programed technical accuracy. Besides, political issues ousted the design team from the construction direction, which led to a work stoppage for more than two years. The result was no worse than expected because of Joaquim Cambraia's commitment and dedication, an engineer responsible for managing the works.[107]

The Taguatinga Hospital represented a great contribution to Lelé's work, and this was not limited to the innovations achieved in the field of therapeutic treatment, such as the garden-solariums and the nursing wards. From the constructive point of view, the hospital inaugurated an important and successful structural organization: a cast-in-place rigid central core combined with prefabricated façade modules on both sides. This composition would be repeated in many more of his buildings.

The success of this model can be observed in other works by Lelé, such as the Bahia Administration Center Secretariat in Salvador (1973), the Camargo Correa Complex in Brasília (1974),[108] and the Codipe building in Brasília (1975), as well as a couple of unexecuted projects designed for two building companies: the housing apartments in Lybia, for Concic-Portuária, and the R9 Block, designed for Rabello to be built at Guará, a satellite city of Brasília. These last two buildings actually corresponded to the same proposition for a mass housing project conceived around 1974, subject to minor implementation changes (with pilotis in the Brazilian

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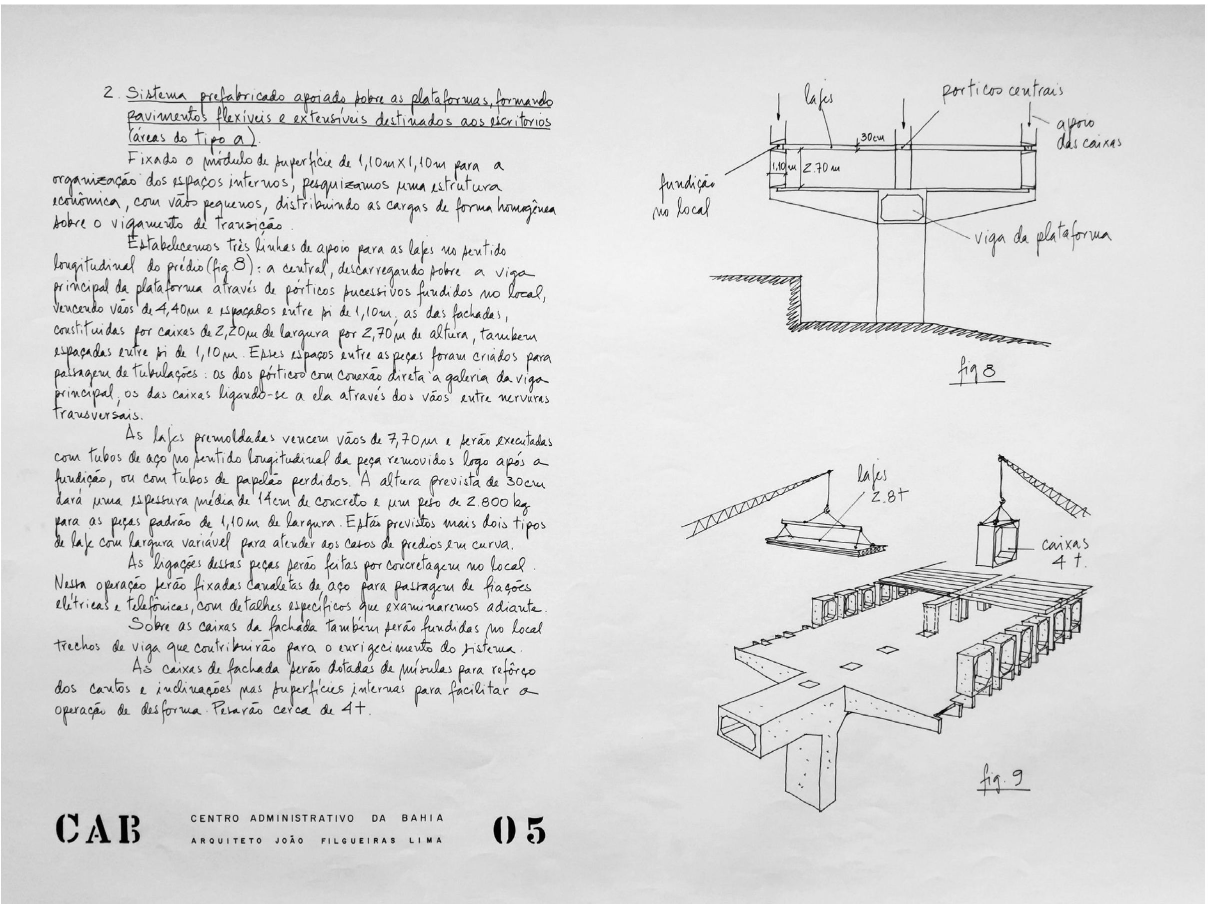
107 João Filgueiras Lima. In: Lima, Arquitetura: uma experiência na área da saúde, 79. [Infelizmente, devido ao despreparo técnico e dificuldades financeiras da firma construtora, aliados a problemas de ordem política, que determinaram o afastamento da equipe de projetos do comando da obra e a paralização dos serviços por mais de dois anos, a construção não apresentou um nível de qualidade correspondente ao rigor técnico planejado. O resultado só não foi ainda pior devido ao emprenho e dedicação do engenheiro Joaquim Cambraia, contratado pela empresa construtora para dirigir a obra] (my translation).

108 The Camargo Correa Complex in Brasília (1974) descends directly from a dropped project designed by Lelé in the early 1970s for the Comind insurance company's headquarters in São Paulo (Tabapuã Street, Itaim Bibi, São Paulo). The unexecuted building's plans (undated) and the pictures of its scale model were found at Lelé's archive in Salvador.


2. Sistema prefabricado apoiado sobre as plataformas, formando pavimentos flexíveis e extensíveis destinados aos escritórios (áreas do tipo a).

Fixado o módulo de superfície de 1,10m x 1,10m para a organização dos espaços internos, pesquizamos uma estrutura econômica, com vãos pequenos, distribuindo as cargas de forma homogênea sobre o vigamento de transição.

Estabelecemos três linhas de apoio para as lajes no sentido longitudinal do prédio (fig. 8): a central, descarregando sobre a viga principal da plataforma através de pórticos sucessivos fundidos no local, vencendo vãos de 4,40m e espaçados entre si de 1,10m, as das fachadas, constituidas por caixas de 2,20m de largura por 2,70m de altura, também espaçadas entre si de 1,10m. Esses espaços entre as peças foram criados para passagem de tubulações: os dos pórticos com conexão direta à galeria da viga principal, os das caixas ligando-se a ela através dos vãos entre nervuras transversais.

As lajes premoldadas vencem vãos de 7,70m e serão executadas com tubos de aço no sentido longitudinal da peça removidos logo após a fundição, ou com tubos de papelão perdidos. A altura prevista de 30cm dará uma espessura média de 14cm de concreto e um peso de 2.800 kg para as peças padrão de 1,10m de largura. Estão previstos mais dois tipos de laje com largura variável para atender aos casos de predios em curva.

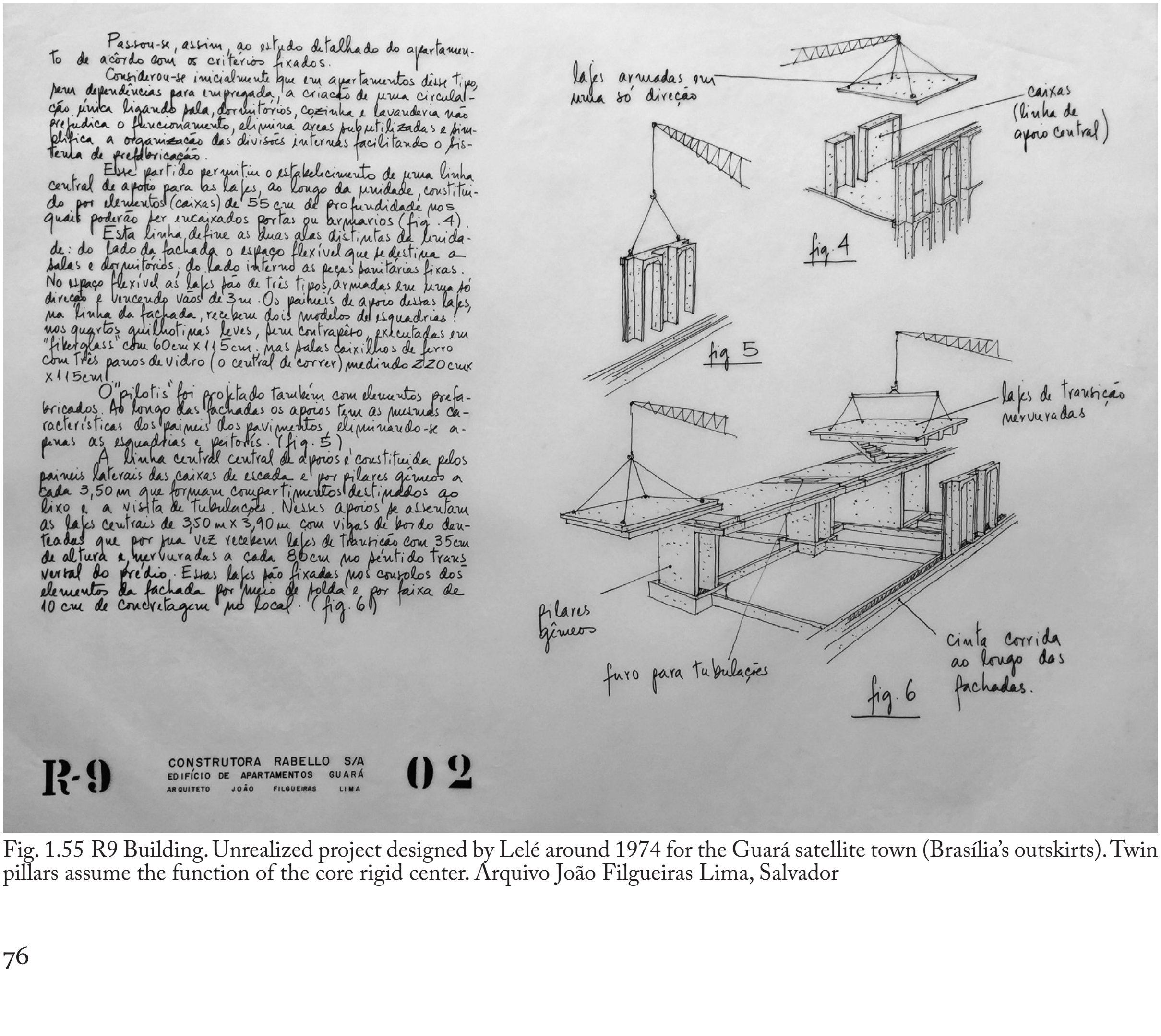
As ligações dessas peças serão feitas por concretagem no local. Nessa operação serão fixadas canaletas de aço para passagem de fiações elétricas e telefônicas, com detalhes específicos que examinaremos adiante.

Sobre as caixas da fachada também serão fundidas no local trechos de viga que contribuirão para o enrigecimento do sistema.

As caixas de fachada serão dotadas de mísulas para reforço dos cantos e inclinações nas superfícies internas para facilitar a operação de desforma. Pesarão cerca de 4t.

CAB CENTRO ADMINISTRATIVO DA BAHIA
ARQUITETO JOÃO FILGUEIRAS LIMA 05

Fig. 1.54 Bahia Administration Center Secretariat. Assembling process of the platforms. João Filgueiras Lima, Salvador, 1973. Arquivo João Filgueiras Lima, Salvador


Passou-se, assim, ao estudo detalhado do apartamento de acôrdo com os critérios fixados.

Considerou-se inicialmente que em apartamentos dêsse tipo, sem dependências para empregada, a criação de uma circulação única ligando sala, dormitórios, cozinha e lavanderia não prejudica o funcionamento, elimina areas subutilizadas e simplifica a organização das divisões internas facilitando o sistema de prefabricação.

Esse partido permitiu o estabelecimento de uma linha central de apoio para as lajes, ao longo da unidade, constituído por elementos (caixas) de 55cm de profundidade nos quais poderão ser encaixados portas ou armarios (fig. 4).

Esta linha define as duas alas distintas da unidade: do lado da fachada o espaço flexível que se destina a salas e dormitórios, do lado interno as peças sanitárias fixas. No espaço flexível as lajes são de três tipos, armadas em uma só direção e vencendo vãos de 3m. Os paineis de apoio dessas lajes, na linha da fachada, recebem dois modelos de esquadrias: nos quartos guilhotinas leves, sem contrapêso, executadas em "fiberglass" com 60cm x 115cm, nas salas caixilhos de ferro com três panos de vidro (o central de correr) medindo 220cm x 115cm.

O "pilotis" foi projetado também com elementos prefabricados. Ao longo das fachadas os apoios tem as mesmas características dos paineis dos pavimentos, eliminando-se apenas as esquadrias e peitoris. (fig. 5)

A linha central central de apoios é constituida pelos paineis laterais das caixas de escada e por pilares gêmeos a cada 3,50m que formam compartimentos destinados ao lixo e a visita de tubulações. Nesses apoios se assentam as lajes centrais de 3,50m x 3,90m com vigas de bordo denteadas que por sua vez recebem lajes de transição com 35cm de altura e nervuradas a cada 80cm no sentido transversal do prédio. Essas lajes são fixadas nos consolos dos elementos da fachada por meio de solda e por faixa de 10cm de concretagem no local. (fig. 6)

R-9 CONSTRUTORA RABELLO S/A
EDIFÍCIO DE APARTAMENTOS GUARÁ
ARQUITETO JOÃO FILGUEIRAS LIMA 02

Fig. 1.55 R9 Building. Unrealized project designed by Lelé around 1974 for the Guará satellite town (Brasília's outskirts). Twin pillars assume the function of the core rigid center. Arquivo João Filgueiras Lima, Salvador case, and without in the model for Lybia).

The rigid central core adopted by Lelé in all of these projects was nothing new. As Bruno Reichlin pointed out, the presence of a sanitary block, enclosed core, or chimney in the middle of a regular planned space, was something that was found in several 'machinist' designs.[109] Naturally, the spatial arrangement of the typical floor plan is determined in those buildings by the lengthwise allocation of a central cast-in-place portico. Whether or not arranged symmetrically along the pavement, hollow core prefabricated slabs – and sometimes precast solid flat slabs – in concrete were set on bearing pads on the previously mentioned porch structures.

The adoption of the enclosed core in Lelé's work was a way of enhancing the building's stability on the horizontal plan and, at the same time, reducing the thickness of the prefabricated slabs comprising the floor and ceiling of each story. By means of a rigid central line in the buildings, Lelé advanced his research on load-resisting systems for heavy prefabrication in reinforced concrete. One component that contributed to the development of this phase and stoods out as the focal point was the façade stacked module. Here, the variety of shapes found on the concrete boxes (rounded, squared and hexagonal corners) designed by Lelé was driven simultaneously by aesthetic purposes and the technical possibilities of the formwork at the time.

By ensuring the quality and feasibility of these elements, the architect also showed his competence in developing new structural syntax. This does not mean that Lelé invented the façade configuration based on stacked boxes. However, the architect's sensibility was evidenced in the way he modified a traditional prefabricated façade element – the panel – into a robust *brise-soleil*. Likewise, when Le Corbusier modified Lucio Costa's original sketches for *La Maison du Brésil* in Paris, Lelé incorporated the raw language of concrete into his architecture.

The architect also proved his capacity for learning from previous experiences and later applying the knowledge gained to his work. This became clear when he designed the Bahia Administration

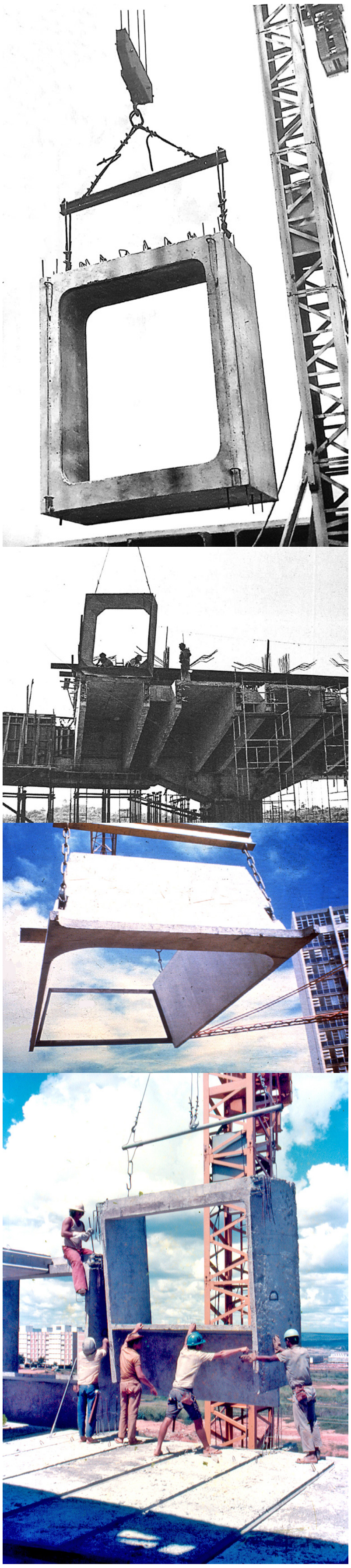


Fig. 1.56 Lelé's concrete stacked-boxes. From top to bottom: Taguatinga hospital (Brasília, 1968), Arquivo Joaquim Cambraia, Brasília | CAB Secretariat (Salvador, 1973), Arquivo João Filgueiras Lima, Salvador | Camargo Correa complex (Brasília, 1974), Arquivo João Filgueiras Lima, Salvador | Codipe building (Brasília, 1975), Arquivo João Filgueiras Lima, Salvador

109 Bruno Reichlin, "Technical Thought, Techniques of Thinking," in *Jean Prouvé: The Poetics of the Technical Object* (Weil am Rhein: Vitra Design Museum, 2006), 45.

Center Secretariat (CAB) in Salvador. Due to the curves that characterize this project, the decision of using the stacked-boxed-façades required a different solution in the search for the convergence adjustments. The linear façade of the Taguatinga hospital – realized five years before within the same parameters – did not contribute to solving the issue. But a building from the university years did. According to Kristian Schiel, "the geometrical solution found for solving the CAB Secretariats came from the experience of the Central Institute of Sciences building (ICC building, Oscar Niemeyer 1962-63)."[110] He explains: "Considering that the curves follow the same pattern throughout the project, that is to say at a constant radius, Lelé adopted the following ratio to resolve the façade problem: for each module of prefabricated box on the inner part of the curve, two modules on the outer part would be used."[111]

The discussions on precast concrete panels and the relevance of modular façade elements to his work led Lelé to give a speech at the Brazilian Institute of Architects in Rio de Janeiro. In his talk, the architect showed that he was aware of the prevailing prefabricated systems in Europe at that time:

> There was much discussion [of prefabricated systems] then. In Europe, the Camus system of load-bearing walls was widely disseminated. The Soviet Union and the Eastern European countries were developing panels on a large scale. However, the Colina precast premise was completely opposite to that process [Camus], in which the load-bearing walls strictly limit the inside spaces. More flexible spaces were intended at that time [in Brasília].[112]

Although Lelé kept his distance from the European precast solutions due to potential layout limitations, the architect appropriated some of their ideas in order to make his earlier projects feasible. This seems to be the case of the concept behind the prefabricated façade panels from the Camus system later employed by Lelé at the Colina building (1962). The architect was right in affirming that the French system operates with constraints which make the apartments' internal space distribution more rigid, and this would have been undesirable at the UnB buildings. However, it appears that some assimilation of both production and assembly processes of the precast concrete panel for the façades occurred at a very early stage.

While the University of Brasília's staff housing keep the same flexible spaces criterion as the apartment buildings designed for Lybia and the satellite city of Guará (R9), one aspect

110 Kristian Schiel. Interview with Adalberto Vilela on May 2, 2016 in Brasília. [A solução geométrica para resolver as curvas das Secretarias do CAB veio da experiência do Minhocão] (my translation).

111 Idem. [Tendo em vista que as curvas seguem o mesmo padrão em todo o projeto, com o mesmo raio, Lelé adotou a seguinte proporção: para cada módulo de caixa premoldada na parte interna da curva, serão usados dois módulos na parte externa] (my translation).

112 Edgar Graeff, Fávio Marinho Rêgo, Joaquim Guedes, and João Filgueiras Lima. *Arquitetura Brasileira Após Brasília. Depoimentos*, (Rio de Janeiro: IAB/RJ, 1978), 220. [Nesse tempo se discutia muito. Na Europa se fazia o processo Camus, muito difundido, de paredes portantes, que a União Soviética e os países do leste europeu estavam desenvolvendo em grande escala. A proposta de pré-fabricação da Colina era inteiramente antagônica à daquele processo que, com as paredes portantes, limita muito os espaços internos. O que se pretendia aí, nessa época, eram espaços mais flexíveis] (my translation).

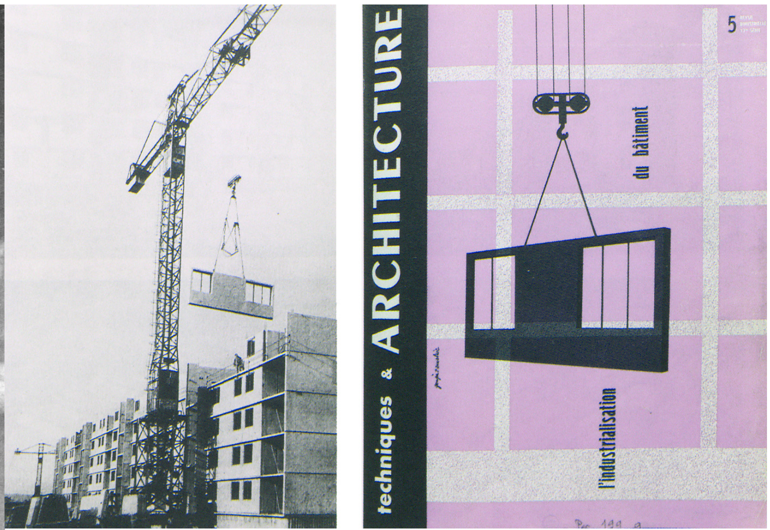


Fig. 1.57 View of the Camus building site in Nanterre, France | Issue of the journal *Technique et Architecture* dedicated to buiding industrialization (nov, 1957). Yvan Delemontey, *Reconstruire la France: l'aventure du béton assemblé 1940-1955* (Paris: Éditions de la Villette, 2015), p. 289

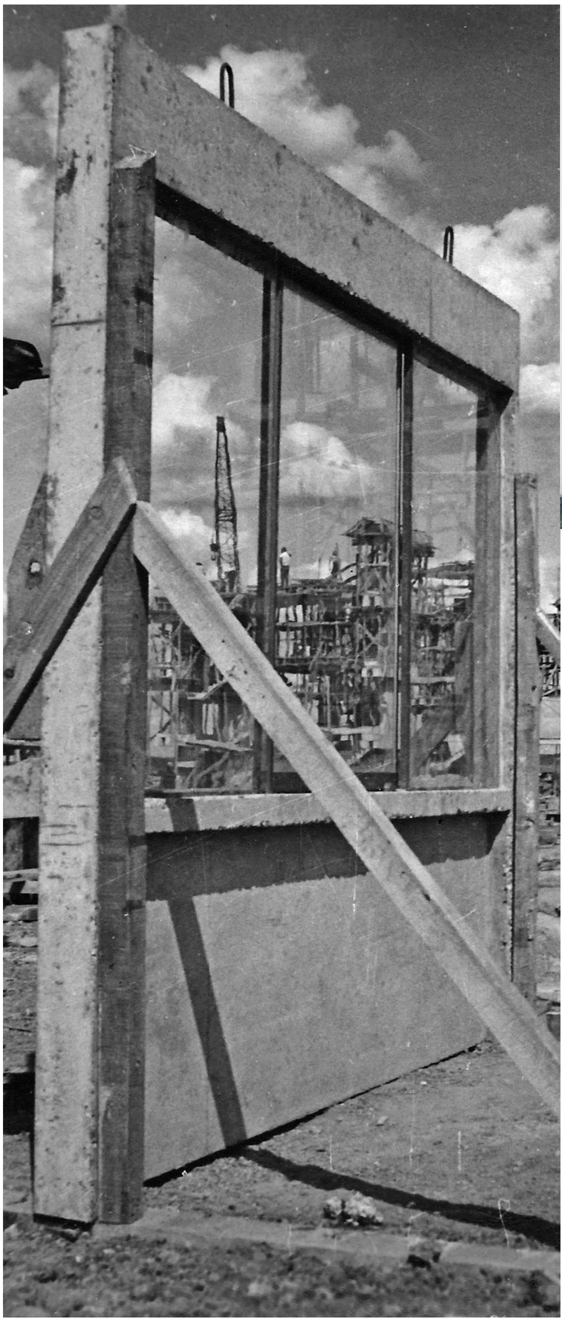


Fig. 1.58 Colina's façade panel. University of Brasília. João Filgueiras Lima, Brasília, 1962. Luiz Henrique Pessina's master thesis (UnB, 1964)

distinguishes them from the internal unit organization: the Colina complex apartments are devoid of the central rigid core. This structural feature in Lelé's work would first appear at the Taguatinga hospital (1968). From this project onwards, the notion of a load-resisting skeleton was strengthened by upcoming projects, particularly the Portobras building (1973) in Lelé's interpretation of Le Corbusier's *Le plan libre,* where there is no structural core or pillars in the middle of the typical floor plan.

Lelé knew about the most popular prefabricated systems operating in Postwar Europe, not only from his readings of technical magazines in Brazil, but also from the trips he made to the Continent on two occasions: in 1963, already covered in the last chapter, and in 1969. "I was hired by Brasília's Health Secretary and therefore I could visit the health systems and hospitals in many parts of the world, with emphasis on Northern Europe, which had a role model infrastructure. I also took a further training course on prefabrication in the former Eastern Germany,"[113] the architect asserted.

In contrast to the previous trip, the 1969 journey was sponsored by Brasília's Health Secretary and aimed to promote the technical visits of doctors, engineers and architects to

113 João Filgueiras Lima, "Mestre da Surpresa [Entrevista a Marcos de Sousa]," *Arquitetura e Urbanismo* 15, no. 82 (1999): 28. [Fui consultor da Fundação Hospitalar de Brasília e pude conhecer os sistemas de saúde e hospitais de várias partes do mundo, com ênfase para os da Europa do Norte, que são modelares. Eu fiz também um curso de aperfeiçoamento sobre pré-fabricação na antiga Alemanha Oriental] (my translation).

referral hospitals in Europe. At that time, Finland had one of the most advanced health care systems. Lelé's contact with Nordic architecture went beyond the traditional purposes of such a techno-scientific cooperation trip. This expedition to Finland allowed the architect to assimilate natural lighting as a critical aspect in his works. Lelé himself reports his impressions:

> It is the preoccupation with detail… What greatly enriches Alvar Aalto's architecture is the preoccupation with the building's functions and its details. I don't think anybody has done this better than him. The detail is fundamental. You learn this with Aalto, Czajkowski (Józef) and other important architects of the same generation. […] I learned a great deal in Finland. I visited a city up north, Tampere, where there was a hospital with six hundred marvellous beds. I became very enthusiastic about the hospital; the ambulatory full of sheds, with the light coming in (I went there in the summer); full of gardens, and, at the same time, everything has the highest technology. It was the only hospital at that time, in 1969, where completely computerized surgery was already being conducted. And despite all that technological absorption, the building was super human, with works of art, moderate, integrated without excesses, with beautiful furniture, and toys. You fall in love with the wooden toys made there.[114]

The architect explored natural light in his corporative designs, even then in a somewhat muted way. Until that point, natural roof lighting had been incorporated through openings found at the buildings' transversal beams (in the Disbrave building, for instance, and Taguatinga hospital). Variations on the design of the roof beams usually provided the necessary protection against direct insolation, which should be avoided in regions with a hot climate, like Brasília. Through simple extensions (structural branch) to the roof beam section, Lelé obtained the expected opening protection. But the experience with *Planalto de Automóveis* workshops (1972) – a Ford maintenance shop and car dealership in Brasília – would later become a milestone in Lelé's career. Like the Disbrave workshops, the Planalto building is a long horizontal pavilion built alongside the *W3 Norte* Avenue in Brasília. However, the apparently trivial choice of using a small prefabricated element attached to the pleated roof structure afterwards assumed major relevance within Lelé's work. Introduced with the purpose of blocking the sun and allowing natural ventilation inside the buildings, the shed later became a symbol of his architecture.

Although the analysis of the various types of sheds Lelé developed over the years has already been discussed by other scholars,[115] they have not addressed the technical challenges involved in its production. My intention here is to emphasize that this component that first

114 Latorraca, João Filgueiras Lima, Lelé, 29–30.

115 For more details about the shed development within Lelé's work see: Jorge Isaac Perén Montero, "Ventilação e iluminação naturais na obra de João Filgueiras Lima 'Lelé': Estudo dos hospitais da Rede Sarah Kubitschek Fortaleza e Rio de Janeiro" (Universidade de São Paulo, 2006); Marieli Azoia Lukiantchuki, "A evolução das estratégias de conforto térmico e ventilação natural na obra de João Filgueiras Lima, Lelé: Hospitais Sarah de Salvador e do Rio de Janeiro" (Universidade de São Carlos, 2010); Eduardo Westphal, "A linguagem da arquitetura hospitalar de João Filgueiras Lima" (Universidade Federal do Rio Grande do Sul, 2007).

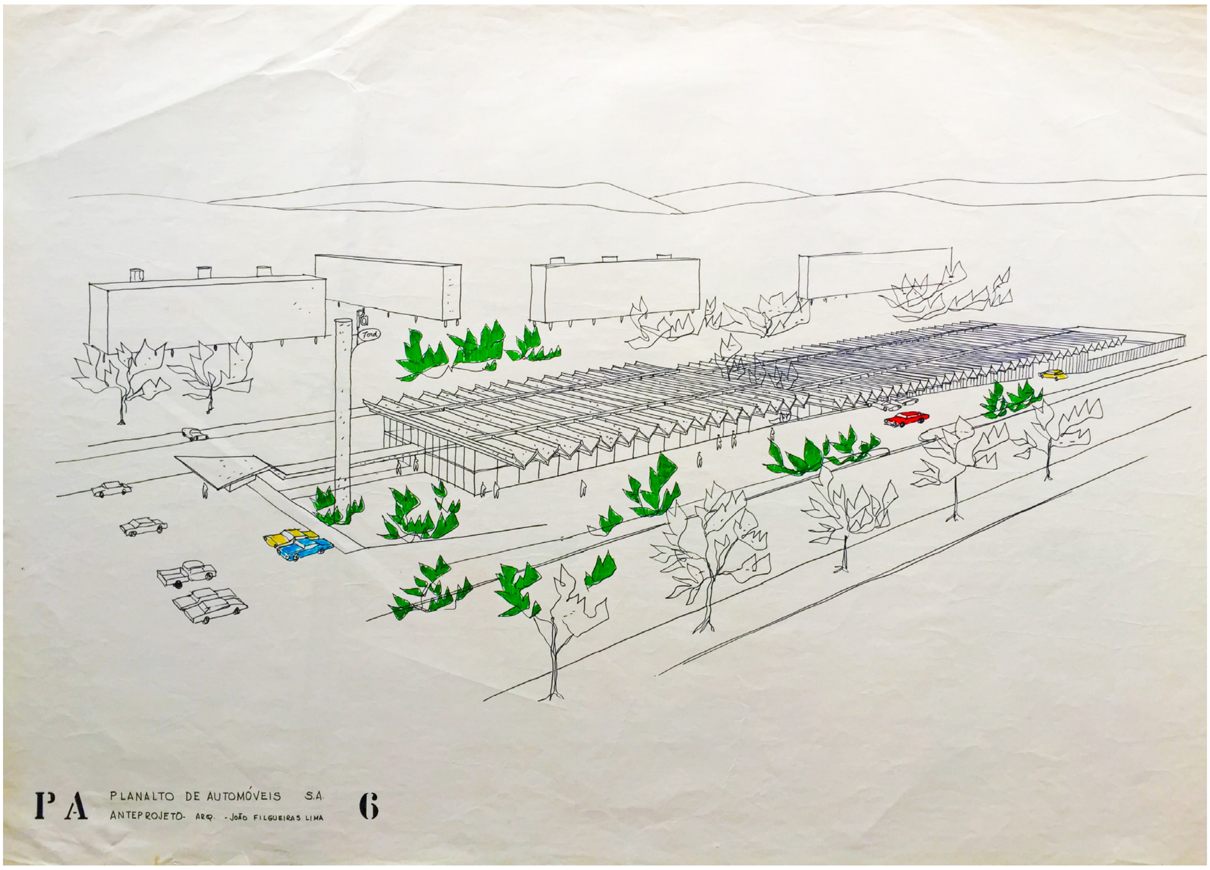


Fig. 1.59 Drawing plan for the Planalto de Automóveis workshops. Aerial view of the complex. João Filgueiras Lima, Brasília, 1972. Arquivo João Filgueiras Lima, Salvador

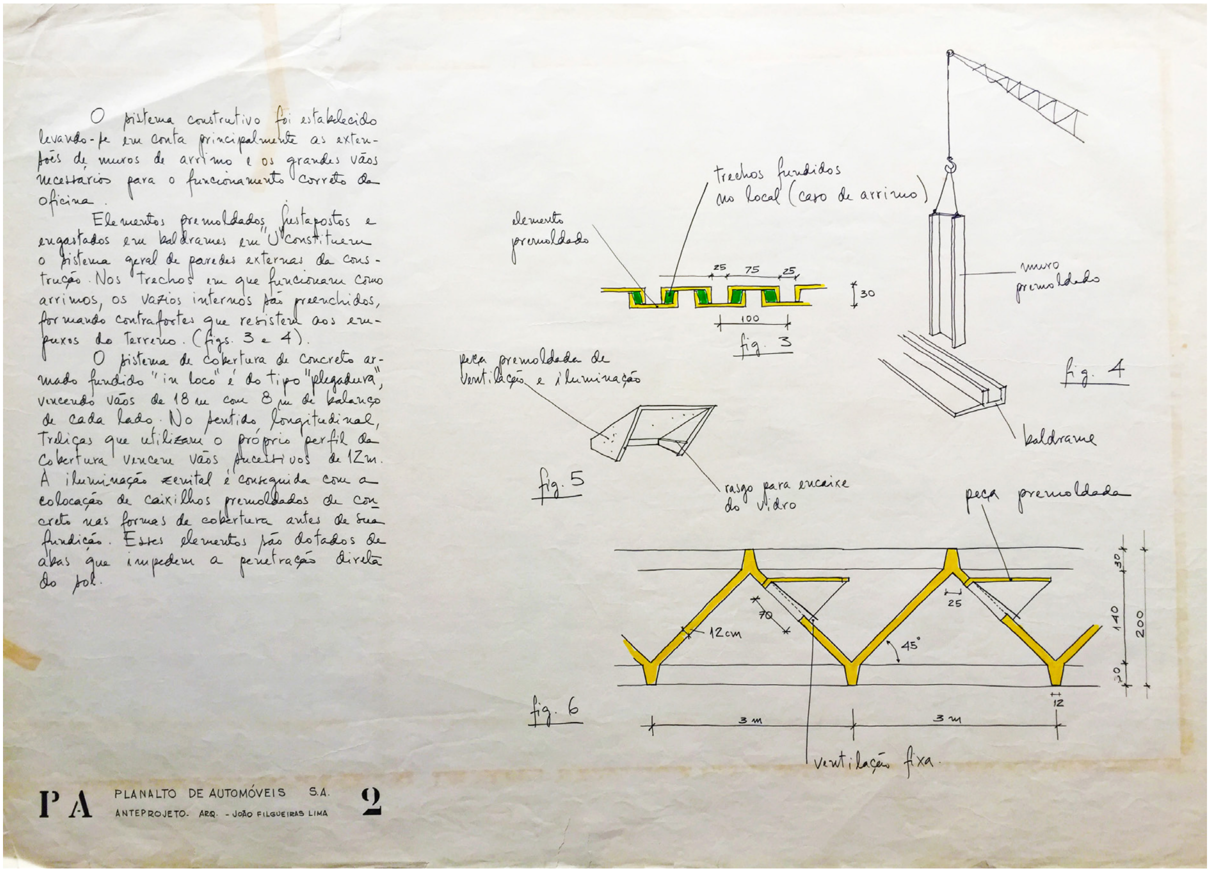


Fig. 1.60 Drawing plan for the Planalto de Automóveis workshops. Description of the structural solution and prefabricated shed. João Filgueiras Lima, Brasília, 1972. Arquivo João Filgueiras Lima, Salvador

appeared in his work as a discreet element did not come out of the blue, but was part of previous and intense research. Lelé, who had long since been aware of the experiments with *argamassa armada* run by the *Grupo de São Carlos,* decided to invite the engineer Frederico Schiel to support him with the development of a peculiar roof element. At the *Planalto de Automóveis'* project descriptive board, the architect thus expresses his goal of using the element, suggesting furthermore its jointing method: "The zenith lighting is achieved by placing premolded concrete frames in the roof formwork before its casting."[116] Yet, what was not clear for Lelé was how that component might be eventually produced. At that time, the term "shed" had not yet been employed in a systematic manner in his work.[117]

It is curious – to put it mildly – that the architect specified "concrete" instead of "*argamassa armada*", knowing that he was already up to date with the material advancements in Brazil.[118] Kristian Schiel – who had collaborated with Lelé as technical designer during the works for the Taguatinga hospital – was thus tasked to provide a solution to the shed construction. During the construction of the Planalto workshops, Lelé sent the young architect on a mission: "Kristian, go to São Carlos, talk to your father, and try to make a prototype of this element (shed) in *argamassa armada*."[119] Although the component was developed in a short period of time, the tests conducted by Dr. Frederico Schiel and his team at the Structures Laboratory of the São Carlos School of Engineering were sufficiently conclusive to warrant the required resistance, even though their method of execution (based on the projection of the object onto a planar surface) would become subject to Lelé's further revision.

An inventive procedure for pre-casting the small shed was employed along the lines of established practices in assembling prefabricated parts following several steps. The critical point of the component's execution process was undoubtedly the folding edges, where built-in steel pivots granted the pleating of the wooden formwork. Once the task had been achieved, the pictures sent to Lelé in Brasília confirmed that it had been more than "a small experiment, rather artisanal."[120] They marked the beginning of a fruitful and close cooperation between the architect and the engineer, which enabled them years later to determine a new method that redefined the use of *argamassa armada* in Brazil. Nonetheless, the period of collaboration

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116 João Filgueiras Lima. [A iluminação zenital é conseguida com a colocação de caixilhos premoldados de concreto nas fôrmas de cobertura antes de sua fundição] (my translation). In: Planalto de Automóveis SA Basic Project [Anteprojeto], project descriptive board [memória], drawing board 2 [prancha 2]. Brasília, undated. Arquivo João Filgueiras Lima.

117 The term "shed" started to be used more systematically within Lelé's work from 1977 onwards, when the architect designed the Daher Clinic in Brasília, a complex of healthcare facilities specialized in plastic surgery and related medical fields such as mastology and endocrinology. At this building, fiber-glass sheds were incorporated as a solution to provide natural light and ventilation from the space between the roof beams.

118 As far as this is concerned, Lelé used to try out new materials even before applying them to construction. In conversation with Kristian Schiel, Lelé declared that he had already built a parrot house made of *argamassa armada* in Brasília, some months before the commission for designing the Planalto workshops. I am indebted to Kristian Schiel for this and other very meaningful anecdotes.

119 Kristian Schiel. Interview with Adalberto Vilela on May 2, 2016 in Brasília. [Kristian, vai para São Carlos, conversa com seu pai e tenta fazer um protótipo para essa peça (shed) em argamassa armada] (my translation).

120 João Filgueiras Lima. In: Lima, O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes, 56. [Os sheds do prédio são de argamassa, uma experiência pequena, até bastante artesanal] (my translation).

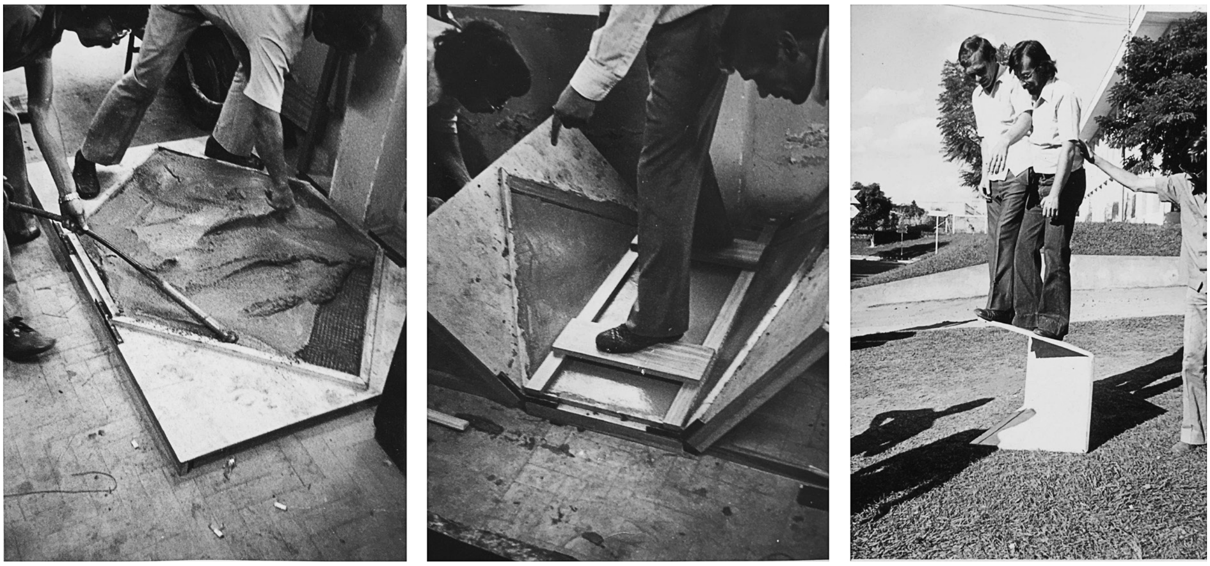

Fig. 1.61 Planalto building's shed (ca. 1972). Prefabrication phases at the Structures Laboratory of the São Carlos School of Engineering. Arquivo Kristian Schiel, Brasília

between Lelé and Dr. Schiel would not be without divergences of opinion, following the construction of the *Planalto* workshops.

During the implementation works of Camurujipe Valley's basic sanitation (1979-1982) – a poor area in the northern region of Salvador with valleys more than 40m high and where one third of the city's population was concentrated – Lelé and the engineer clashed over the procedures of making *argamassa armada* precast elements. Commissioned to act as a consultant for the RENURB factory, Frederico Schiel did not accept changes in the *argamassa armada* composition. It seems obvious that any modification in the cement to water proportion would interfere with the material's resistance. However, in order to obtain a softer consistency for the mortar, Lelé increased the amount of water in the mix, bringing more flexibility to the pouring process. This was necessary because the architect was implementing an uncertain and original procedure of casting elements: the vertical pouring through a movable "double mold."[121]

Despite the fact that reinforced mortar has been traditionally produced via horizontal casting methods using fixed molds on the ground, it is not an exaggeration to affirm that Lelé and his team went through a process of paradigm change.[122] Such processes typically

121 Also named "involving mold", according to the engineer João Bento de Hanai, the double molds involve exposing a large proportion of the precast component's surface after the casting process. In: João Bento de Hanai, *Construções de argamassa armada: fundamentos tecnológicos para projeto e execução* (São Paulo: Pini, 1992), 117.

122 The paradigm change entails modifications in the *argamassa armada* prefabrication standards, affecting concepts, projects and contents. The changes made by Lelé are concentrated around 5 points, presented as follows: 1. Formwork: the recurrent use of metallic forms of elaborate design led to a new standard of movable parts with adjustable frames. / 2. *Argamassa* Pouring: the process of pouring *argamassa* within the formwork is now done vertically, which contradicts the traditional and horizontal way of doing it with concrete or *ferrocemento*. / 3. Material composition: Lelé's *argamassa* fluid mix is apparently incompatible with the resistance to cracking associated with the components. The factor water/cement is much lower when compared with traditional concrete mixtures. / 4. Steel mesh: Lelé adopted a reduced number of meshes in his components – usually only one – while proposing the large-scale adoption of welded steel meshes rather than woven wire screens / 5. Design: the mentioned changes to the *argamassa armada* procedures triggered more sophisticated component design, resulting from a greater freedom and possibilities.

create strife and debate around technical and ideological differences. And this case was not an exception. In order to substantiate his idea, Lelé devised ingenious and elaborate movable metallic formwork, allowing for a higher level of freedom during the components' design phase. Here again, extraordinary outcomes were obtained as a result of a process being carried out with the contribution of experts. It is as though the architect always liked to bring skilled collaborators back together who shared with him a fondness for challenges and who were looking for different ways to solve problems. According to Lelé himself:

> This project [Camurujipe Valley's basic sanitation] demanded the creation of much more complex elaborate metallic frames than those used for premolded concrete. Thus, a pioneer locksmith [metal workshop] sector was developed (very important for the subsequent achievements of reinforced mortar industrialization), and that counted with the relevant participation of various technicians, among whom were: Osmar, inventor of the electrical trio (a trio that plays on a truck crossing city's avenues ahead and along with people dancing and singing) together with Dodô, and Mariano Casañas, a professional of great creative capacity, who was already part of the original team in Brasília.[123]

It is a mistake to think that Lelé's relationship with his collaborators always ran smoothly. Most of the time, the architect's impatience with the slowness of the public sector in Brazil and his eagerness to see practical results created a fast-paced, creative, and energetic work environment. Unanimity among all of his former assistants, pressure and short deadlines were already part of the atelier routine. As stated by Kristian Schiel, "to some extent, Lelé reproduced in his office the rhythm and enthusiasm from the first years of Brasília."[124]

Besides the modifications implemented in the mixture and at the formwork level, the changes proposed by Lelé also affected the wire mesh, a central element of any prefabricated part using the *ferrocemento* technology. Although since 1965 the welded wire fabric had already been tried by the *Grupo de São Carlos*,[125] their experiments with the new feature took place on a limited scale. The popularization and consolidation of welded wire meshes was then assigned to Lelé's industrial production within the Brazilian building sector, as a result of lower production costs and easy handling aspects.[126]

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123 João Filgueiras Lima. In: Latorraca, João Filgueiras Lima, Lelé, 98.

124 Kristian Schiel. Interview with Adalberto Vilela on May 9, 2016 in Brasília. [Lelé de certa forma reproduzia em seu escritório de projetos o ritmo e o entusiasmo dos primeiros anos de Brasília] (my translation).

125 In 1965, the *Grupo de São Carlos* replaced the use of woven wire in some of the structures by welded wire fabric of 5x5cm^2 mesh and 2.6-3.0mm wire diameter. For further information, see: Dante Martinelli et al., "'Ferrocemento' Structures by the São Carlos Group (Brazil)," in *International Symposium on Ferrocement*, ed. G. Oberti and S.P. Shah (Bergamo: Istituto Sperimentale Modelli e Strutture S.P.A., 1982), 3/127.

126 Conforming to Kristian Schiel, the resistance to shrinkage fissures increases as the density of mesh bars per m^2 increases. Welded wire screens had two grid models: 5 x 5 cm or 2.5 x 5 cm mesh. Woven wire meshes included openings of 2 x 2cm, ensuring higher density. The main advantages of welded mesh are the smaller production costs and the easy handling conditions. In São Carlos the engineers worked on a smaller scale than Lelé. Everything was experimental. The high steel mesh

Other improvements were observed in the finishing of precast elements (curing process by warm hydration), and in their storage and transportation, making them easier to deliver on pallets or hangers ("*balancim*") thereby keeping the architect's manual handling compromise. The architect recalled:

> When we think of the use of *argamassa armada* for building we also think of a technology that could employ people, because unemployment is a major problem in Brazil. We could not invent an industrialized technology that meant the loss of jobs in construction, a sector which keeps many families eating and surviving. We had to invent a technology to continue employing people. The level of automation in every factory built for the CIEPs, in Rio de Janeiro, was low – at Sarah's CTRS, though, it is higher. The components' weight was reduced at a level that allowed two men to manually carry them. We did all that to maintain the workforce through a hybrid system using industrialization without giving up the workers.[127]

Nevertheless, I cannot fail to mention some of the shortcomings of the shifts promoted by the architect and his team. The public nature of Lelé's work increased as his state commissions increased. The different sources of funding that supported his experiments in the field of prefabrication in Brazil became a central issue in his oeuvre. The architect even advocated the idea of a commercial commitment between the government and factories: "In order to have a building company that invests in a school factory the State is required to undertake the purchase of the entire production. No one can set up a factory like that and then hear 'now, I am not going to build schools. I do not want any more of these prefabricated ones, I want something different.'"[128]

Furthermore, creating and managing a building factory should not be seen as a strictly

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consumption within Lelé's factories led to the widespread use of welded meshes. [A resistência a fissuras de retração aumenta conforme a densidade de barras por m2 também aumenta. A tela soldada costumava ter uma malha de 5x5 cm ou de 2.5x5 cm. A trançada, se não me falha a memória, era de 2x2 cm, maior densidade. A vantage da soldada é o custo de produção menor e a maior faciilidade de manuseio (não tem os "vícios" inerentes à trançada). Em São Carlos, o pessoal trabalhava em escala menor que o Lelé. Tudo era experimental. Já o consumo alto de uma fábrica de argamassa armada levou à tela soldada. A Telcon ampliou sua produção para atender à demanda da época, criada pelo Lelé com suas fábricas] (my translation). In: Kristian Schiel. Email interview with Adalberto Vilela on November 21, 2016.

127 João Filgueiras Lima. In: Lima, O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes, 113. [Quando nós pensamos no uso da argamassa armada para construir, pensamos também numa tecnologia que empregasse gente, porque o desemprego é um dos grandes problemas do Brasil. Não podíamos inventar uma tecnologia industrializada que significasse a perda de empregos na construção civil, que continua a ser o que mantém muitas famílias comendo, sobrevivendo. Tínhamos de inventar uma tecnologia que continuasse a empregar gente. O nível de automação nessas fábricas todas que foram feitas para os Cieps, no Rio de Janeiro, era baixo – no CTRS do Sarah é maior. O peso das peças era diminuído para permitir que dois homens as carregassem. Tudo isso para manter a mão-de-obra, havia um sistema híbrido, de usar a industrialização sem abrir mão dos operários] (my translation).

128 João Filgueiras Lima apud Marques, "A obra do arquiteto João Filgueiras Lima, Lelé: projeto, técnica e racionalização," 111. [Para ter uma construtora que invista numa fábrica de escola é preciso que o Estado garanta a compra de toda a produção, pois ninguém pode montar uma fábrica como essa para depois ouvir 'agora não vou mais construir escola, não quero mais essas pré-fabricadas, quero diferente'] (my translation).

individual enterprise, but rather as the conclusion of a long process that may involve – in the basic instance – the convergence of a common and sustained political will with a significant level of engagement and competence on the part of the technical team. Any disturbance to this delicate balance can lead to the downfall of the industrial activity in question.

Before the first factory (RENURB) made its appearance in 1979, Lelé's professional attitude regarding rationalized construction had a different orientation. From this understanding, this first part of the thesis has addressed the key moments of the architect's shifting approach to prefabrication, from which the upcoming conclusion is to be drawn. Therefore, three aspects have become central to the narrative: the decisive figures with whom Lelé worked (technicians, politicians, workers, engineers and so on), his constructive knowledge acquired from a long process of investigation into building rationalization (and not from random circumstances), and the role of the building companies in boosting the architect's industrial mind. Thus, one may say that Lelé's practice provides us with a clear perception of which conflicts and contradictions operated as a mutual learning device toward some more effective precast initiatives.

Building in Brazil: a question of scale or persistence?

Tactics for constructing teams, professional disagreements, common interests and adaptation mechanisms, all contributed to consolidate in Lelé a framework of rationalized strategies essential for the development of his further designs. Drawing, for instance, is a strong apparatus within this context, mainly because it embodies the architect's technical mind. One could say that Lelé's drawings are intimately intertwined with realism. However, though precise and plausible, the architect's mental image of architecture might not have always corresponded to the built reality.[129] This would not be a problem if it did not reveal, among other things, the logic by which prefabrication – from a certain moment on – was frequently put forward as a disadvantage in the face of archaic procedures still in use by the construction sector in Brazil. This becomes evident when we put into perspective the sequence of failures attributable to Lelé and his team, which remains a prerequisite for the architect's constructive research: the capacity of converting a lack of means into challenges.

I would like to draw attention to a small serially-produced component. I refer to the plastic spacer disc (15 mm) designed by Lelé to prevent contact between the wire mesh and the inner part of the forms during the pouring phase, thereby ensuring a uniform minimum mortar cover. Lelé did not create the object, since spacers had already been used for years in concrete construction. However, the architect contributed enormously to *argamassa armada*

129 For an enriching analysis on Lelé's relation with architectonic representation, see: "O desenho como indicador de uma poética" [Drawing as a poetic indicator]. In Elane Ribeiro Peixoto, "Lelé: O Arquiteto João Da Gama Filgueiras Lima" (Universidade de São Paulo, 1996), 155–65.

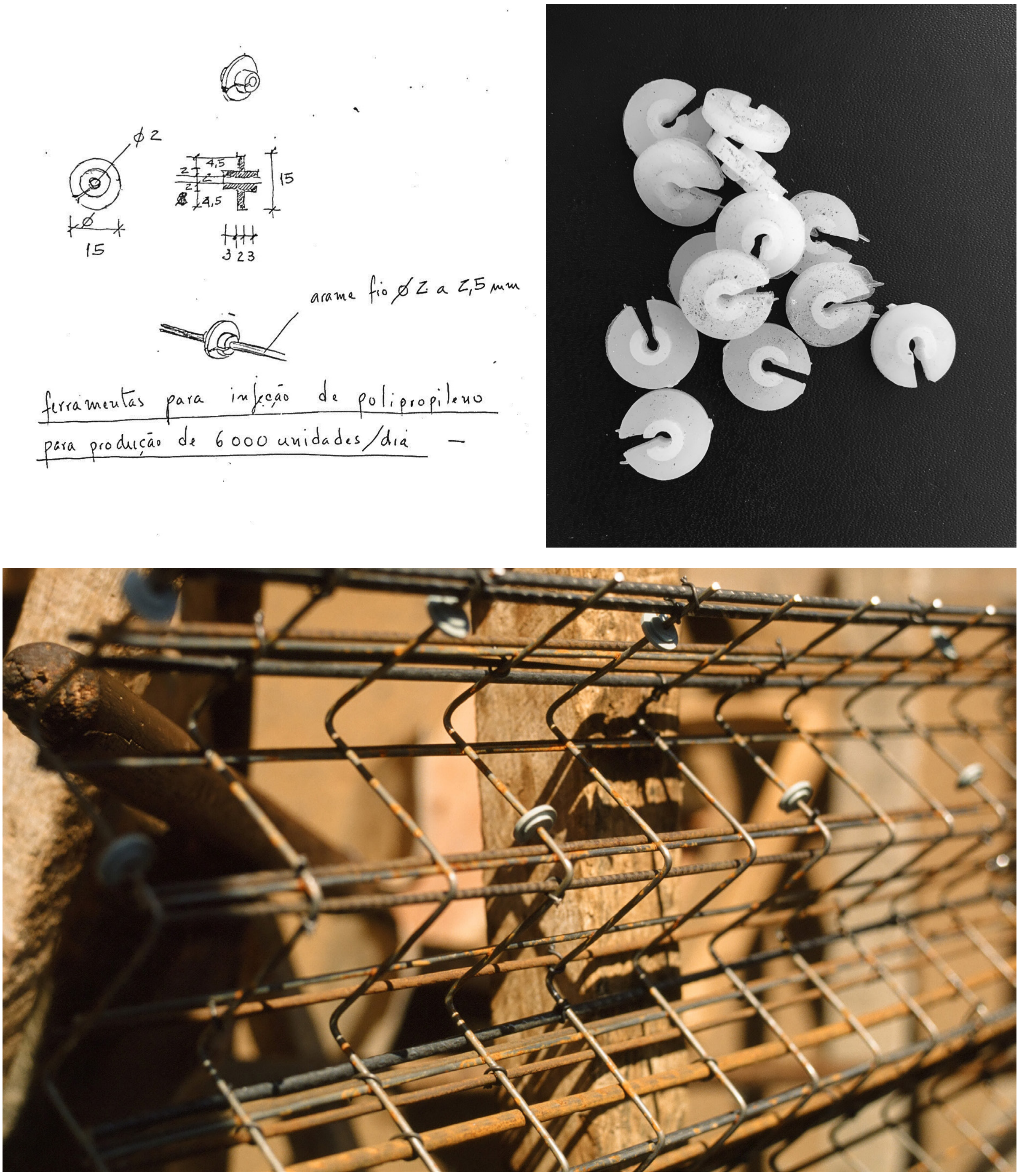

Fig. 1.62 Plastic spacer. Top left: Lelé's sketches detailing the object dimensions and production estimation. Arquivo Kristian Schiel, Brasília | Top right: samples of the spacer from the CTRS factory in Salvador. Photograph by the author | Bottom: Application of the spacer in the welded steel mesh of a precast *argamassa armada* element. Arquivo Kristian Schiel, Brasília

procedures when he redesigned the spacer disc, reducing its dimensions to new standards. This illustrates the architect's indiscriminate interest for providing solutions – which would have been impossible to adopt otherwise – to recurring construction problems regardless of scale. From Salvador's transportation system to the joints of footbridges, Lelé needed to cope with a host of incompatibilities, in his endeavour to pursue prefabrication from the works at the University of Brasília onwards.

In his doctoral thesis, Gilbert Simondon noted that "when incompatibilities arise from the gradual overloading of the subassembly system, a game of limitations is played out, and if boundaries are crossed this constitutes progress."[130] The list of long-established 'incompatibilities' in Brazil includes unregistered patents due to lack of interest in the construction market, and failed urban mobility plans due to discontinued public policies, besides numerous unfinished or aborted projects because of a shortfall in financial resources. Even in the face of this wide range of problems, Lelé often succeeded in transforming obstacles into opportunities and hence promoted structural advances in rationalized architecture. It must be remembered, moreover, that this knowledge was gradually built on a body of constructive experiences directly associated to the architect's professional and personal interests.

In this compendium of undertakings in which his interlocutors played an essential role, what brings rationalization to the fore in Lelé's work is more related to his constructive aspirations rather than the circumstances in which the architect acted. In a period that anticipated the creation of factories – that is to say, when an industrial production method was being incorporated into his architecture – an effort to enable an increasingly rationalized production is clearly visible. However, the implementation of Lelé's first factory (RENURB, 1979-1981) – almost 20 years after his first incursion into on-site heavy prefabrication (the Colina building, 1962) – shows that perhaps evolution is not the appropriate term to designate this long and intricate process, but resilience.

Lelé's capacity to adjust and adapt not only led to the materialization of the technical object, one way or another. Above all, it favored an attitude and behaviour that leaned towards an operative-based method and practice guidelines. All in all, one can say that rationality in this phase of Lelé's work represents an inseparable component of his search for solutions, which were not always governed by favorable economic principles, as many of his accomplishments ended up being even more costly than traditional construction. Usually seen as a prerequisite for industrialized architecture, rationalization in Lelé is also a political and social compromise with regard to the challenges of building a better country. It now remains to be investigated whether the mechanisms of this broad constructive lexicon reinforce or undermine Lelé's perception of architecture as process.

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130 Gilbert Simondon, Du mode d'existence des objets techniques (Paris: Aubier, 1989), 27–28. [C'est dans les incompatibilités naissant de la saturation progressive du système de sous-ensemble que réside le jeu de limites dont le franchissement constitue un progrès] (Translated by Jemma Dunnill).

Part II

Light prefabrication: within the framework of systems and components

Fig. 2.1 Worker and local resident during the construction of prefabricated stairways as part of the sanitation project for the Camurujipe Valley in Salvador, Brazil (1980-81). Arquivo Kristian Schiel, Brasília

"The greatest humanistic and historical task of the oppressed: to liberate themselves..."

Paulo Freire

4. From *ferrocemento* to *argamassa armada*: the resurgence of a material

Lelé's systematic involvement with *argamassa armada* in Brazil (1980) began during a period of clear decline in this technology in some European and North American countries. The hopeful tone with which a group of engineers (*Grupo de São Carlos*) presented their accomplishments in Brazil during the 1st International Symposium on Ferrocement in Bergamo in 1982,[1] contrasted with the pessimistic air of the speech given by Mario Nervi, engineer and son of Pier Luigi Nervi, deceased two years before. The heir of the then prestigious Studio Nervi[2] was emphatic in his talk at the event's closing session: "I am convinced that 'ferrocement' could have fruitful applications only in the 'developing countries'[3] (my emphasis) where the cost of the labour is proportional to a low level of the cost of life. This would mean the same conditions we had in Italy during the first ten years after the war."[4]

The high incidence of labor on the final cost of *ferrocemento* due to better economic conditions in the postwar period led to the phasing out of the technology, not only in Italy,[5] but in many countries in Europe, North America and Australia. In these countries, where pre- and poststressed concrete, steel structures and high-strength concrete were in the spotlight, the application of ferrocement for building purposes was drastically reduced from 1960 onwards. In the so-called countries with a social economy (Cuba, China, and Eastern Europe), the situation was even more striking: while the public investment in the precast building industry placed countries like Poland, the Soviet Union and Czechoslovakia among the world's key research centers on ferrocement – besides Japan, the USA and Great Britain – the main use of ferrocement in Cuba and in Asian-Pacific countries remained associated with constructions on water, such as boatbuilding and floating wharfs.

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1 Dante Martinelli et al., "'Ferrocemento' Structures by the São Carlos Group (Brazil)," in *International Symposium on Ferrocement*, ed. G. Oberti and S.P. Shah (Bergamo: Istituto Sperimentale Modelli e Strutture S.P.A., 1982), 3/127-3/134.

2 See Alberto Bologna and Gabriele Neri, "Pier Luigi Nervi in the United States. The Heigh and Decline of a Master Builder," in *Structures and Architecture: Concepts, Applications and Challenges*, ed. Paulo J.S. Cruz (Guimarães, Portugal: Taylor & Francis Group, 2013), 1900–1906.

3 The heterogeneity of countries worldwide should indicate why "developing countries" is a problematic term. Instead of adopting this classification model, in this work I rather suggest positioning countries according to their geographical position. The traditional distinction of "developed" and "developing" countries generalizes national efforts, omitting significant aspects of their advancement.

4 Mario Nervi, "Ferrocement Application in the Developing Countries," in *International Symposium on Ferrocement*, ed. G. Oberti and S.P. Shah (Bergamo: Istituto Sperimentale Modelli e Strutture S.P.A., 1982), A-50.

5 According to Mario Nervi, the fast decline in ferrocement applications in Italy was propelled after the S.A.F.C.A. (Società Anonima Ferro Cemento Applicazioni) went into liquidation in 1960. In: Ibid., A/50. For other forms of ferrocement application in Italy after this period, see João Bento de Hanai, *Construções de argamassa armada: fundamentos tecnológicos para projeto e execução* (São Paulo: Pini, 1992), 33.

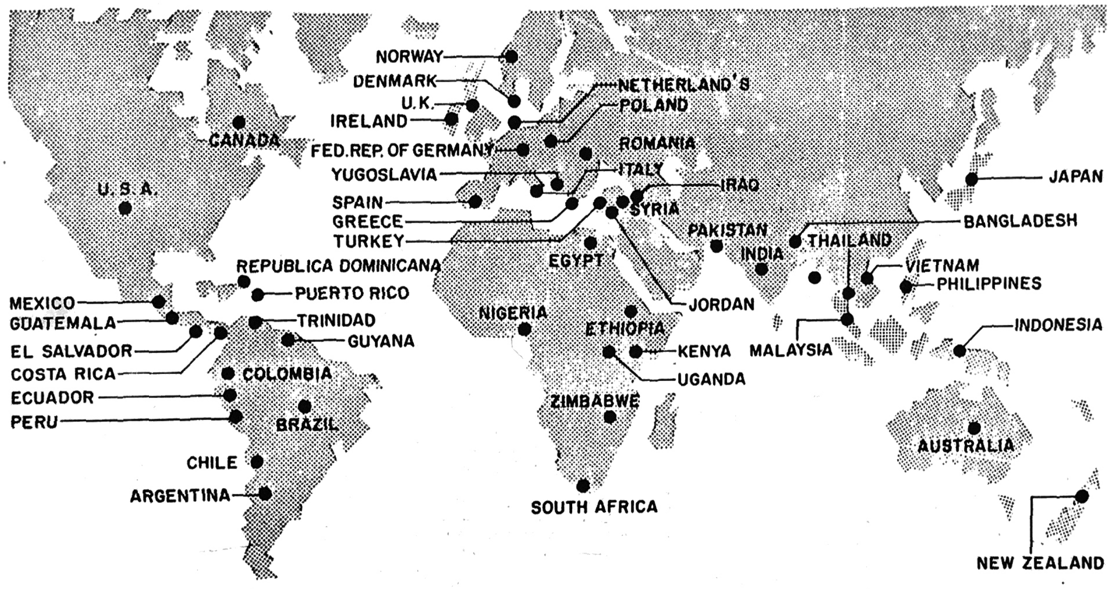

Fig. 2.2 Universities (by countries) where ferrocement technology was taught between 1981 and 1988. IFIC Curriculum Campaign. L. Robles-Austriaco, "IFIC Outreach Programs", in 3rd Intl. Symposium on Ferrocement (Roorkee, India: McGraw-Hill, 1988), 649.

Despite the global outreach programs created by the IFIC[6] (International Ferrocement Information Center) during the 1980s to promote the widespread use of the technology – especially in the Middle East and Southeast Asian countries[7] – the recognition of ferrocement as a structural material did not lead to its increased application in building construction in the Global South.[8] According to Arne D. Jensen – engineer from the Technical University of Denmark and participant at the symposium in Bergamo – "in the developing countries the material has shown particularly good applicability under primitive conditions and for purposes for which there has been and still will be a great need: water tanks, grain silos, fishing boats, barges, etc."[9]

6 The International Ferrocement Information Center (IFIC) was founded in October 1976 at the Asian Institute of Technology (Thailand) as a result of the recommendations made in 1972 by the U.S. National Academy of Sciences' Advisory Committee on Technological Innovation [full-text recommendation at: Julien Engel et al., *Ferrocement: Applications in Developing Coutries* (Washington, D.C.: National Academy of Sciences, 1973), 11.]. IFIC receives financial support from the Government of New Zealand and the International Development Research Center (IDRC) of Canada. Surprisely, Switzerland and Russia are not listed on IFIC's Curriculum Campaign map. For more on the attributions and purposes of the instittition, see: Lilia Robles-Austriaco, "International Ferrocement Information Center," *Concrete International* 9, no. 9 (1987): 39–41.

7 Through a pilot project called FIN (Ferrocement Information Network) launched in 1985, IFIC established an agreement with five universities – from Malaysia, the Philippines, India, Saudi Arabia and Indonesia – to accelerate the diffusion of ferrocement in Southeast Asian, Middle Eastern and South Asian countries. The institution also developed other activities to promote the technology, such as seminars, training programs, demonstrations, canoe races and research. More information can be found at: Ibid.; Lilia Robles-Austriaco, "IFIC Outreach Programs," in *Third International Symposium on Ferrocement*, ed. S.K. Kaushik and V.K. Gupta (Roorkee, India: McGraw-Hill, 1988), 644–649.

8 The Global South is a term that appeared about 1969 and was largely used over the 2000s. Basically, it refers to a group of countries interconnected by a common past of colonialism and neo-imperialism, sharing a similar social, political and economic structure. Most scholars prefer the term to the 'Third World' and 'Developing Countries.'

9 Arne Damgaard Jensen, "Production Technologies, Applications and Cost Evaluation," in *International Symposium on Ferrocement*, ed. G. Oberti and S.P. Shah (Bergamo: Istituto Sperimentale Modelli e Strutture S.P.A., 1982), A/52-A/54.

If on the one hand the expert's report, which closed the event's proceedings, oversimplified the complex development of ferrocement in Southern countries, on the other his brief review of the main contributions of the symposium drew attention to a neglected aspect of central importance: cost evaluation. "Only two papers dealt with cost evaluation as their main subject. Four papers mentioned cost evaluation,"[10] highlighted Jensen, who attributed the difficulties of giving a realistic overview of the subject to the differences between economic systems, working procedures and applications.

Given that cost evaluation was at the heart of the choice to downsize ferrocement and shell structures in many European and northern American countries,[11] it seems pertinent to question how some of the strategies used in developing nations ended up promoting the application of ferrocement to structures with relative success? The simple fact that in poor regions cheap labor force combined with the wide availability of component materials (sand, cement, wire mesh and steel bars of small diameter) at low cost did not imply any impetus to search for alternatives to ferrocement construction. So, what exactly contributed to broadening the field of application of the material, making it suitable for structures in Southern countries?

Maybe the response to this question can be found in the way the technology was appropriated in those regions. Whereas the initial characteristic as a "do-it-yourself material"[12] favored a certain freedom of ferrocement's use in countries where technical standardization came later,[13] collaborative practices created a fruitful research environment, regardless of whether independent or academically linked. This was the case in Brazil, where the research on *argamassa armada* (ferrocement) initiated early in the 1960s by a group of engineers (*Grupo de São Carlos*) was followed up and enhanced by the architect João Filgueiras Lima (Lelé) and his team many years later. Like other Southern countries' material tryouts and experiments, the first attempts by the *Grupo de São Carlos* to build ferrocement structures in Brazil included silos (Andirá, 1964), ground water tanks (Araraquara, 1973), shell roofs (Itabuna, 1965), water towers and precast culverts.

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10 Ibid., A/53. The 1st International Symposium on Ferrocement involved 93 participants, from 28 countries; a total of 54 papers were submitted.

11 Some of the best-known concrete engineers proved the downfall of ferrocement and shell structures in Europe and North America during the second half of 20th century. Pier Luigi Nervi (1891-1979), who abandoned his "ferrocemento" from 1960 onwards, was followed by Félix Candela (1910-1997), who discontinued after 1971 his experiences with shell structures in Mexico, followed by Eduardo Torroja (1889-1961) and Ildefonso Sanchéz del Río (1898-1980) in Spain. For further information on the development of ferrocemento and concrete shells, see: Bill Addis, *Building: 3000 Years of Design, Engineering and Construction* (New York: Phaidon, 2007), 480–499; José A. Fernández Ordóñez and José Ramón Navarro Vera, *Eduardo Torroja: Ingeniero, Engineer* (Madrid: Pronaos, 1999); Pier Luigi Nervi, *Aesthetics and Technology in Building* (Cambridge, Mass.: Harvard University Press, 1966); Roberto Gargiani and Alberto Bologna, *The Rhetoric of Pier Luigi Nervi: Concrete and Ferrocement Forms* (Lausanne: EPFL Press, 2016).

12 See Jensen, "Production Technologies, Applications and Cost Evaluation," A/52.

13 In Brazil, the official standard on ferrocement came out only in November 1989. Published by ABNT, the NB-1259 was entitled "Ferrocement – Design and construction – Procedure" [Projeto e execução de argamassa armada]. In comparative terms, the Soviet standard for ferrocement structures – SN-366/67 – was published in 1967. See Hanai, *Construções de argamassa armada: fundamentos tecnológicos para projeto e execução*, 34.

One of the limitations known to prevent the wide use of ferrocement applied to structures is the difficulty associated with its construction.[14] Even considering the developments achieved by the *Grupo de São Carlos* in ensuring the mechanical properties and durability of *argamassa armada* while reducing the costs, a certain restraint concerning the premolded unities' shape visibly affected their work. This is due to the complexity, to a lesser or greater extent, of the mechanisms to execute the folding angles of the precast thin elements. The final geometry of a monolithic ferrocement component depends on the means available for its fabrication, and in the production process the formwork is given a central place.

Lelé's main contribution to component design and fabrication resides in the inherent limitation of the production model adopted by the *Grupo de São Carlos*. While assimilating the group's major adaptations of Nervi's *ferrocemento* – namely the reduction of both cement content (to 600-650 kg/m^3) and the steel proportion (to 250-300 kg/m^3) – Lelé opted for an even more fluid cement mortar matrix with a poor ratio of steel mesh[15] to optimize the casting process in movable metallic formwork. By placing the free articulated molds on the production chain, Lelé significantly accelerated the output rate of his plants.[16] But his manufacturing procedures will be the subject of the last part of this investigation.

In this second part (Systems and Components), I intend to show how the material change (from concrete to *argamassa armada*) – recurrently seen as a technical response to enable Lelé's projects in his phase of light prefabrication – was not exclusively associated to the weight of components. In fact, besides the heaviness issue, questions related to assembly details, handling, aesthetic considerations and above all the manufactured process also dictated the design decisions. This led to a change of scale (moving from urban landmarks to urban equipment) and program (from that moment on, predominantly social) in his work, but also a new way of thinking and producing architecture (now through small components).

What matters here is to ascertain how Lelé effectively developed his *argamassa armada* components. To what extent are they "the tidy sum" of a process exclusively centered on functionality and low-cost systems? Other possible variants may be at stake too.

4.1 The role of politics for a public-sector architect

At the end of the 1970s, Brazil was facing a period of adjustments and strategic redirection on the economical and political tracks. The transition process back to democracy

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14 See Bernard R. Walkus, "An Efficient and Economical System for Producing Ferrocement Elements," *Journal of Ferrocement* 11, no. 2 (1981): 155–162.

15 These figures from Nervi, *Grupo de São Carlos* and Lelé's ferrocement constitution were presented in the first part of this dissertation.

16 It is known that, unlike the *Grupo de São Carlos*, Lelé oriented his experiences not only towards prefabrication, but also building industrialization. This led to different approaches and results.

during the last years of military dictatorship (1974-85) came at a high price to Brazilian citizens. The excessive external debt, allied to an increasing inflation and a severe economic recession, led to crises in politics (upheavals within the military command), industry, commerce and many other sectors of an ever more dissatisfied population. Under the direction of the Army General Ernesto Beckmann Geisel (1974-79), the cycle of extraordinary economic growth (*Milagre Econômico*) initiated in 1969 proved an untenable situation, despite significant investments in infrastructure during the period.[17]

Based in Brasília, Lelé's professional practice at that time seemed not affected by the economic and political turmoil in view of his growing number of commissions from both private and public-sector entities. His great range of clients reflected the variety of building techniques implemented by the architect, such as the use of prestressed concrete girders at the Sarah Hospital in Brasília (1976-80), concrete shells at the DASP Training Center[18] (Brasília, 1973-77), brick vaults at Nivaldo Borges residence (Brasília, 1972-78), and some prefabricated experiences like the flat ceiling house for Mário Kertész (Salvador, 1977) and the Research Center for the Cerrado Regions (Embrapa) in Brasília (1978).

It is worth remembering that all these projects were being developed at a time when Lelé was deliberately reducing the administrative structure and costs of his office[19] in Brasília after some accumulated losses. It may seem contradictory, but the large number of ongoing commissions during the 1970s did not prevent the architect from experiencing financial problems at his office. Lelé's well-known inaptitude for business[20] combined with his political persecution during the severe years of the military regime might have contributed to this, as recalled by the architect: "In a way, I was discriminated by the revolution. I could not get hold of anything, even getting a job at the building company was quite tough. I was not banned to

17 Works like the Rio-Niterói bridge (1969-74), the Itaipú dam (1975-82) and the Transamazônica road (1968-74) became symbols of the massive military investment in infrastructure development.

18 The quite controversial project of the DASP Training Center in Brasília involved some changes in both its construction and destination of use. Designed by Lelé in 1973 using prefabricated components, the complex was created to house a training center for civilian public employees in the outskirts of Brasília (now the region of the Digital TV Tower). The shift to conventional building methods (cast-in-place concrete) together with the adaptation of the complex to serve as a federal police training center (*Polícia Federal*) discouraged Lelé due to systematic police repression during the dictatorship period. The architect disregarded this project from his main publications. Sources: Kristian Schiel. Interview with Adalberto Vilela on September 23, 2016 by telephone; and Haroldo Pinheiro. Interview with Adalberto Vilela on March 16, 2017 by email.

19 Lelé started working in private practice soon after his resignation from the university (UnB, 1965). In 1971, he opened his first office at the local commerce of Superquadra 212 Sul in Brasília. In 1977, after some financial problems, he designed and built a new office at 714 Norte, turned towards the W3 Norte Avenue, an important commercial axis of the new capital. Many architects, designers and technicians worked with Lelé during this period, including: Oscar Borges Kneipp, Rubens Lara Arruda, Haroldo Pinheiro Villar de Queiroz, Walter K. Hanashiro, Kristian Schiel, Marlene Freire Lobo, Fernando J. Ferreira de Andrade, Mariano Delgado Casañas, and Paulo Athaydes. José Lourenço de Souza, Cláudio Blois Duarte and Marco Antônio Pinheiro participated during the 212 Sul office, but did not join Lelé when he moved to the new address. In: Haroldo Pinheiro. Interview with Adalberto Vilela on May 3, 2016 in Brasília.

20 Lelé expressed many times his failure as a financially-savvy entrepreneur. "The short period during which I had an architectural company was the only period I earned money, despite my great financial failure […] I never came to be a businessman. I had no vocation for that. [Esse período breve em que tive escritório foi o único período em que ganhei dinheiro, mas tive um insucesso financeiro enorme […] Nunca fui empresário, não tinha a menor vocação para isso] (my translation). In: João Filgueiras Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes* (Rio de Janeiro: Editora Record, 2004), 65.

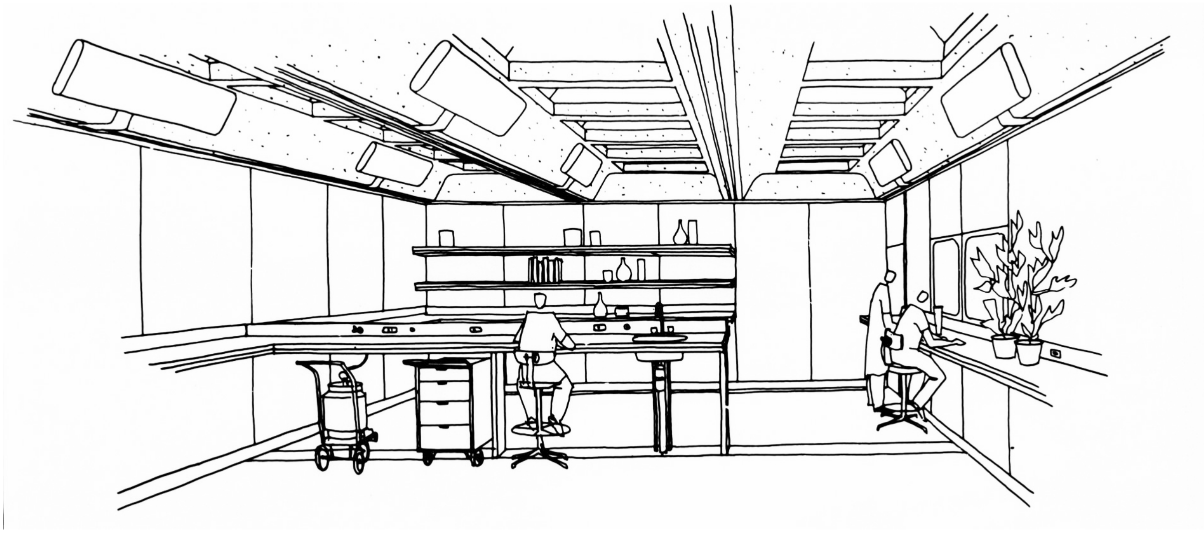

Fig. 2.3 The Research Center for the Cerrado Regions (Embrapa) was built using prefabricated sheds and beams, Brasília, 1978. Laboratories. Design and drawing by Lelé. Módulo no. 48 (1978): 71

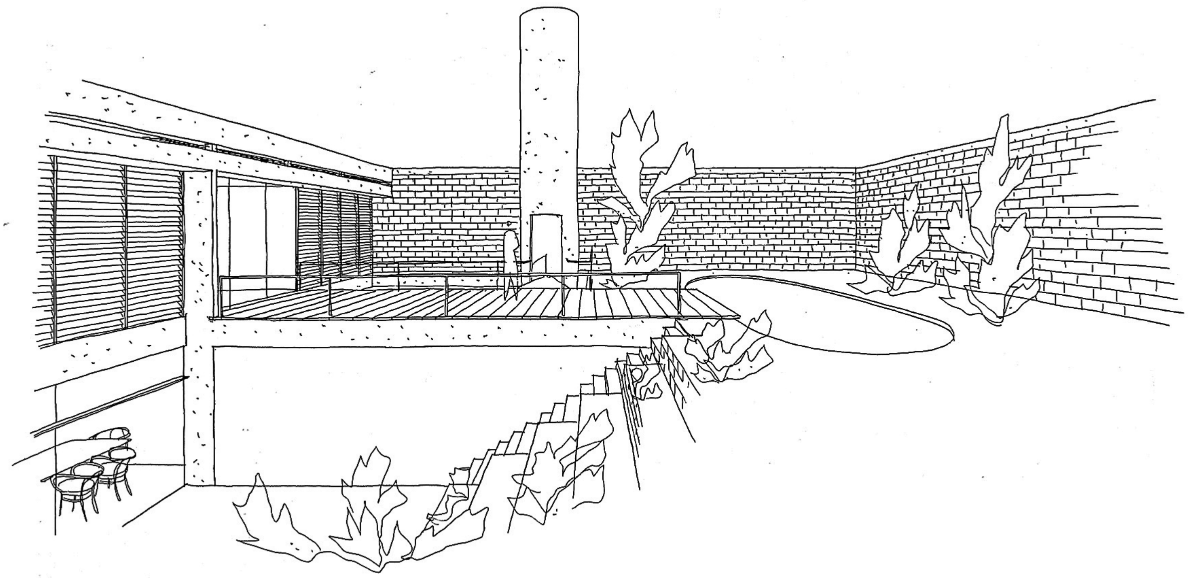

Fig. 2.4 Mario Kertész's residence built with precast concrete elements developed exclusively for the project, Salvador, 1977. Design and drawing by Lelé. Arquivo João Filgueiras Lima, Salvador

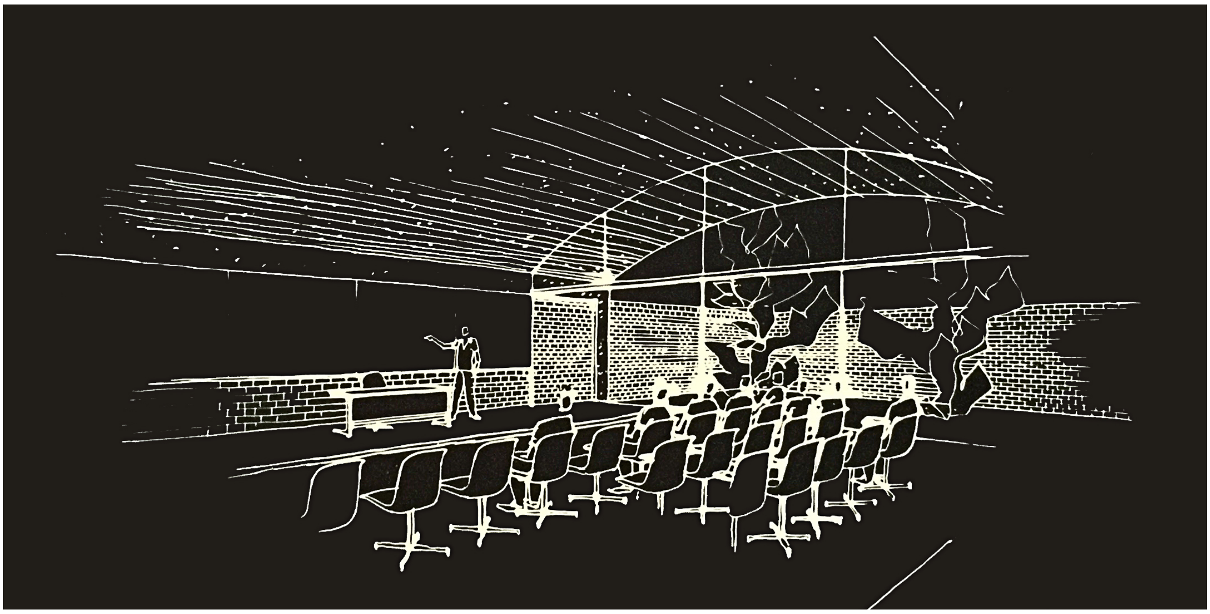

Fig. 2.5 DASP Training Center built with concrete shell ceilings, Brasília, 1973-77. Design and drawing by Lelé. Arquivo João Filgueiras Lima, Salvador

Fig. 2.6 Nivaldo Borges' residence, Brasília, 1972-78. The house was built using the traditional technique of masonry arches and vaults. Main hall with the water garden. Design and drawing by Lelé. Arquivo João Filgueiras Lima, Salvador

live in exile, I was not arrested, but I was part of a marginalized group during the period after Castello Branco."[21]

In clear reference to the effects of the most repressive phase[22] of dictatorship (1968-74) on his work, Lelé depicted a situation of tension between right-wing governments and leftist architects (such as Oscar Niemeyer, Edgar Graeff, Glauco Campello, Carlos Fayet, Mayumi and Sérgio Souza Lima, Elvin Dubugras, and Lelé himself). However, it would be naïve to say that the military always targeted the architects and that they found themselves in permanent opposition to the government. In fact, "the Brazilian dictatorship (1964-1985) did not treat the architects in a particularly cruel way – it granted them the same mixture of ideological persecution and mediocrity that it reserved for other professional categories."[23]

Despite their left-oriented politics and ideologies, some architects – including Niemeyer and Lelé – collaborated with the military at different times. Both the Army Headquarters [*Quartel General do Exército*][24] (1968) and the unrealized project for a military club[25] (1977) designed by Niemeyer in Brasília – together with Lelé's military police head office in Salvador (1979) – show that these parties had not always been on the warpath. Hence, the idea that Lelé's work was intended to deliver political punches[26] or that it relied on a certain aesthetic of scarcity[27] (architecture of poverty) as an act of political resistance may be regarded as questionable.

Lelé's unexecuted project for the military police headquarters in Salvador was realized around 1979, when the architect was already in charge of developing projects for the city via RENURB factory. The undated and unpublished complex presents certain similarities with some of Lelé's previous works in Brasília, such as the Daher Clinic (1977) and the Research Center for the Cerrado Regions (1978). But what comes into question here is the architect's relationship with politics and how it affected his work.

Although it was through politics that Lelé came to assimilate industrial technology to his practice, this does not mean that the architect produced a politically-based architecture.

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21 [De certa maneira, eu era discriminado pela revolução, não tinha acesso a nada, até para conseguir um emprego nessa construtora foi difícil. Não fui banido, não fui preso, mas fiz parte de um grupo que foi meio marginalizado no período posterior ao de Castello Branco] (my translation). In: Ibid., 63.

22 With the implementation of the Institutional Act 5 (*Ato Institucional 5*, or AI-5) – issued by President Arthur da Costa e Silva on December 13, 1968 – the military regime proclaimed a state of siege in Brazil, abolished all political parties, and restricted freedom of the press while dramatically increasing persecution and violence against opposers.

23 Paulo Markun, "Os Arquitetos e a Ditadura," *CAU/BR*, last modified 2014, accessed April 7, 2017, http://www.caubr.gov.br/os-arquitetos-e-a-ditadura/. [A ditadura brasileira (1964-1985) não tratou de modo particularmente cruel os arquitetos – concedeu-lhes a mesma mistura de perseguição ideológica e mediocridade que reservou a outras categorias profissionais] (my translation).

24 Designed by Oscar Niemeyer in 1967, the Army Headquarters in Brasília was developed and constructed by Lelé. At that time, Niemeyer was in exile and working on projects for Lebanon and Israel. Niemeyer, who left only a preliminary draft of the complex, decided to write a letter appointing Lelé as project developer who would be responsible for the upcoming works. See Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes*, 64.

25 Ibid., 120.

26 Richard Williams, *Brazil* (London: Reaktion, 2009), 158.

27 Styliane Philippou, "The Primitive as an Instrument of Subversion in Twentieth-Century Brazilian Cultural Practice," *Arq: Architectural Research Quarterly* 8, no. 3–4 (2004): 294.

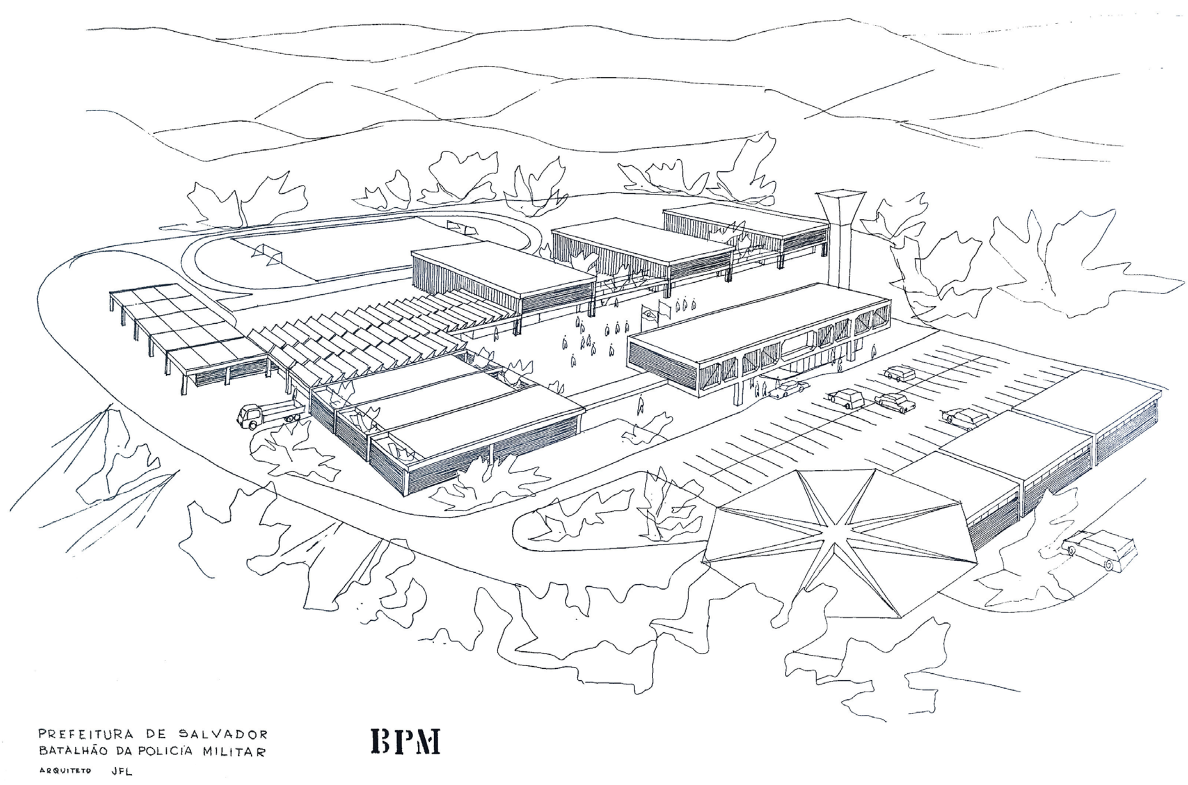

Fig. 2.7 Military police headquarters project for Salvador (unexecuted) designed by Lelé ca. 1979. The work comprises a series of intervention promoted by RENURB in Bahia's capital. Arquivo João Filgueiras Lima, Salvador

On the contrary, Lelé became known as a producer of technical-oriented work, even though he was aware of the importance of politics as the only way of ensuring his large-scale public commissions. Economy for him was related to the adoption of rationalized construction methods, which was inextricably linked with lower material consumption, which therefore led to a reduction of component weight.

In this sense, the role of politics within Lelé's practice extrapolates the idea of a work-oriented mechanism centered around the dispute of opposing ideologies.[28] Yet the political background proved to be more complex than this. In time, politics acquired a central significance for him, to the extent that it determined how leading politicians and their decisions interfered in his urban projects, as we shall see in the next section.

28 When asked during an interview published in 1987 about the development of his work within governments of multiple politico-ideological stripes, Lelé stated the following: "Not that I had made any concessions to them (the military). I simply kept my professional work at the same level, and in these terms, it is clear that you can work with any government." [Não que eu tivesse feito alguma concessão a eles, simplesmente mantive o meu trabalho profissional com o mesmo nível e nesses termos é claro que se consegue trabalhar com qualquer governo] (my translation). In: João Filgueiras Lima, "A serviço do bem e do mal [entrevista a Bené Simões]," *Arquitetura e Urbanismo* 3, no. 11 (1987): 23.

4.2 Urban infrastructure: standpoints on transportation and sanitation

In 1978, while redrafting the office's amendment in Brasília, Lelé received an invitation to undertake a priority project for Salvador: the implementation of the city's transportation program (TRANSCOL). The invitation made by the appointed[29] mayor Mário Kertész – with whom Lelé had worked during the construction of the Administrative Center (Centro Administrativo da Bahia, CAB)[30] between 1972 and 1975 – marked the return of the architect to Bahia.[31] Nevertheless, unlike the time when Kertész's main contribution as Secretary of State[32] was to promote the urban sprawl of Salvador towards CAB – an orientation devoid of historic and social contexts – his first tenure as city manager (1979-81) was characterized by a multi-vector urban policy supported by a humanistic approach.

A sensitive reading of the city with its threefold social and geographical composition – the historic center, the seaside and the low-income settlements – favored a government

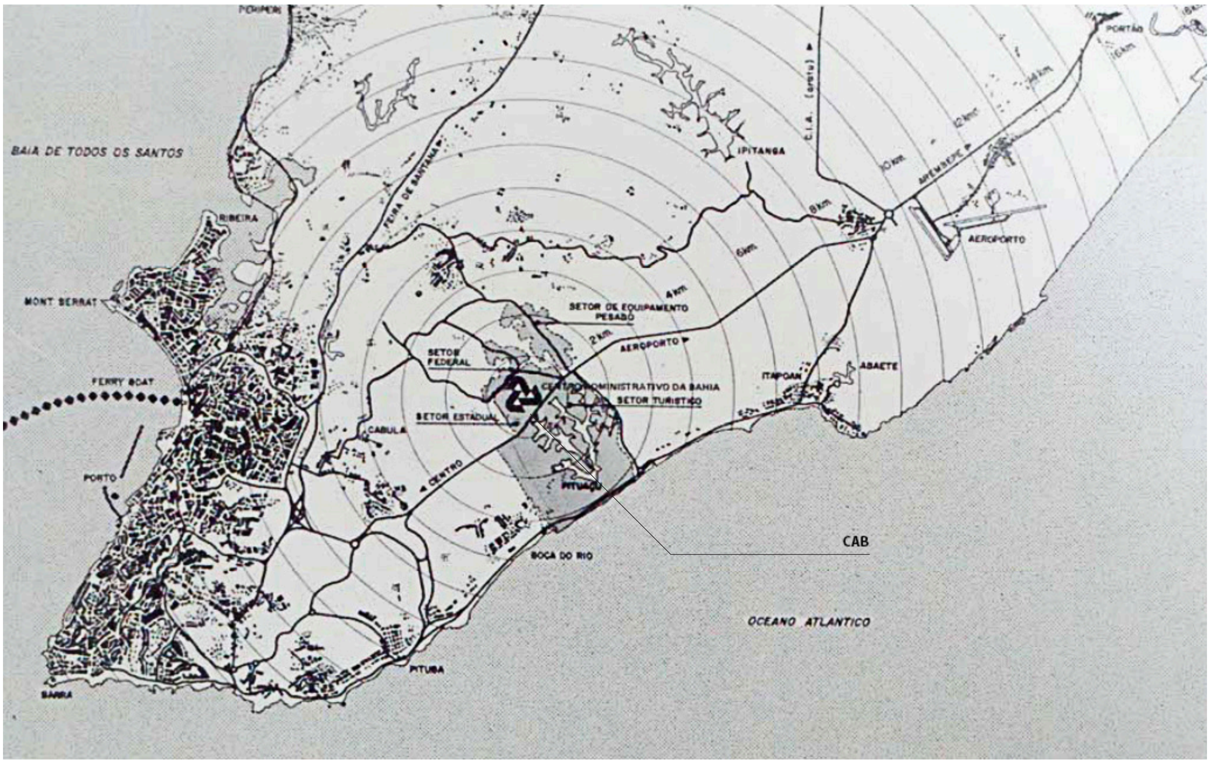

Fig. 2.8 Location of the Bahia Administrative Center (CAB) in Salvador. Michel Vale, "Um Projeto Urbano com Programa Político Municipal" (Universidade Federal do Rio de Janeiro, 2009), 68.

29 At that time, elective positions were nominated by the military regime.

30 The Bahia Administrative Center (*Centro Administrativo da Bahia*, CAB) is a public complex of governmental buildings owned by Bahia State located in Salvador. It was implemented in 1972 by Mário Kertész during Antônio Carlos Magalhães' first tenure as Bahia governor. Lelé was in charge of CAB's main buildings, while Lucio Costa and Burle Marx oversaw the urban planning and the landscape respectively.

31 Architects such as Dimitri Tavares Vilanova, Kristian Schiel, and Fábio Savastano moved from Brasília to Salvador at Lelé's request during this period.

32 From 1971 to 1975, Mário Kertrész served as Secretary of State for Planning, Science and Technology during the first mandate of Antônio Carlos Magalhães, one of the most powerful and influential politicians in Brazil. The main contribution of the young Secretary (at that time 26 years old) was to implement the Bahia Administrative Center (CAB).

based on different patterns of intervention (transport, housing, culture, education, sanitation, maintenance and building conservation). However, the success of Kertész's urban policy cannot be dissociated from two key aspects: the conceptual, political and social approach[33] of his government and the decision to create a strategic planning department within his administration. The first concerns the way in which the main protagonists were in tune with one another on ideological and personal levels: Mário Kertész, the politician and chosen mayor; the anthropologist Roberto Pinho, creator and coordinator of the political program; and Lelé, the architect responsible for the technical solutions. The program sought to integrate agents and actions based on a comprehensive view of the city. In keeping with Michel Vale, "the legacy of his government's experience is mainly due to the symbiosis in which the technical elaboration was expressed – through the expertise of Lelé's research with precast elements – in accordance with the integrated conception of society and culture explained by Roberto Pinho."[34]

The second refers to the organization of four strategic bodies[35] with quick access to the mayor's office in order to accelerate the program's execution: the Central Body of Planning (*Órgão Central de Planejamento*, OCEPLAN), the Social Development Coordination (*Coordenação de Desenvolvimento Social*, CDS), the City Transportation Company of Salvador (*Companhia de Transportes Urbanos de Salvador*, Transur), and the City Renewal Company of Salvador (*Companhia de Renovação Urbana de Salvador*, Renurb).

It is Lelé's participation as RENURB technical coordinator that we should stay focused on. Through that experience, the architect saw the opportunity to apply his prefabrication know-how on a much wider scale than had hitherto been possible. But, this did not mean that by meeting the favorable political and economical conditions for implementing mass production in Salvador all the other problems would be solved. The fact that RENURB technical office had an interdisciplinary structure – composed of independent teams working to support the projects – clearly made things more complex and time-consuming. "There were teams which centered on raising funds for projects and programs, a team assigned to building scale models, a team of sociologists, a traffic engineering team, a structural engineering team, a visual programming team, and a technical team composed of architects and civil engineers,"[36] explained José Fernando Minho.

This goes to show that RENURB was not centered exclusively around the factory of precast elements, under the coordination of Lelé. The public company's organization chart[37] is

33 Interpretation of the term "*tripé político-conceitual-propositivo*" used by Michel Hoog Chaui Vale, "Um projeto urbano com programa político municipal: a experiência do arquiteto João Filgueiras Lima em Salvador na 1.ª gestão Mário Kertész (1979-1981)" (Universidade Federal do Rio de Janeiro, 2009), 68.

34 Ibid., 76. [O legado da experiência do seu governo se constitui principalmente pela simbiose em que se expressaram a elaboração técnica, através da atuação de excelência na pesquisa de Lelé com pré-moldados e da concepção integrada de sociedade e cultura explicitadas por Roberto Pinho.] (my translation)

35 For a full description of each public body, see: Ibid., 40–43.

36 José Fernando Minho. Interview with Adalberto Vilela on April 20, 2016 in Salvador.

37 Vale, "Um projeto urbano com programa político municipal: a experiência do arquiteto João Filgueiras Lima em Salvador na 1.ª gestão Mário Kertész (1979-1981)", 295.

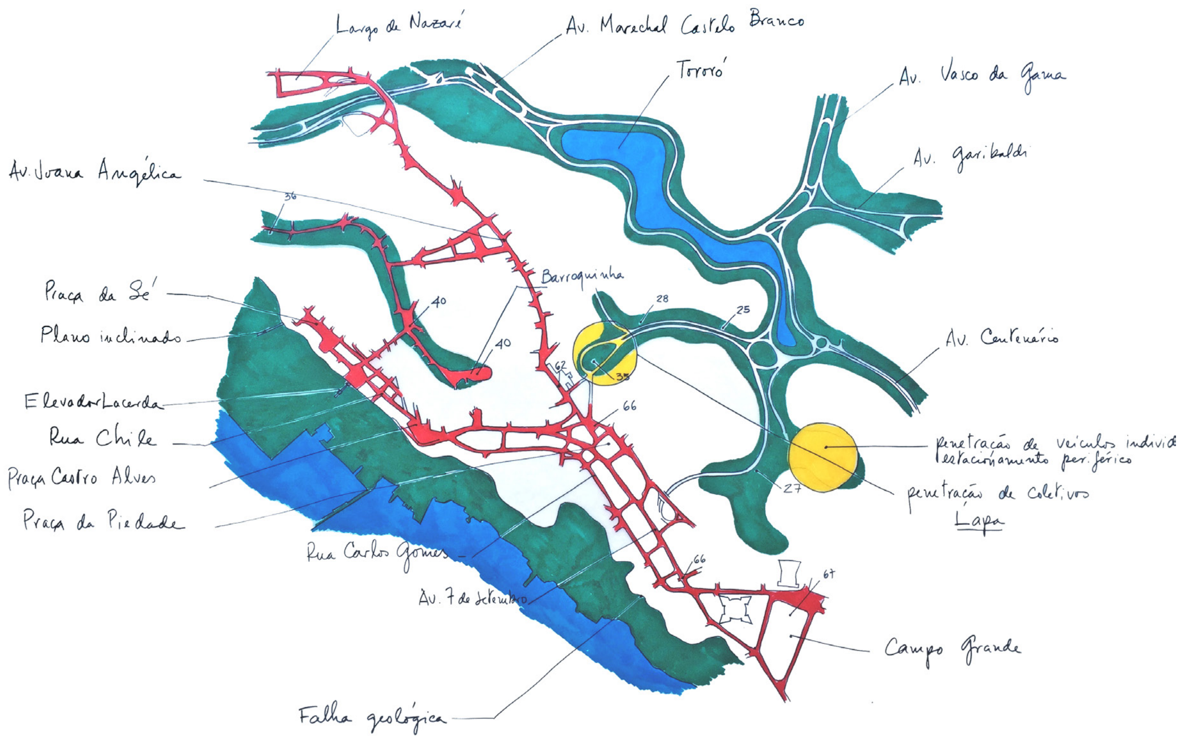

Fig. 2.9 Map showing the Lapa Transfer Station (yellow circle at the center) as a connection point between the valley avenues (green) and the "Campo Grande-Sé" bus corridor (red). Lelé, 1979. Arquivo João Filgueiras Lima, Salvador

proof of the multi-vector activities developed at the sectors that comprised its administrative structure. But if the complexity and varied constitution of RENURB's team seemed to operate in different directions, their primary objective – the implementation of the TRANSCOL transportation program – joined the various forces in a common goal.

Created in 1977 with the benefit of having observed previous studies,[38] the program set certain directives to be observed. Among these, one aspect appears to be of significant relevance: the decision of "removing from the (historic) center the great mass of vehicles that circulate through it and which constitutes one of the most serious factors of its deterioration."[39] It was based on this guideline – but also on a substantial financial support from the World Bank (IBRD)[40] – that Lelé began to intervene on different scales of Salvador's urban fabric.

38 The main studies prior to Mário Kertész's urban interventions in Salvador can be divided into two different groups: the proposals and interpretations presented by the Urban Planning Office for the City of Salvador (*Escritório do Plano de Urbanismo da Cidade do Salvador*, EPUCS, 1943-50) and the plans developed by the municipal administration (*Prefeitura Municipal de Salvador*, PMS) throughout the 1970s, such as the *Adequação da rede urbana de Transporte Público ao novo sistema viário urbano* (1973), EUST (1975-77), TRENSURB (1976), PLANDURB (1976-78), and TRANSCOL (1977). For further information, see: Vale, "Um Projeto Urbano Com Programa Político Municipal: A Experiência Do Arquiteto João Filgueiras Lima Em Salvador Na 1.ª Gestão Mário Kertész (1979-1981)"; Nivaldo Vieira de Andrade Junior, "Diógenes Rebouças E O EPUCS: Planejamento Urbano E Arquitetura Na Bahia, 1947-1950," *URBANA* 5, no. 6 (2013): 25–51; Antônio Risério, "Um Mestre Da Precisão E Da Delicadeza Estética E Social," in *A Arquitetura de Lelé: Fábrica E Invenção*, ed. Max Risselada and Giancarlo Latorraca (São Paulo: Imprensa Oficial SP, MCB, 2010), 30–45.

39 Message sent to the City Council by the Mayor Mário Kertész in March, 1981. PMS: Salvador, 1981, p. 4. In: Vale, "Um Projeto Urbano Com Programa Político Municipal: A Experiência Do Arquiteto João Filgueiras Lima Em Salvador Na 1.ª Gestão Mário Kertész (1979-1981)," 45. [*retirar do Centro a grande massa de veículos que por ele circula e que se constitui num dos fatores mais sérios de sua deterioração*] (my translation).

40 The World Bank (*International Bank for Reconstruction and Development*, IBRD) was established in July 1945 and is still today an important source for reducing poverty in many Latin American and Caribbean countries. Mário Kertész took

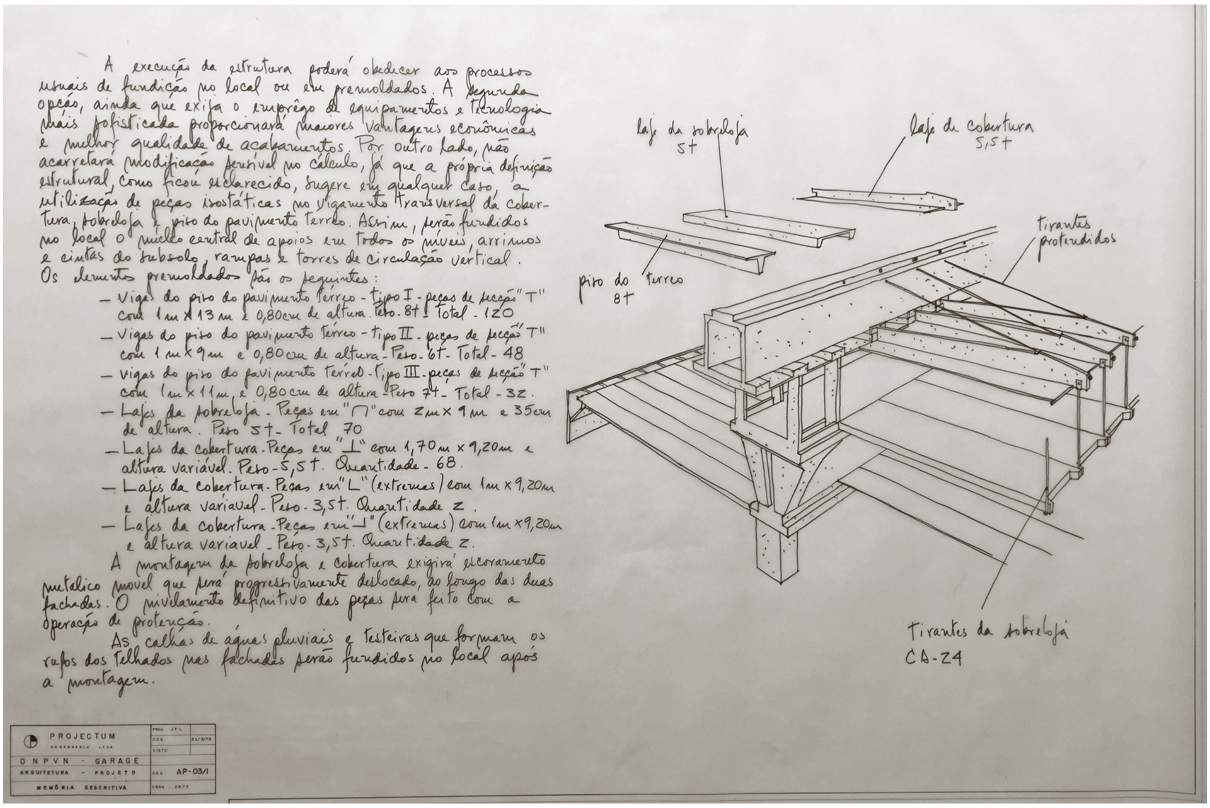

Fig. 2.10 Portobrás garage building (unexecuted). Design by Lelé, Brasília, 1975. The project laid the groudwork for the Lapa Station structural solution. Arquivo João Filgueiras Lima, Salvador

In this sense, Lelé took on the role of urban planner of Salvador, both examining the minutiae of the equipment he designed – such as bus stops, sidewalks, police stations, benches, public toilets, retaining walls, telephone booths and waste recipients – and also acting on the macro level of the transportation system (the transfer of bus stations and neighborhood bus terminals). By reconfiguring the connections and hubs of Salvador's transportation network in accordance with the "city's capricious topography,"[41] the architect came to open and pave routes connected with new transfer stations, such as the *Estação de Transbordo da Lapa* (1979), *Estação de Transbordo do Aquidabã* (1980) and the *Estação de Transbordo da Rodoviária* (1981).

Among these projects, the Lapa Transfer Station deserves special attention for its relevance within the Salvador transportation system. There is no doubt that the building was conceived by Lelé to be a singular urban landmark of the city, on the same lines as Nervi proposed when he designed the George Washington Bridge Bus Terminal in New York (1962).[42] What was not clear until now is that both the design and structural solution of the *Estação de Transbordo da Lapa* assimilated previous studies by the architect. I refer to the unexecuted Portobrás garage building designed in Brasília in May 1975, when Lelé was a Projectum employee.

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a loan of USD 50,000,000 from IBRD, originally destined for São Paulo State during the Paulo Maluf mandate, to be used for the Camurujipe Valley project. In: Mário Kertész. Interview with Adalberto Vilela on April 19, 2016 in Salvador. See: n.d., "Missão do BIRD faz uma visita às obras," *Jornal Da Bahia* (Salvador, May 9, 1981).

41 João Filgueiras Lima, in: Giancarlo Latorraca, *João Filgueiras Lima, Lelé*, ed. Marcelo Carvalho Ferraz (Lisboa, São Paulo: Editorial Blau, Instituto Lina Bo e P.M. Bardi, 2000), 98.

42 I am indebted to Laurent Stalder for this and so many other relevant observations.

Fig. 2.11 The George Washington Bridge Bus Station in New York. The terminal was designed by Pier Luigi Nervi (1963), working in collaboration with the Port Authority's chief engineer John Kyle. Image: Library of Congress/Docomomo NY

Fig. 2.12 Scale model of Lapa Station, Salvador. Design by Lelé, 1979. Photograph by Celso Brando. Arquivo João Filgueiras Lima, Salvador

The Lapa Transfer Station is positioned at the center of a highly-frequented transportation axis of the city – the segment from the *Campo Grande* to the *Sé* square – the same that was subject to two different urban programs: the bus corridor (partially implemented by RENURB, 1979-81) and the VLT (Light Rail Vehicle). The latter was planned during Mário Kertész's second tenure (1986-88 – TMS, *Transporte Moderno de Salvador*), but never implemented.

Regardless of whether buses, trams or both are taken as means of public transportation programs, one item of urban equipment has always been of central concern: the bus stop shelter. Isolated or combined, the new equipment was required to have three functional attributes: it should be easy to produce, transport and assemble. Based on this assumption, Lelé's multiple designs for bus shelters over

Fig. 2.13 Scale model showing the configuration of Lapa Station in Barris Valley, in Salvador. Designed by Lelé in 1979, the building was produced and assembled by the RENURB factory and inaugurated in November, 1982. Arquivo João Filgueiras Lima, Salvador

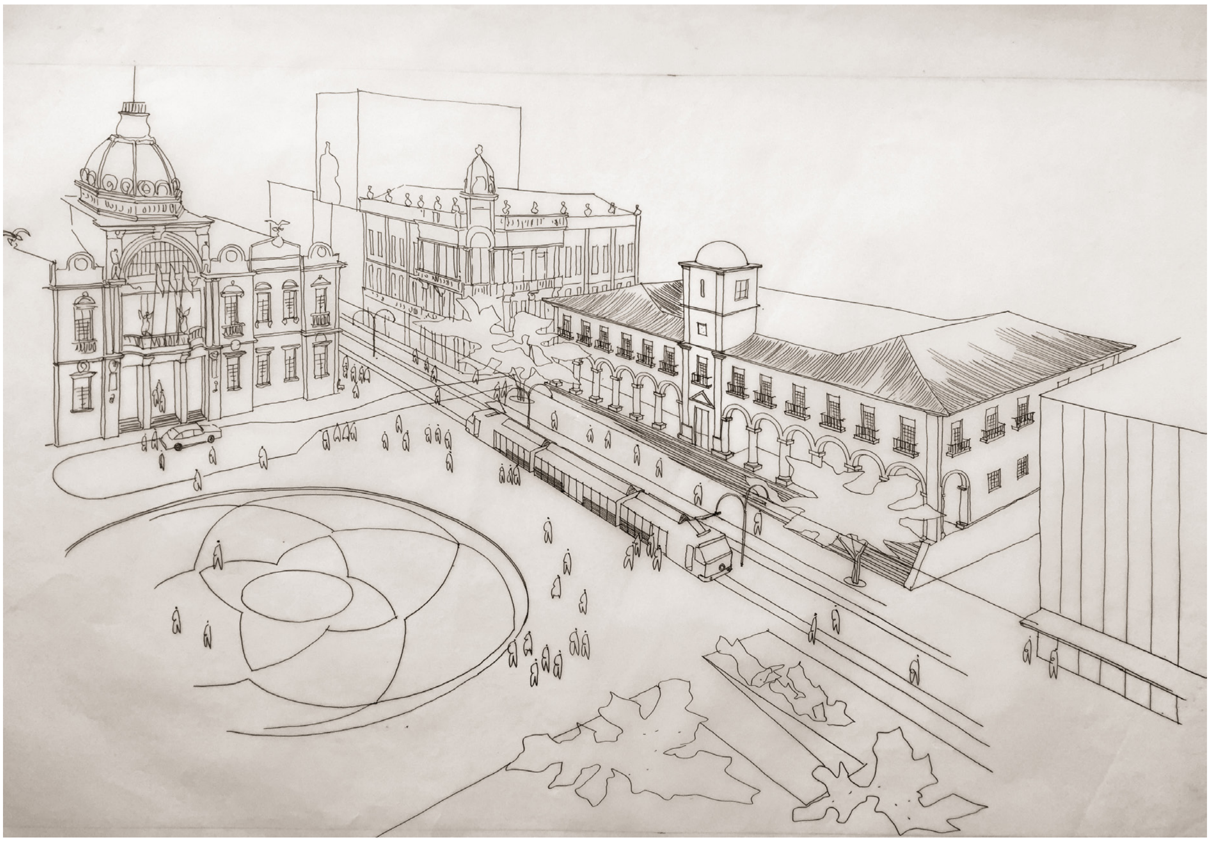

Fig. 2.14 A second proposal by Lelé, also unexecuted, envisaged the implementation of the '*bonde moderno*', a VLT light railway service in the historic center of Salvador, Bahia (1986-88). Arquivo João Filgueiras Lima, Salvador

Fig. 2.15 A bus terminal of the corridor *Campo Grande-Sé* proposed by Lelé (1980-81) in Salvador. The project was designed in accordance with Transcol program. Arquivo João Filgueiras Lima, Salvador

Fig. 2.16 RENURB bus shelter model for Salvador, Bahia. Precast reinforced concrete. Design by Lelé, 1979. Arquivo João Filgueiras Lima, Salvador

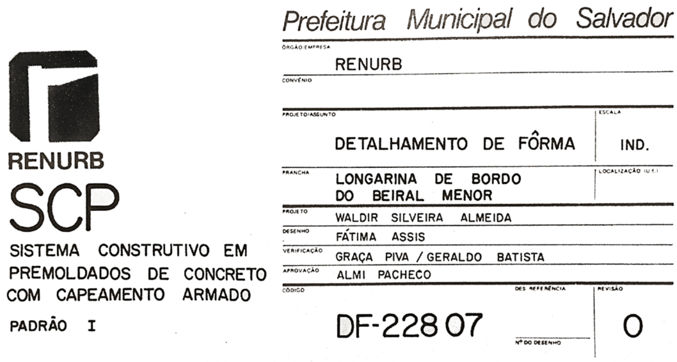

Fig. 2.17 Detail of a technical drawing from RENURB showing the company's logo based on the bus shelter's profile section. Arquivo DESAL, Salvador

the years proved a revealing way of meeting the objectives proposed. The equipment bears witness to the fact that the final solution is not always associated with less material consumption and weight reduction, two central ideas of the architect's discourse in this phase. When it comes to components and building systems, these notions impact on his conception of lightweight prefabrication and use of *argamassa armada*.

We shall begin by looking at the first bus stop shelter model largely mass-produced by RENURB in Salvador (1979-81). It soon became the prototypical economic, resistant and industrialized product in which the company invested during the first years of the factory's operation.[43] The reinforced concrete structure was comprised of three parts: a roofing element, 2.10 m x 4.30 m weighing roughly 2.5 t, a 2.05 m hollowed column weighing 1.6 t (simple)

43 The RENURB bus shelter also became the company's logotype.

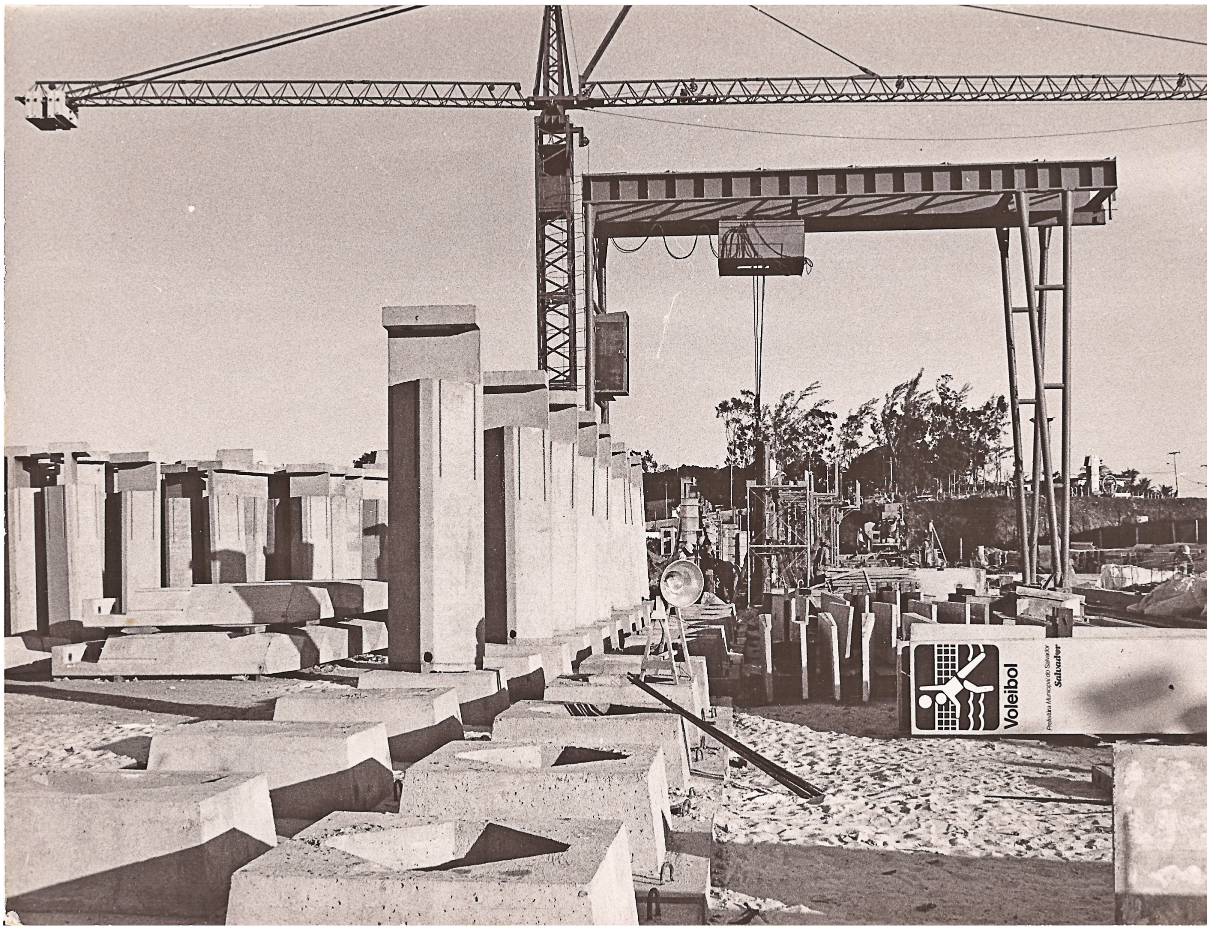

Fig. 2.18 Bus shelter components (footings, column, and roofing) at RENURB's storage yard. Design by João Filgueiras Lima, 1979. Arquivo Kristian Schiel, Brasília

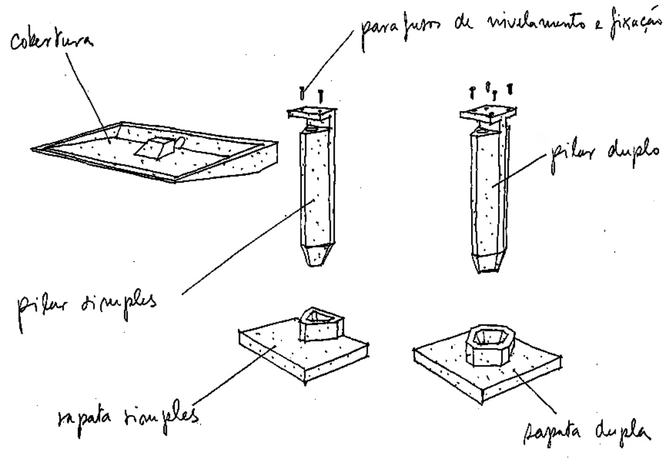

Fig. 2.19 RENURB bus shelter model. Precast reinforced concrete. Design by Lelé, 1979. Arquivo João Filgueiras Lima, Salvador

or 2.3 t (double), and a shallow footing also presented in two versions, simple (1.95 t) or double (2.2 t). In its lightest version, the bus shelter single module weighed 6.05 t. The heavier one (double module) weighed 9.5 t in total. The process was entirely based on the simple fitting of components, the leveling adjusted by two galvanized steel bolts threaded into sockets, which were incorporated into the top of the pillars during the precasting operation.

But the curious fact is that this widespread and apparently successful bus shelter was preceded by a project which had been declined and which differed from the chosen model in the unity of its structural composition, as well as the detail of its fabrication process. With a solid unibody concrete structure, the first version of Renurb's bus stop seemed the most appropriate way of providing a solution to the general issue of conservation in Brazil. The economical value and quality of a single

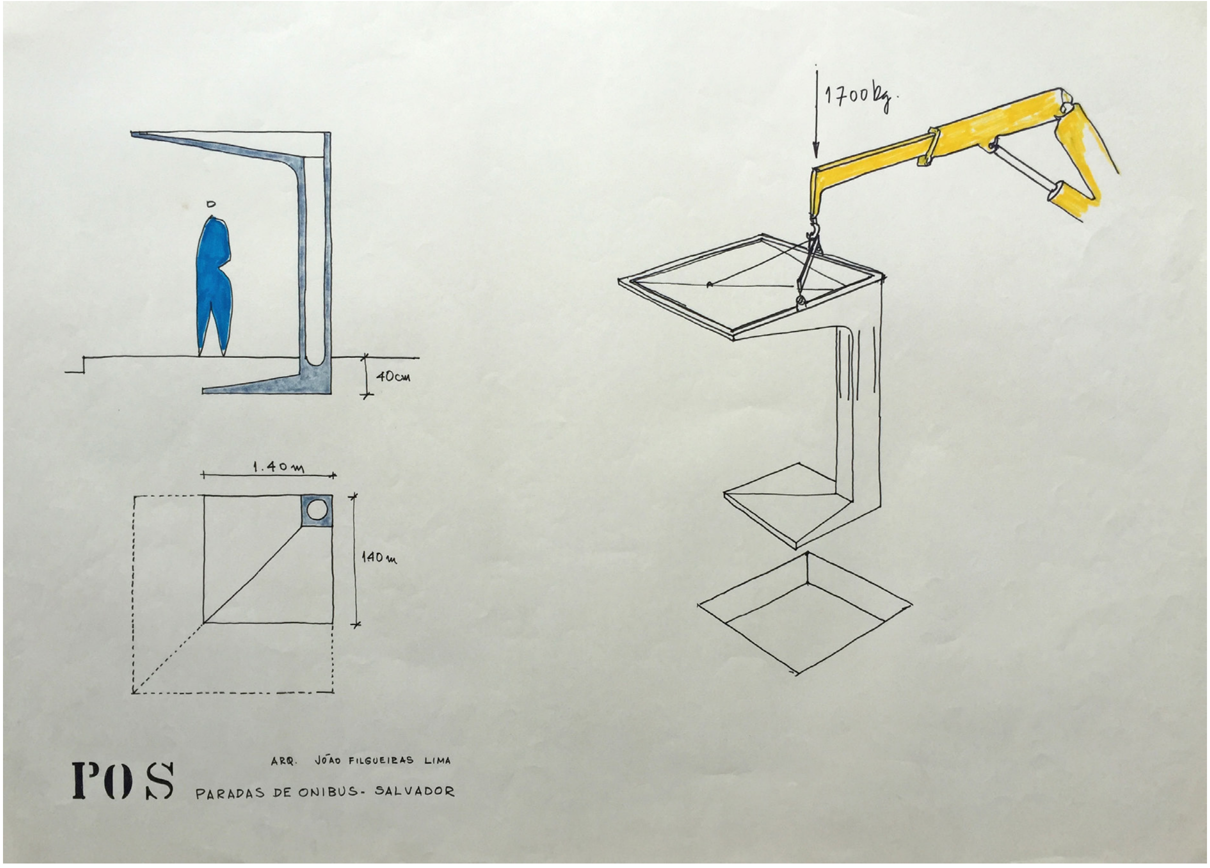

Fig. 2.20 Lelé's first version of the RENURB bus shelter in Salvador (POS, *Parada de ônibus - Salvador*). Not executed. Design by Lelé, 1979. Arquivo João Filgueiras Lima, Salvador

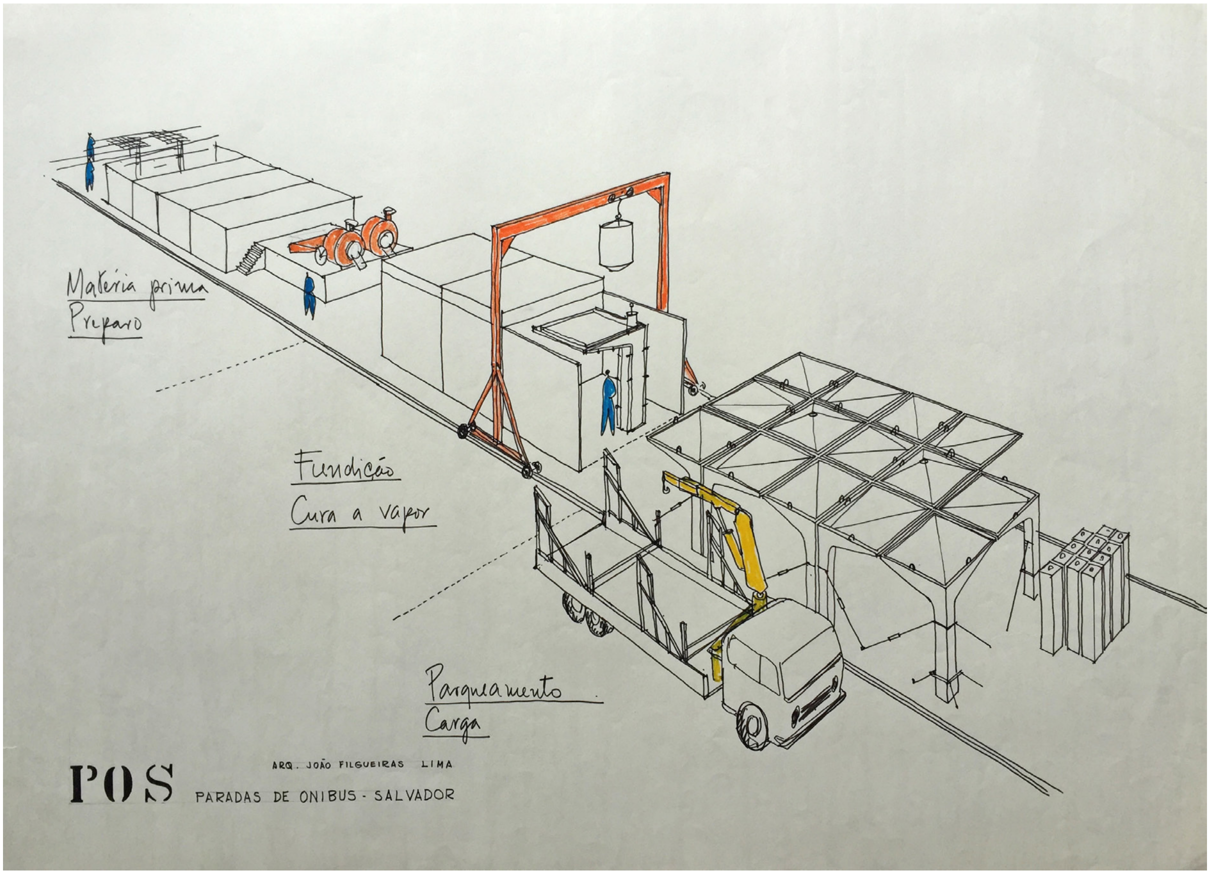

Fig. 2.21 Production line of the RENURB bus shelter in Salvador (first version). Here Lelé proposed the production of precast concrete elements by means of the thermal vapor cure. Arquivo João Filgueiras Lima, Salvador

industrialized model would enable "the transference and replacement of units, which seems fundamental in view of the fragility of the surface public transport programs in modern cities."[44]

In terms of maintenance, it is evident that a unibody structure would be less susceptible to natural deterioration than an arrangement of united parts due to the absence of joints. If we take into consideration that "one of the most intricate and most difficult problems to be solved in both design and construction of structures assembled of precast members is the joining of the latter,"[45] a jointless concrete structure should represent an advantage. However, Lelé decided otherwise and started developing the solid tripartite shelter including roof, column and footing. One may enquire whether his decision was influenced by factors other than transportation, knowing that the delivery of components is a determinant usually limited by height and weight restrictions.[46]

Initially it seemed that the combination of weight/transportation was the crucial cause of Lelé's abandonment of the bus shelter's first version, as confirmed by one of his former collaborators: "And later he (Lelé) realized that this model would become heavy to transport, and then he decided to break the ensemble up into disjointed parts."[47] But a close observation of the drawings shows a discrepancy in the loads found. Whereas the single-structure shelter weighs 1,700 kg in total, each component designed for the multiple-member structure – except for the simple hollowed column (1,600 kg) – surpasses the overall weight of the single-piece bus shelter. From this example arises the dilemma facing the architect's central argument around the component's weight and its relation to prefabricated systems in concrete or *argamassa armada*.

However, weight is not the central question when speaking about prefabrication, no matter what the material. Despite divergent opinions,[48] my point here is that there were other factors – such as the fabrication process, structure, aesthetics, transportation and assembly – that contributed to Lelé's decision to not always choose the lighter alternative. For example, returning to the issue of the Salvador bus shelter and closing this case, I do not believe that the formwork of the first version could be portrayed as a hurdle which halted or obstructed the object's execution. In fact, the final geometry of the second and definitive version is more complex, and it contains joints and grooves that the unibody structure does not need in practice, such as the fitting spaces for assembling.

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44 João Filgueiras Lima. Urban Furniture – Salvador. Bus Shelter [Mobiliário Urbano – Salvador. Abrigo de Ônibus], descriptive memorial [memória], drawing board unnumbered and undated. João Filgueiras Lima Archive. [possibilita a transferência e reposição das unidades, o que nos parece fundamental face à fragilidade dos programas de transportes coletivos de superfície nas cidades modernas] (my translation).

45 László Mokk, *Prefabricated Concrete for Industrial and Public Structures* (Budapest: Akadémiai Kiadó, 1964), 45.

46 For an overview of the available delivery methods of pre-fabricated components and their limitations, see: Ahmed Almulla et al., "Prefab City: A Compendium of Strategies for Prefabricated Building Techniques in Urban Environments" (Northeastern University, 2010), 8–25; Ryan E. Smith, *Prefab Architecture: A Guide for Modular Design and Construction* (Hoboken, NJ: John Wiley & Sons, 2010), 193–205.

47 Haroldo Pinheiro. Interview with Adalberto Vilela on May 3, 2016 in Brasília. [Depois ele percebeu que ficava pesado para transporter, daí ele resolveu fragmentar] (my translation).

48 According to Buckminster Fuller (1970), "the key to all industrialization was no other than the problem of weight." In: Pedro Ignacio Alonso, "The Architecture of Assemblage in the Rhetoric of a New Construction: Between the Expanded Meaning and the Turning Point of Building" (Architectural Association School of Architecture, 2007), 126.

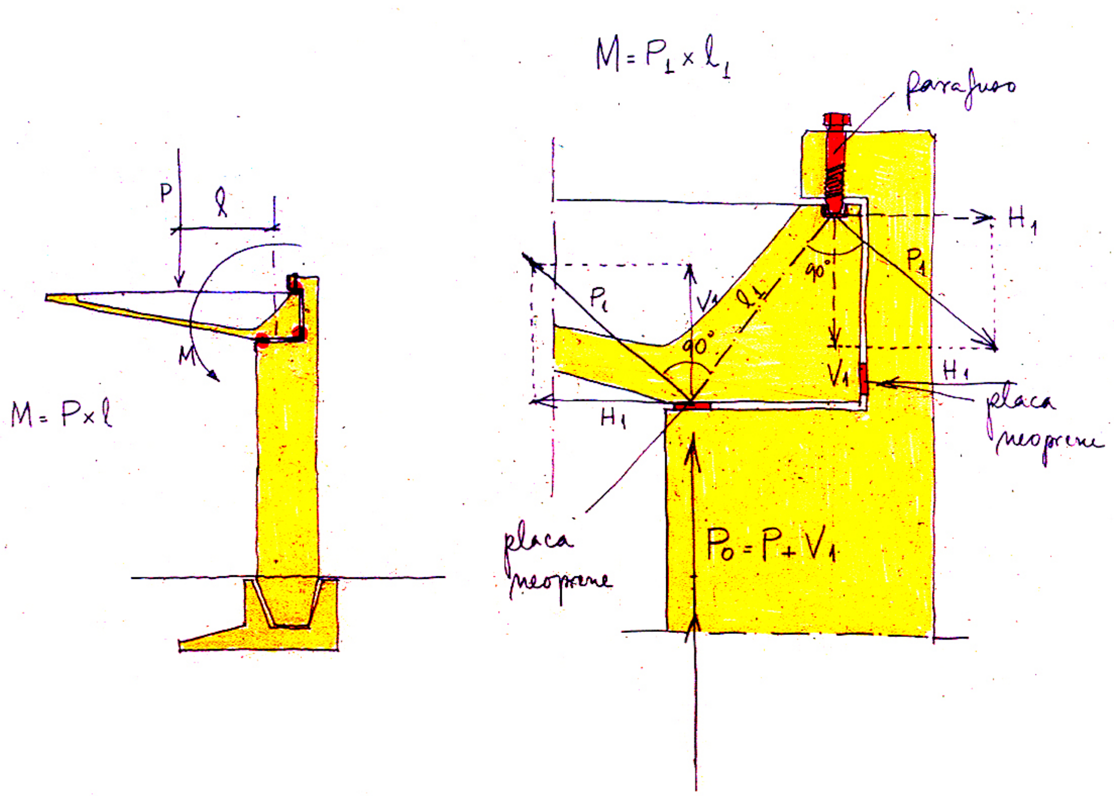

Fig. 2.22 RENURB bus shelter force scheme. The roofing element is connected to the column at three different points (in red), as shown in Lelé's drawing. Arquivo João Filgueiras Lima, Salvador

Furthermore, one structural aspect should be noted when we look carefully at the bus shelter's connection details. The force employed by the galvanized steel bolts to level the roofing element (weighing 2.5 t) developed a reactive force[49] at the junction point between the two concrete bodies: the roof and the column. The cross-section drawing shows that the connection is made of three[50] points distributed across the inner edges of the column's head – a bolt on the top and two neoprene plates, one at the bottom and another on the back. This arrangement restrains rotations and translations from occurring in any direction, which contributes to the stability of the ensemble and therefore puts the force system in equilibrium.[51]

Likewise, it must be remarked that this solution went beyond Salvador. Lelé applied a similar structural principle[52] to a new version of a bus shelter developed in Rio in 1985, during Leonel Brizola's government (1983-87). Completely redesigned, the new model is by far more advanced than its predecessor. This is true not only because of the observed material change – from reinforced concrete in Salvador to *argamassa armada* in Rio – but also, and more importantly, because of the painstaking use of metallic formwork. In that case, it is perhaps

49 The nature of the reactive forces developed on a loaded body depends on the exact way in which the body is either supported or connected to other bodies. In: Daniel L. Schodek, *Structures* (Upper Saddle River, NJ: Prentice-Hall, 2001), 42.

50 For a single model of the bus shelter, the total number of connections between the roofing element and the column is five (three neoprene plates and two galvanized bolts).

51 A body is in equilibrium when the force system acting on the body tends to produce no net translation or rotation of the body. It is in a state of balance. In: Ibid., 39.

52 Stabilization of the forces thanks to the insertion of a metallic latch.

Fig. 2.23 Precast bus shelter in *argamassa armada* developed by Lelé in Rio de Janeiro (1985) as part of the governmental program *Fábrica de Escolas* (School Factory). Photograph by Celso Brando. Arquivo Zeca Franco, Rio de Janeiro

the most ingenious mold ever developed in Lelé's work. The piece created by Mariano Casañas,[53] a long-time collaborator of the architect, advanced technical matters in articulated metallic formwork to another level.

Thus, it is not unlikely that Lelé's clever structural solution for this urban equipment may become representative of the way the architect coped with constraints based on the weight of precast components. Counteracting the prevalence of a basic

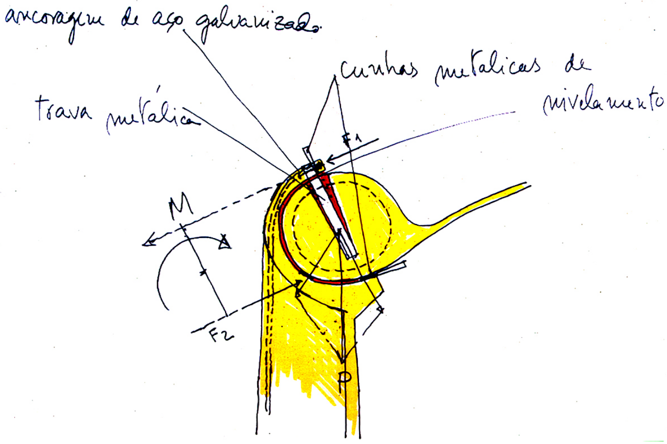

Fig. 2.24 Detail of the force scheme on the roofing joint of the bus shelter in Rio. Design by Lelé, 1985. Arquivo João Filgueiras Lima, Salvador

53 Mariano Delgado Casañas was born in 1948 in Santa Cruz de Tenerife, a port city in Spain's Canary Islands. He went to Brazil at the age of six, together with his large family. In 1959, his father decided to move to Brasília to work on building construction. His advanced knowledge in metallurgy was acquired from a long period working as a Gravia employee, a pioneering company in the new capital specialized in metalwork. This expertise put him in contact with Lelé in 1968, during the works for the Taguatinga hospital. Mariano would later reveal the talent of Vicente Muñoz, another Gravia employee and Lelé's future collaborator in the field of metal profiles.

Fig. 2.25 Bus shelters in argamassa armada. Lelé, Rio de Janeiro, 1985. Photograph by Celso Brando. Arquivo João Filgueiras Lima, Salvador

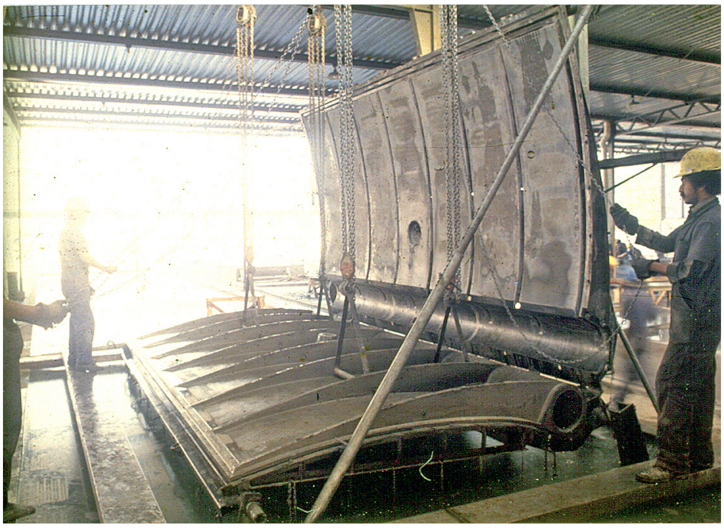

Fig. 2.26 Metallic mold for the *argamassa armada* bus shelter. Design by Mariano Casañas. Rio de Janeiro, 1985. Arquivo João Filgueiras Lima, Salvador

prefabrication understanding – according to which the lighter the parts the better – Lelé came up with a way out of this issue. Although his decision to choose the technically more complex and heavier model may seem disadvantageous, the proposed joint arrangement made the tripartite structure behave like a rigid connection. Thus, both of the bus stop shelter models for Salvador – the planned one and the accomplished one – shared an equivalent mechanical condition.

In the long run, the motivation for this comparison is twofold: to show how the choice of a single typology of prefabricated urban equipment is significant enough to analyze Lelé's systemic[54] thinking – constructive, mechanic, functional, and critical[55] – and to call attention to the fact that the architect's studies for the bus shelters in Salvador gave rise to a production mode henceforth centered on the fragmentation pattern of precast elements. From that moment onwards, there were no more unibody industrialized structures. The idea of dividing in order to better precast took central stage. And it was following this same logic that Lelé – still as RENURB technical coordinator – embarked on a significant experience with light prefabrication: the basic sanitation of the Camurujipe Valley.

54 Systemic thinking combines analysis (making sense of things by taking them apart) and synthesis (making sense of things by seeing how they fit together). Analytical thinking is used for identifying the elements, synthetical thinking is used for finding the repeating pattern. In: Laboratory for Systemic Modeling (LAMS), 'Systemic Thinking", EPFL, Lausanne, accessed April 21, 2017, http://lamspeople.epfl.ch/balabko/Professional/Systemic_Thinking/Index.htm.

55 In recent interviews, Lelé clearly showed dissatisfaction with the progressive replacement of his bus shelters by the Salvador municipal administration. At the center of his criticism was a bus stop designed by the English architect Nicholas Grimshaw (1996) and commercialized in Salvador (2000), Brasília (2002) and other cities in Brazil. His argument is based on the assertion that the European model is not efficient enough when it comes to consider the user's comfort (sun and rain). For further readings, see: João Filgueiras Lima, "Um Construtor Social [Entrevista a Ledy Valporto Leal]," *Finestra* 12, no. 51 (2007): 27; Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes*, 95; Daniel Paz, "O cidadão ausente. A cidade do Salvador e os seus abrigos de ônibus," *Vitruvius*, last modified 2004, accessed May 3, 2017, http://www.vitruvius.com.br/revistas/read/arquitextos/05.054/528; Roberto Gonçalves Araújo, "Cinquenta anos do mobiliário urbano de transporte público em Brasília" (Universidade de Brasília, 2011).

4.3 Basic Sanitation: *o Vale do Camurujipe*

In addition to the efforts towards the enhancement of Salvador's public transportation system, the intervention in slum areas on the outskirts of the city became a decisive integrated action within Kertész's administration. The sanitation of the Valley – crossed by Salvador's main river (Camurujipe) – stamped the mayor's mark on a public deprived of essential services, such as drainage, sewage collection and accessibility. The ambitious project[56] was designed to reach and transform the socio-economic reality of 500,000 inhabitants, one third of Salvador's population at that time. However, the political impact of this initiative seems to have backfired.

The inclusive nature of the activity carried out under Kertész government strengthened popular political expression, which in a context of dictatorship echoed as a threat to the ruling power of Antônio Carlos Magalhães.[57] Kertész's dismissal from the city hall in November 1981 showed that his "hybrid attitude"[58] – between the alignment with centralizing and authoritarian orientations and the environment of a democratic transition – proved to be his undoing. What is at issue here is the fact that the mayor's downfall directly affected Lelé. In addition to losing his position at RENURB, along with most of his collaborators, the architect was unable to follow up on his experiments in *argamassa armada* in Bahia at that time.

But the interruption of the Camurujipe Valley's project left behind a true testimony to the great stride of light prefabrication in Brazil. I am talking about the set of three basic precast devices developed by Lelé[59] and his team at Renurb's design office in 1980: ramps and drainage stairways; prefabricated channels and retaining walls. Among the three subgroups, we shall pay special attention to the channels, which played a fundamental role during the deployment stage of the sanitation program of the suburbs in Salvador. According to Robério Bezerra: "the first stage of the basic sanitation works to be carried out was the rectification, dredging and margin covering of the Camurujipe River. With the river problem solved, which represents the

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56 The Camurujipe Valley's sanitation project encompassed 22 low-income districts of Salvador. The watershed reached 3.9 thousand hectares of hilly areas throughout 15 kilometers of river extension. A list of basic priorities was established by the Salvador City Hall, covering six topics in the following order: 1. Land legalization; 2. Basic sanitation in the valleys and on slopes; 3. Slope stabilization; 4. Water system installation; 5. Suplementation of electrical installation; 6. Basic urbanization. The project was budgeted at USD 150,771,224.00 (price in April 1981). For detailed information on this public initiative in Bahia, see: n.d., *Salvador: Saneamento Básico* (Salvador: Prefeitura Municipal do Salvador, 1981); Vale, "Um Projeto Urbano Com Programa Político Municipal: A Experiência do Arquiteto João Filgueiras Lima em Salvador na 1.ª Gestão Mário Kertész (1979-1981)"; Robério Ribeiro Bezerra, *Argamassa Armada: Aplicação em Urbanização de Favelas e Saneamento Básico (ET-64)* (São Paulo: ABCP, Associação Brasileira de Cimento Portland, 1984).

57 Antônio Carlos Peixoto de Magalhães (1927-2007) was one of the most powerful and influential politicians in Brazil. He served as Governor of Bahia during three periods: 1971-75, 1979-83 and 1991-94.

58 Expression employed by Michel Vale. In: Vale, "Um Projeto Urbano Com Programa Político Municipal: A Experiência Do Arquiteto João Filgueiras Lima Em Salvador Na 1.ª Gestão Mário Kertész (1979-1981)," 64.

59 The authorship of the initial urban infrastructure plan for poor areas in Salvador was claimed by the engineering team (drainage sector) from the Central Body for Planning (OCEPLAN). According to its coordinator – Eng. Robério Ribeiro Bezerra – in July 1979 his team presented to the then Mayor of Salvador, Mário Kertész, a proposition for infrastructure works, drainage and sewage disposal for the district of Calabar. This proposal was defined by the installation of drainage galleries – flat or over steps – built in clay structural bricks topped by concrete plates, also used as pedestrian paths. The engineer asserted that this same model was later improved by the architect João Filgueiras Lima, who, oriented by Prof. Frederico Schiel, developed structural components in argamassa armada. In: Bezerra, *Argamassa Armada: Aplicação Em Urbanização de Favelas E Saneamento Básico (ET-64)*, Preface.

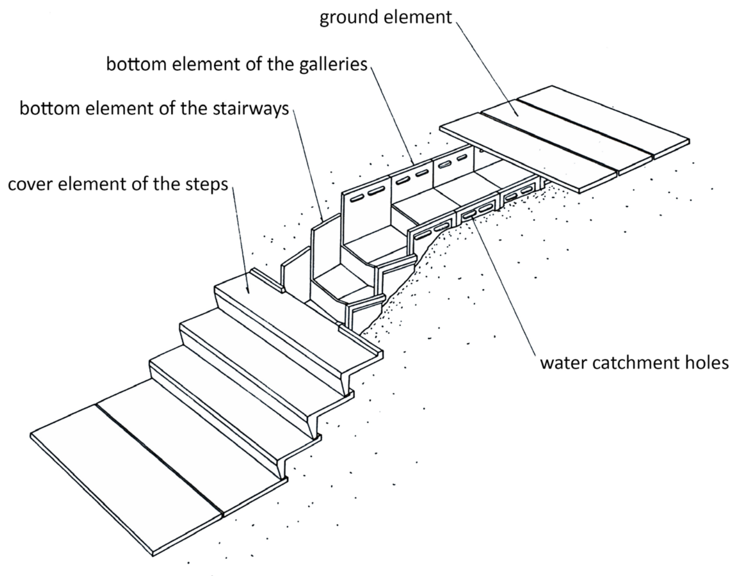

Fig. 2.27 Ramps and Drainage Stairways (micro-drainage). Lelé's general conception, developed by Kristian Schiel and the RENURB team. Salvador, 1980. Arquivo Kristian Schiel, Brasília.

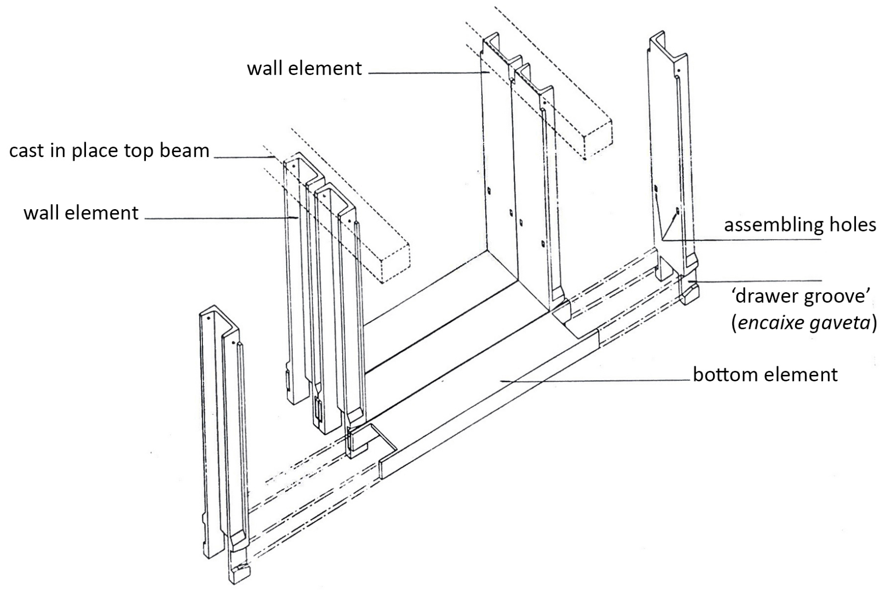

Fig. 2.28 Channel (macro-drainage). Lelé's general conception, structural design by Frederico Schiel, developed by the RENURB team. Salvador, 1980. Arquivo Kristian Schiel, Brasília

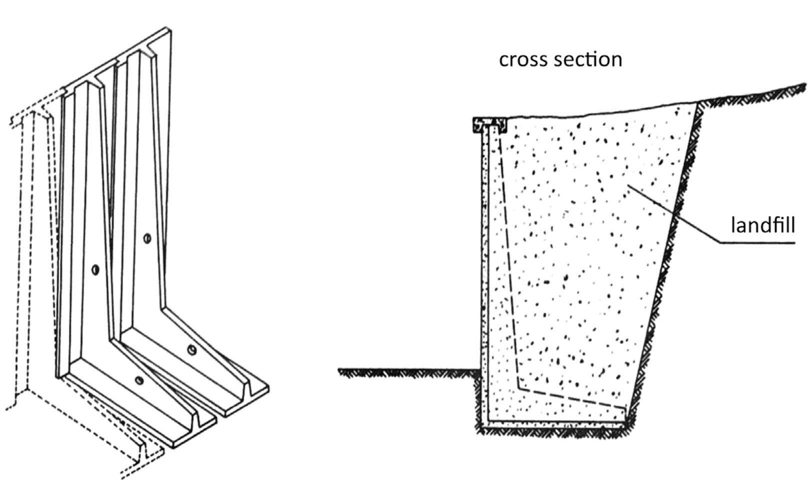

Fig. 2.29 Retaining wall. Lelé's general conception and structural design, developed by the RENURB team. Salvador, 1980. Robério Bezerra, *Argamassa armada: aplicação em urbanização de favelas e saneamento básico* (São Paulo: ABCP, 1984), p. 21

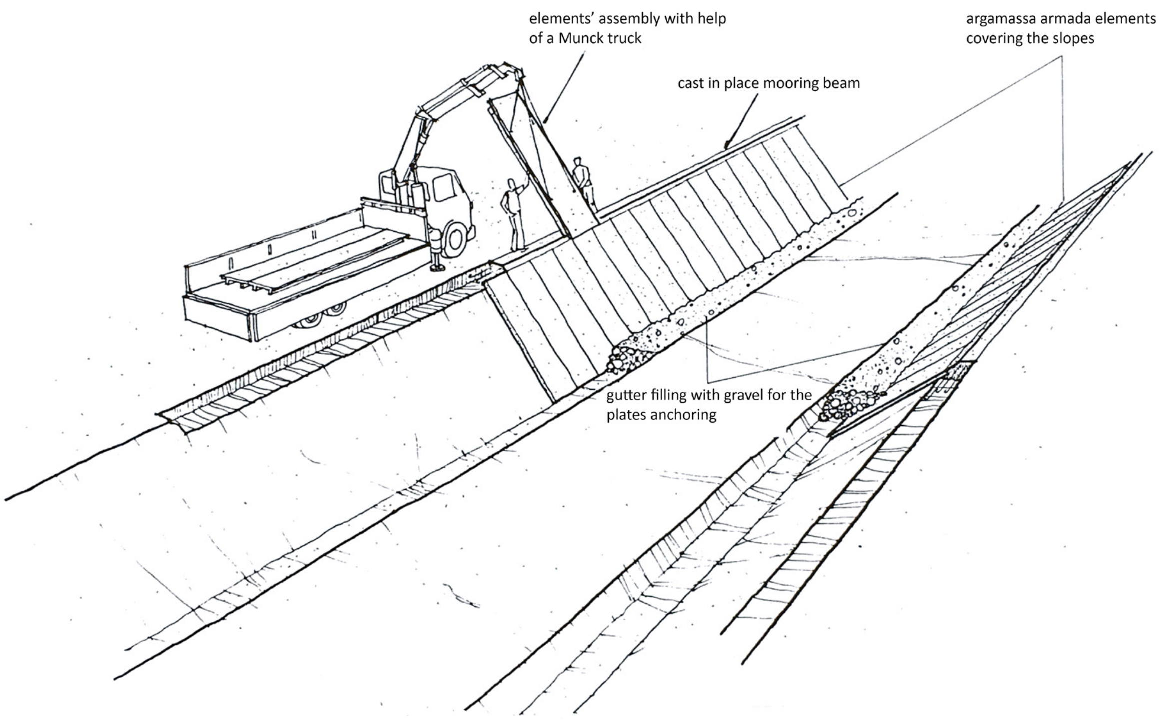

Fig. 2.30 Margin covering procedure of the Camurujipe River in Salvador. Prefeitura Municipal do Salvador, *Salvador. Saneamento Básico*, p. 13

backbone of the system, the second stage was the macro-drainage of the settlements."[60]

This sequence of actions oriented the deployment of prefabricated channels (macro-drainage) as a priority structure within the scope of interventions. Whereas the retaining walls were destined to stabilize the hillsides, ramps and stairways (micro-drainage) connected themselves to the channels, and thereby completed the draining system. It is important to notice here that this system collects and conducts both rainwater and wastewater, without any kind of separation. The lack of adequate sewage systems in Salvador reflects the precarious situation in which a large part of the Latin American population still lives. Far from being exclusive to Brazil, the sanitation and drainage problems faced by Lelé and his team in Bahia are also encountered in big urban centres like Lima, Caracas or Bogotá.[61]

However, due to a particularity of Salvador's topography, together with the conditions of the precarious sites,[62] the sanitation works implemented there adopted various non-standard measures, as we shall see. Built on top of a geological fault scarp,[63] the city's urban development

60 Vale, "Um Projeto Urbano Com Programa Político Municipal: A Experiência Do Arquiteto João Filgueiras Lima Em Salvador Na 1.ª Gestão Mário Kertész (1979-1981)," 35. [A primeira etapa das obras de saneamento básico a ser executada foi a retificação, dragagem e revestimento do Rio Camurujipe. Resolvido o problema do rio, que se coloca como a espinha dorsal do sistema, a segunda etapa foi a macro-drenagem dos assentamentos] (my translation).

61 For a comprehensive survey of developments in urban infrastructure projects in peripherical areas of medium to large sized towns in Latin America, see: Julían Salas Serrano, *Mejora de Barrios Precarios en Latinoamérica: Elementos de Teoría y Práctica*, ed. David Serna Cárdenas (Bogotá: Escala, 2005).

62 Difficulties of access, irregular topography and high populational density were among the adversities encountered during the sanitation works in Salvador.

63 Salvador was founded in 1549 by Thomé de Souza, the first governor-general of Brazil, at that time a Portuguese

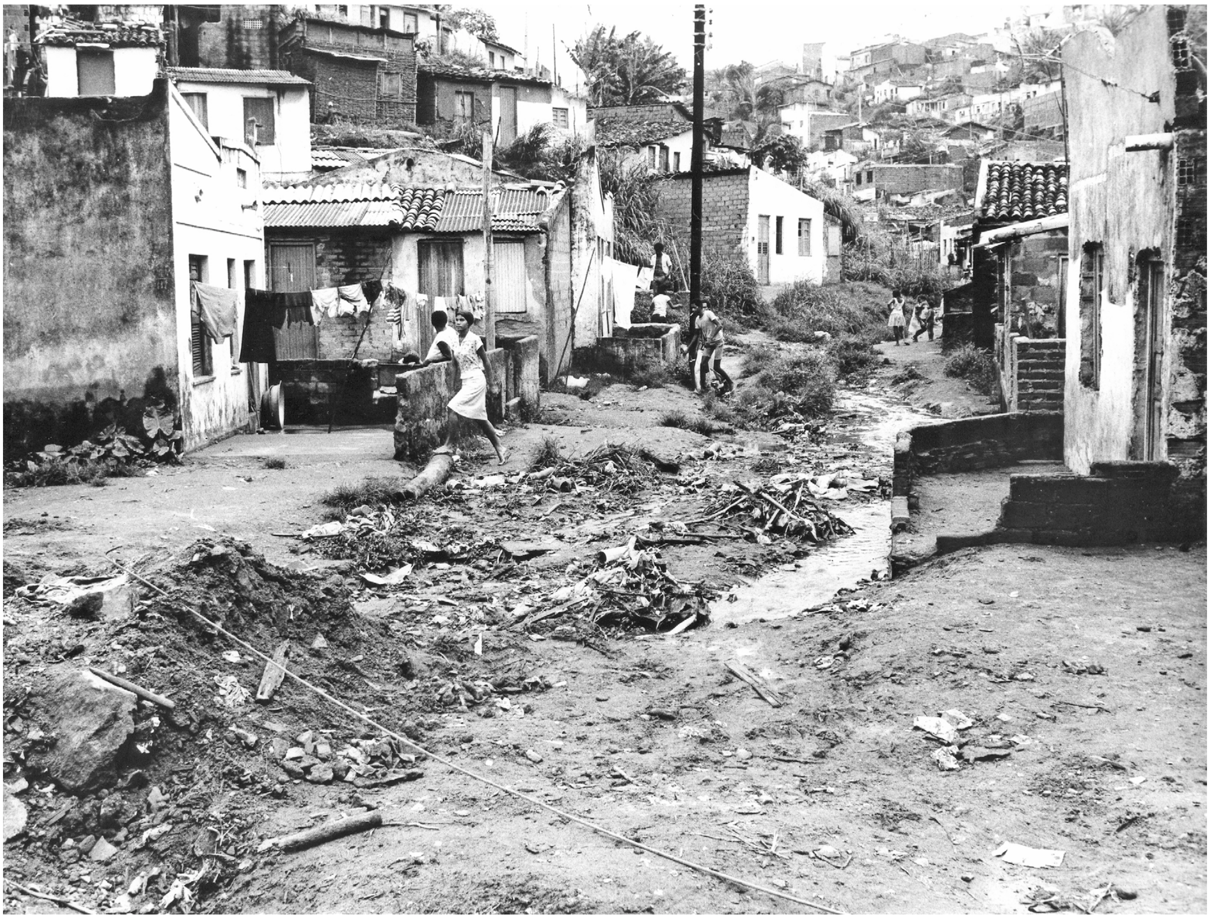

Fig. 2.31 Precarious living conditions in the *Favela do Bom Juá*, in th northern part of Salvador, before the RENURB's sanitation works (1979). Arquivo João Filgueiras Lima, Salvador

was shaped between hill ranges and valleys, reaching over 40 m high and with inclinations often greater than 45 degrees. Historically, it began at the top of the hills and gradually moved down, towards the slopes until reaching the bottom of the valleys.

"Unlike Rio de Janeiro where the favelas go uphill, in Salvador the favelas go downhill, which is much worse, because the people below receive the waste, the garbage,"[64] explained Lelé. The accumulation of waste (plastic bags, mattresses, tyres, etc.) on these sites was poorly attended by public services; and this, together with the progressive sedimentation on the Camurujipe river bed, increased problems like flooding and erosion. In view of this situation, Lelé proposed an alternative which was socially fair and technologically sound. He described the guidelines as follows:

colony. The City of the Savior (*Cidade do Salvador*) was planned by Luís Dias to be the country's central administration. For more information, see: Teodoro Sampaio, *História da fundação da cidade do Salvador* (Salvador, Bahia: Tipografia Beneditina Ltda., 1949).

64 João Filgueiras Lima, "Formação do Artista e do Arquiteto," *Módulo*, no. 76 (1983): XII. [Lá, ao contrário do Rio de Janeiro onde as favelas sobem o morro, as favelas descem, o que é muito pior, porque as pessoas em baixo recebem os dejetos, o lixo] (my translation).

> We should not only study a light technology – a floating thing, that could be compatible with the existing tension capacity of the soil – but, at the same time, a technology that will not remove people from their place. Our proposal was not to urbanize the settlements, but to implement the basic sanitation. With *argamassa armada*, we obtained very thin components, one-and-a-half or two centimeters thick, to be carried by hand. In fact, what we intended was to create a boat floating in the garbage, sludge and mud.[65]

It is clear from the cited excerpt that weight takes centre stage again. In fact, Lelé's idea of creating a self-supporting floating structure which would be manually handled during the works reveals more than a technical solution. Two central strands can be identified in this passage of text. In the first place, the architect seems concerned about the obvious vulnerability of the local population. Therefore, the use of heavy machinery was understood as unnecessary and even inappropriate for the works. This ensured that the intervention could be broached without damaging people's houses, which in those environments tend to be highly concentrated. Thus, the solution would be bounded. Light and economical, with no machinery allowed for assembling, and fast to produce. Considering that at that moment Lelé did not have sufficient knowledge regarding *argamassa armada* structures, the question that arises is how?

Secondly, there is a strong emphasis on the manual handling of *argamassa armada* precast components, which started during the sanitation works at the Camurujipe Valley in Salvador. From that moment onwards, Lelé seems to promote the lightweight material stressing its feature of being able to "be carried by hand." Through a varied range of sources – such as books, journal articles, pictures and drawings – the marketization of lightness figures prominently. There is no doubt that the material was tailored to provide slender monolithic parts, but as we will see, this does not imply that all the designed components were susceptible to manual transport. It looks like there was a need to prove or justify the technology shift from prefabrication in reinforced concrete to *argamassa armada*. The question which emerges is why?

In my view, unlike Lelé's previous works in concrete, the emergence of *argamassa armada* as the priority material of construction required clearly defined objectives and strategies. If on the one hand the architect may be unwilling to capitalize on his work – as proven during the RENURB patent case[66] – on the other hand it is clear that there had been a propagandist effort towards the diffusion of a light new technology. To a certain extent, this contributed

65 Ibid. [O que tínhamos era que estudar não só uma tecnologia leve, uma coisa flutuante, que pudesse ser compatível com essa capacidade de tensões admitidas pelo terreno mas, ao mesmo tempo, uma tecnologia que não retirasse as pessoas dali. Nossa proposta não era fazer urbanização, era de fazer o saneamento básico. Com argamassa armada conseguimos peças bem finas, com um centímetro e meio, dois centímetros de espessura para poderem ser transportadas a mão. Na verdade, o que pretendíamos era um barco flutuando no lixo, no lodo e na lama] (my translation).

66 At the insistence of OCEPLAN's engineers, the Renurb technical board prepared the patent applications for the four devices – the *argamassa armada* drainage stairs and runways, channels and retaining walls together wih the concrete bus shelter. Unlike Nervi, for example, Lelé was not interested in making money with his inventions with *argamassa armada*. Kristian Schiel. Interview with Adalberto Vilela on April 25, 2017 by telephone. For more information on Nervi's patents, see: Claudio Greco, *Pier Luigi Nervi: von den ersten Patenten bis zur Ausstellungshalle in Turin 1917-1948* (Luzern: Quart Verlag, 2008).

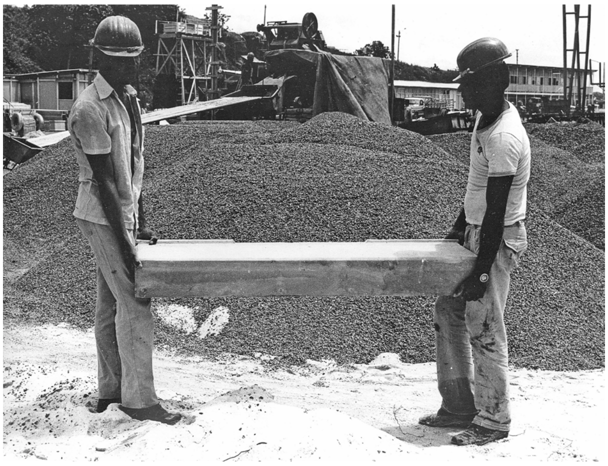

Fig. 2.32 Manual handling. Cover element of the drainage stairway's steps. RENURB, Salvador (1980). Arquivo João Filgueiras Lima, Salvador

Fig. 2.33 Manual handling. Hollowed precast column. Abadiânia (1984). João F. Lima, *Arquitetura: uma experiência na área de saúde* (São Paulo: Romano Guerra, 2012), p. 59

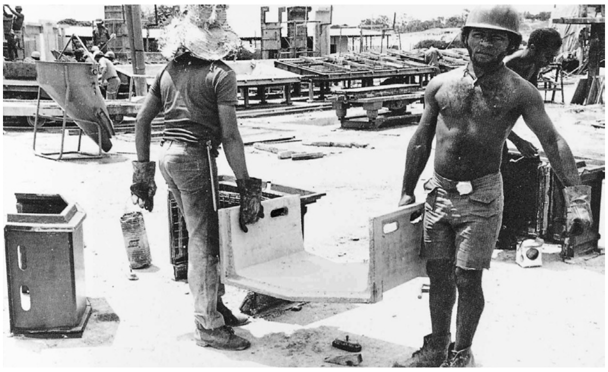

Fig. 2.34 Manual handling. Bottom element of the drainage stairways. RENURB, Salvador (1980). Giancarlo Latorraca, *João Filgueiras Lima, Lelé* (São Paulo: Instituto Lina Bo e P.M. Bardi; Lisboa: Editoral Blau, 2000), p. 107

Fig. 2.35 Manual handling. Channel's wall element. RENURB, Salvador (1980). João Filgueiras Lima, *Escola Transitória Modelo Rural* (Brasília: MEC/CEDATE, 1984), p. 13

to spreading knowledge and increasing the application of *argamassa armada* in Brazil. As Hanai and Ballarin put it, "the ferrocement technology had achieved a national dimension as a consequence of an integrated work performed by João Filgueiras Lima, the São Carlos Group and the Brazilian Portland Cement Association."[67]

Even though these three parties rarely came to work on the development of joint projects – with Lelé taking a more isolated professional position – their roles were fundamental for the establishment of a constructive culture in *argamassa armada* in Brazil. The engineers of the *Grupo de São Carlos* launched the technical basis in the research field, the Brazilian Portland Cement Association[68] (ABCP, *Associação Brasileira de Cimento Portland*) supported the technology transfer and worked on technical advising, and Lelé promoted advancements in both the design and industrial production concepts of *argamassa armada*.[69] But to return to the first question, it now remains for us to see how Lelé came to operate interventions in *argamassa armada* structures, a technology which had until then carried little significance in his work.[70]

In January 1980, the engineer Frederico Schiel sent a letter from Munich to his son in Salvador, Kristian Schiel – an architect who was part of Lelé's team at RENURB – condemning their "anteprojeto" (preliminary draft) for a prefabricated channel in *argamassa armada*. Professor Schiel, who retired from the São Carlos School of Engineering in 1975, acted at that moment as technical consultant for the sanitation works at the Camurujipe Valley. Along with a three-pointed explanation of why Lelé's proposition would not work, the engineer's letter also provided sketches of his main solution and three other alternatives. Amid a range of considerations on the hydraulic behavior, shape and stability of precast "ferrocemento" components, a solution was offered in the solidification of the connections between the wall and bottom elements, as stated below:

> Since your channel is relatively small (not very wide) one can surely insert the wall elements in the base. In other words, because of the narrow width, a solid and specifically designed bottom part would not be so expensive. Then you are practically independent from the quality of the soil and would have a light and fast assembling of the *peças*

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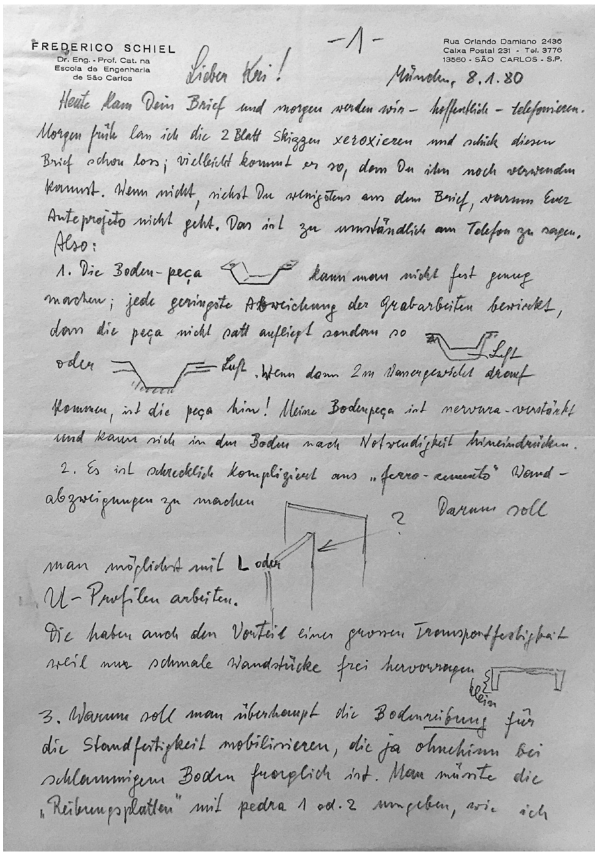
67 João Bento de Hanai and Adriano Wagner Ballarin, "Prefabricated Construction Systems Designed by Architect João Filgueiras Lima," in *Third International Symposium on Ferrocement*, ed. S.K. Kaushik and V.K. Gupta (Roorkee, India: McGraw-Hill, 1988), 528.

68 Founded in 1936, the Brazilian Portland Cement Association (ABCP) is a non-profit civil society organization, based in São Paulo capital. Its aim is to conduct technical studies and research on cement and its derivatives, in order to ensure the product's quality. The institution also promotes the dissemination of information on Portland Cement, instructing professionals about the economical ways to use it in construction. Among the services the association provides are technical publications (books, articles, and journals) and standardized laboratory tests.

69 In a wider field of debate about building industrialization initiatives in Brazil (and not exclusively on *argamassa armada* itself), Ana Paula Koury mentions the Brazilian Center of Construction (1969) (CBC, *Centro Brasileiro da Construção - Bowncentrum*) and the Master Program in Building Industrialization (1970) of the São Carlos School of Engineering as representing two different views on the role of the Brazilian State in the process of building industrialization. In: Koury, "Arquitetura construtiva: proposições para a produção material da arquitetura contemporânea no Brasil," 106.

70 Until that moment, the only work where Lelé had tried the application of *argamassa armassa* structures was at the *Planalto de Automóveis* Building (1972), in Brasília. This episode was previously addressed in the first chapter.



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-1-

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13560 - SÃO CARLOS - S.P.

Lieber Kri! München, 8.1.80

Heute kam Dein Brief und morgen werden wir – hoffentlich – telefonieren. Morgen früh kann ich die 2 Blatt Skizzen xeroxieren und schick diesen Brief schon los; vielleicht kommt er so, dass Du ihn noch verwenden kannst. Wenn nicht, siehst Du wenigstens aus dem Brief, warum Euer Anteprojeto nicht geht. Das ist zu umständlich am Telefon zu sagen.
Also:
1. Die Boden-peça kann man nicht fest genug machen; jede geringste Abweichung der Grabarbeiten bewirkt, dass die peça nicht satt aufliegt sondern so Luft oder Luft. Wenn dann 2m Wassergewicht drauf kommen, ist die peça hin! Meine Bodenpeça ist nervura-verstärkt und kann sich in den Boden nach Notwendigkeit hineindrücken.
2. Es ist schrecklich kompliziert aus „ferro-cimento" Wand-abzweigungen zu machen ? Darum soll man möglichst mit L oder U-Profilen arbeiten.
Die haben auch den Vorteil einer grossen Transportfestigkeit weil nur schmale Wandstücke frei hervorragen. klein
3. Warum soll man überhaupt die Bodenreibung für die Standfestigkeit mobilisieren, die ja ohnehin bei schlammigem Boden fraglich ist. Man müsste die „Reibungsplatten" mit pedra 1 od. 2 umgeben, wie ich

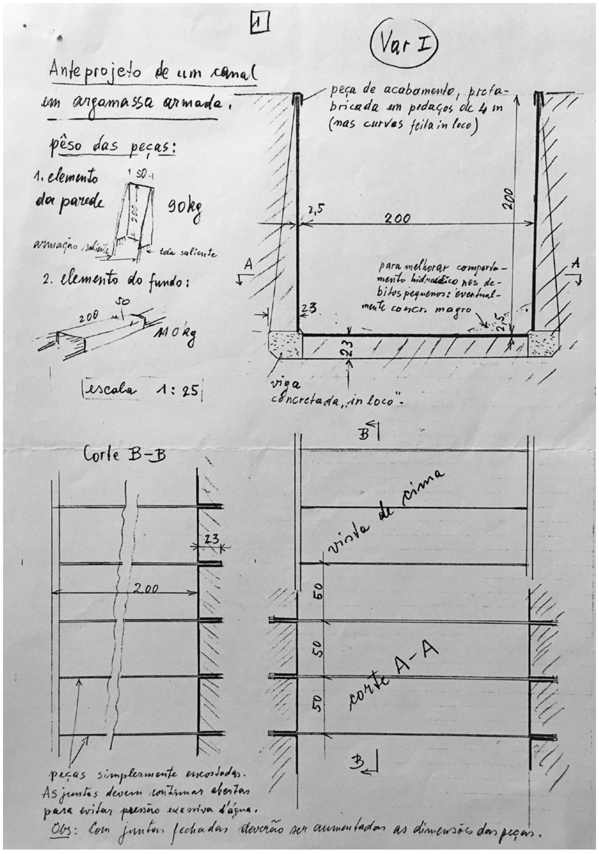

Fig. 2.36 Frederico Schiel's letter to his son, the architect Kristian Schiel. Munich, January 1980. The documents show the engineer's proposition for a new structural solution to the sanitation channels in Salvador. Arquivo Kristian Schiel, Brasília

(components, in Portuguese).[71]

The cost reference found in Prof. Schiel's argument refers to the possibility of pouring concrete at the channel's base through two different methods: whether along the two lower corners of the channel (as beams), or as a ten-centimeter thick bottom slab. In both cases, the decision is clear to join the precast elements – walls and bottom or, as in the second method, just the walls – with cast-in-place reinforced concrete. However, this approach could not work. In addition to the channel's bottom profile, whether flat or non-flat, questions like water speed, water trajectory angle and mud accumulation led to another necessity: the creation of a special element for curves.

In the next couple of days,[72] new sketches were added to the channel's elaboration process by Prof. Schiel. One page dated from January 10, 1980 shows that the first step towards the final jointing solution had been taken: the discontinuation of the cast-in-place stages in reinforced concrete at the lower level. The adoption of a U-shaped wall element designed to fit

71 Frederico Schiel. Letter to Kristian Schiel. Munich, January 8, 1980. Source: Arquivo Kristian Schiel [Da Euer Kanal relaktiv klein ist (nicht sehr breit) kann man ohne weiteres die Wände in die Sohle einspannen oder, mit anderen Worten, wegen der geringen Breite ist die entsprechend fest projektierte Sohle nicht zu teuer. Man, ist dann praktisch unabhängig von der Bodenqualität und hat ein leichter und schnelles montieren der (sic) "peças"] (translation assistance by Filippo Sottovia, Andrea Hagn and Silvan Blumenthal).

72 From January 8 to 10, 1980. Prof. Frederico Schiel used to date and sign his documents.

the bottom part through a "drawer groove" is intriguing evidence of how the ingenious and definitive connection had evolved. At the end of February 1980, the channel's complete version, including the curved module, was defined.

Nevertheless, unlike the drainage stairs components which weighed around 50 kg and could be transported manually, the precast channel parts required a different assembling strategy. Weighing less than 100 kg each, the three elements of the channel (two walls and one bottom) were mounted forming 2 m x 2 m maximum square sections.[73] This operation was intended to be assisted by small loading cranes, as the overall weight of a single pre-assembled module exceeded 270 kg. As reported by Bezerra:

> The elements will be assembled, whenever possible, at the building site, by horizontally fitting the parts of each module on a uniform platform. The mounted module will be settled with the help of a crane and winch device, using the holes in the wall as support points during transportation. The works will be complemented by manual operations. In exceptional cases, assembly may be carried out by manual operations, since the element's weight (approx. 100 kg) allows for their handling.[74]

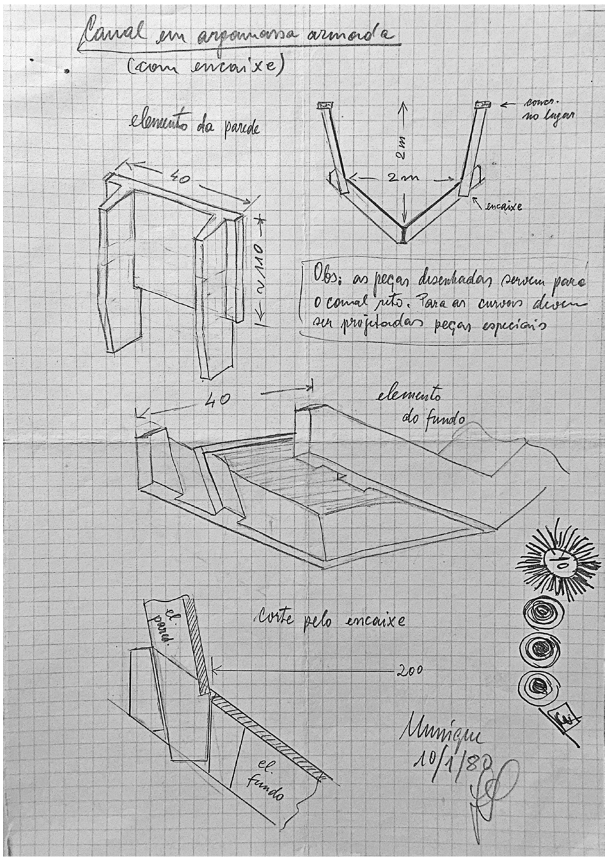

Fig. 2.37 Studies by Frederico Schiel showing the chamfered bottom part of the Salvador's sanitation channel: a solution that came quite close to the definitive drawer groove. Arquivo Kristian Schiel, Brasília

Fig. 2.38 Sanitation channel precast element in *argamassa armada*, Salvador, 1980. Connection between a wall and bottom element through the drawer groove (final solution). Component thickness: 3 cm. Arquivo Kristian Schiel, Brasília

73 A complete list with the precise weight per component of the three precast devices – drainage stairs, channels and retaining walls – designed for the sanitation works in Salvador is available at: Bezerra, *Argamassa Armada: Aplicação em Urbanização de Favelas e Saneamento Básico (ET-64)*, 2.

74 Ibid., 24–25. [As peças serão montadas, sempre que possível, no canteiro da obra, fazendo-se o travejamento e encaixe das peças componentes de cada módulo, deitadas sobre uma plataforma uniforme. O módulo montado será assentado por equipamento provido de lança e guincho, utilizando-se para apoio da locomoção os furos existentes nas peças laterais. A complementação do assentamento será feita por operações manuais. Em casos excepcionais, a montagem poderá ser feita por operações manuais. A massa das peças (aprox. 100 kg) permite seu manuseio] (my translation).

Fig. 2.39 Accomplished channel in a poor neighborhood of Salvador. (1980) Arquivo Kristian Schiel, Brasília

It was acknowledged from the beginning that the manual assembly of the channel module was unachievable. Evidence of this is a schematic drawing (Feb. 1980) by Frederico Schiel which indicates a simple trolley built over the channels with a pulley system installed to facilitate the assembling process. It is curious that, contrary to the very limited uptake of the trolley project, another manufactured prototype – the triple module – had a wider reach. Proposed to accelerate the channel construction in long straight sections, the unimplemented project for Salvador ended up inspiring Lelé to redesign, years later, a new version for the sanitation pathway in Rio de Janeiro (1986).

From a technical point of view, the main advance made by the Camurujipe Valley's project in Salvador was that it laid the groundwork for the industrialization of *argamassa armada* in Brazil. This would not have been possible without the fruitful cooperation between the relevant actors professionally involved, such as the engineering team (drainage sector) from the OCEPLAN department, the technicians from the RENURB office, and the numerous workers responsible for effectively assembling the precast parts under poor work conditions. Despite the differences of interpretation over production aspects between Lelé and Prof. Schiel – namely the dilution of *argamassa* mixture and the vertical pouring phase of components – a small but telling detail punctuates the technical divergences[75]

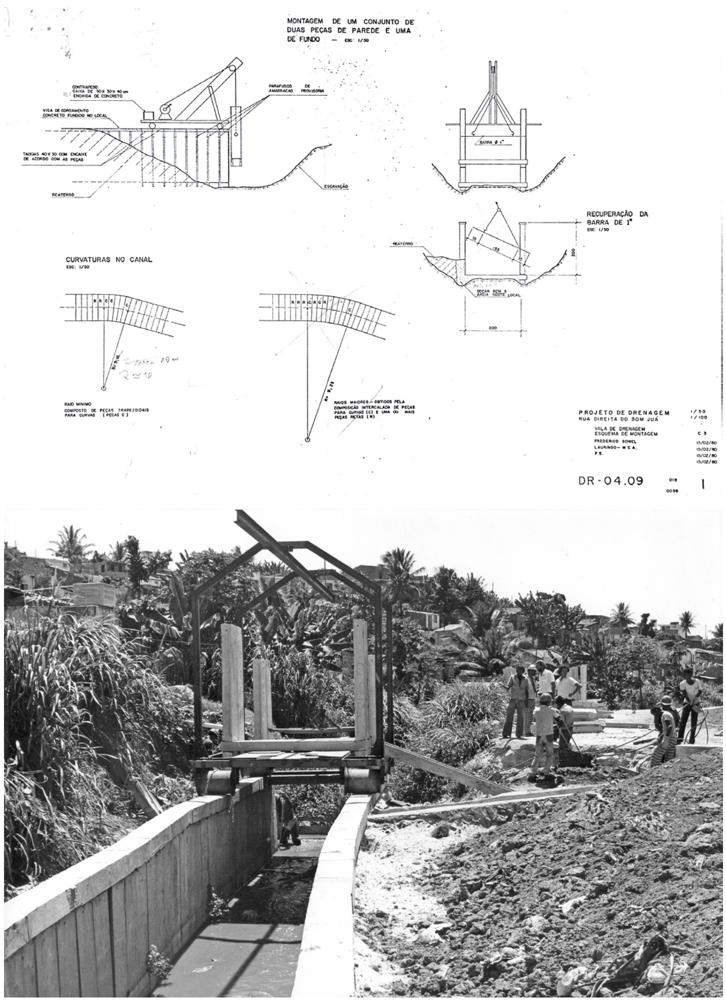

Fig. 2.40 Frederico Schiel's assembly scheme (above) of a trolley to assist the channel construction. A different version was built (below) despite the unsuccessful operation at the building sites. Arquivo Kristian Schiel, Brasília

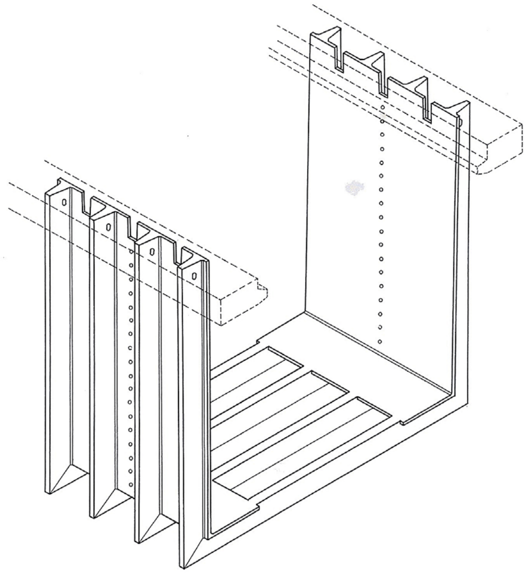

Fig. 2.41 The triple-module (in *argamassa armada*) proposed to accelerate the channel assembly for straight sections. Arquivo Kristian Schiel

75 As explained in Part 1, in some cases, Lelé and Prof. Schiel took different views regarding the means of producing *argamassa armada*. Basically, the engineer did not agree with Lelé's method of making the *argamassa* mix more malleable. This change affects both the casting and curing phases.

Fig. 2.42 Construction of a drainage channel in the suburbs of Rio de Janeiro. Lelé redesigned the system (1986) on the basis of the previous experience in Salvador. Photograph by Celso Brando. Arquivo Zeca Franco, Rio de Janeiro

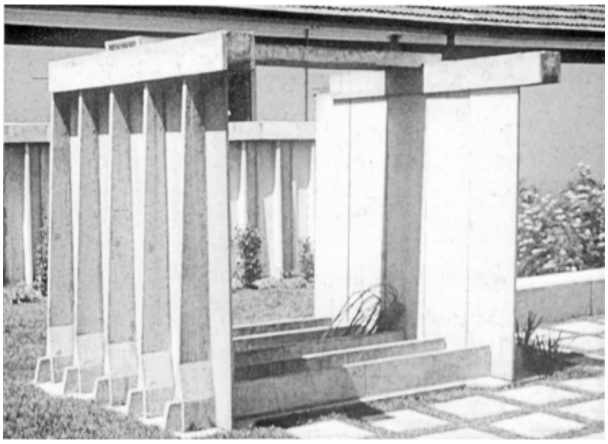

Fig. 2.43 Prototype of Lelé's new version for the drainage channels in Rio de Janeiro (1986). Photograph by J. Salas. Júlian Salas, *Mejora de barrios precarios en Latinoamerica: elementos de teoría y práctica* (Bogotá: Escala, 2005), p. 74

between them: the metallic formwork designed by Mariano Casañas.

Prof. Schiel's plans for the channel elements already involved the use of fixed molds on the ground, as he had been doing since the 1960s. The metallic and articulated formwork developed by Casañas not only set the pace for producing the final structures suggested by the engineer, but they also brought Lelé a sense of security in the process. From then on, Lelé's precast elements became increasingly more sophisticated in terms of both geometrical shape and production. This level of self-confidence was fundamental for the architect to tackle a new situation at the end of Mário Kertész's administration. Using new tools and resources, we shall see how the Abadiânia Transitory Schools in the countryside of Goiás State turned out to be much more than a "romantic experience."[76]

76 According to Lelé, the Abadiânia experiment was essentially romantic, in the sense that it was integrated into an

5. The dream of a community work model in the Brazilian Central Plateau

In 1982, Lelé embarked on a series of reforms designed to improve the education, health and economic sectors of a small town in the interior of Goiás state, called Abadiânia.[77] The project brought together a transdisciplinary team of 22 participants – "10 professionals from the area of healthcare, 7 from the domain of agriculture, 3 from the education sector, and the architect João Filgueiras Lima (Lelé) with the foreman João Evangelista, expert in infrastructure"[78] – to work in close collaboration with the newly elected Mayor Vander Almada.[79] At first glance, it may appear that history was repeating itself, as we looked at Lelé's participation in Mário Kertész's administration in Salvador in the previous chapter. But as we shall see, the two consecutive experiences could not be further apart.

The fact that both projects came in a row does not imply that one led to another. Contrary to what one might think, Lelé's initiative in Abadiânia (1982-1984) was not an immediate consequence of Kertész's ousting from power in Salvador at the end of 1981. This is especially true if we consider that the architect had maintained longstanding ties with the small town, which he used to visit regularly. The agronomist João Benko, part of the multidisciplinary team, recalled that "before 1982, Abadiânia had already served as a meeting point for Lelé and his family, especially at Christmas and New Year's Eve. Here he learned about the news of the Revolution through his fellow journalists who used to tell him about the events in Brasília."[80]

Fig. 2.44 Aerial view of the former village of Abadiânia, Goiás, ca. 1982. Arquivo João Filgueiras Lima, Salvador

ambitious and far-reaching proposal put forward by a small group of professionals working in different areas. They collaborated, unpaid, for the municipal administration in support of the communitarian pastoral project developed by Brother Matheus Rocha in the region. In: Latorraca, *João Filgueiras Lima, Lelé*, 137.

77 The municipality of Abadiânia, located 120 km from Brasília, had a population of 9,402 inhabitants in 1991, according to the Brazilian Institute of Geography and Statistics (IBGE, 2017). This total differs significantly from the population indicated by Lelé in his study on the town in 1982 (around 17,000 inhabitants). Source: Arquivo João Filgueiras Lima, AMA - Ação no Município de Abadiânia, the "population, health and education" board (população, saúde e educação).

78 Albineiar Plaza Pinto. Letter (undated) entitled "Carta às amigas e aos amigos em tempos de golpe" (letter to friends during a coup). [Dez profissionais da área da saúde, sete profissionais da área de agricultura, três profissionais da área de educação, e na infraestrutura o arquiteto João Filgueiras Lima (Lelé) e o mestre de obras João Evangelista dos Santos, o João da Irene] (My translation). Arquivo Albineiar Plaza Pinto, Abadiânia.

79 Vander da Silva Almada (1943-2014) studied agronomy at the University of Brasília. He served as Mayor of Abadiânia from 1983-1988. The municipal elections which took place in Brazil on November 15 were the last to be held under the aegis of the military regime.

80 João Benko. Interview with Adalberto Vilela on May 24, 2016 in Abadiânia. [Antes de 1982, Abadiânia já era ponto de encontro de Lelé e sua família, sobretudo durante o Natal e Réveillon. Aqui ele ficava sabendo sobre as notícias da Revolução por meio de amigos jornalistas que contavam para ele os acontecimentos de Brasília] (my translation).

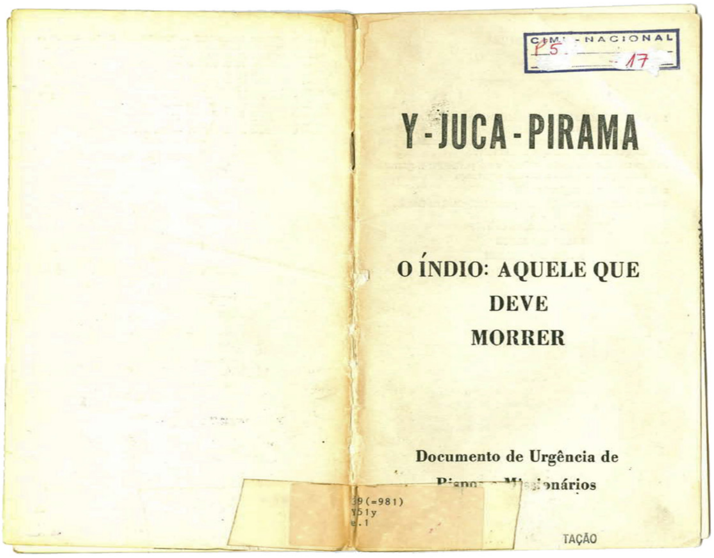

Fig. 2.45 Cover of the Y-Juca-Pirama document denoucing the military dictatorship. Accessed May 18, 2017, https://issuu.com/porantim/

The small town in Goiás had already inscribed its name on the recent history of political and social resistance in Brazil, when in 1973 it was the place where an important letter[81] denouncing the military dictatorship was signed: "*Y-Juca-Pirama, o Índio: aquele que deve morrer. Documento de urgência de bispos e missionários* (Y-Juca-Pirama, the Indian: the one who must die. Urgent document from bishops and missionaries).[82] In a way, the letter-manifesto paved the way for Abadiânia to host a group of leftist political activists (theologians, sociologists, writers and artists) – such as Dom Tomás Balduino, Herbert de Souza (Betinho), and Henrique de Souza Filho (Henfil) – especially after the Amnesty Law of 1979.[83] The revision of the infringements for political reasons on the part of the central government led to a wider circulation of ideas against the regime, which found a convenient and safe place in the small town close to Brasília.

At the center of it all was friar Mateus Rocha, a Dominican Brother responsible for bringing together this heterogeneous group of people with whom he shared his vision of a proactive Christianity and who concentrated in Abadiânia, including Lelé who came directly from Salvador. Soon after returning from his theological studies in France,[84] Mateus Rocha had gone to live in parish communities organized around the creation of youth Christian movements in Brazil, such as the *Juventude Estudantil Católica*, JEC (Young Catholic Students).

It was on the basis of these Christian movements that friar Mateus Rocha encouraged the creation of the project called AMA, *Ação no Município de Abadiânia* (Action in the Municipality

81 I am indebted to João Benko, Divina Benko, Gil Santini Pinto, Albinéiar Plaza Pinto and João Evangelista for this and other important information concerning Abadiânia.

82 Considered to be the first document in defence of Brazil's indigenous population during the military regime, the manifesto signed in Abadiânia in 1973 – and published in December the same year – condemned the massive deforestation and the negative impact that the construction of the Transamazon highway was causing to Indians living in Northern Brazil. The title is a reference to the homonymous short narrative poem by the Brazilian author and playwright Gonçalves Dias (1823-1864). He first published "I-Juca-Pirama" in his poetry book "Últimos Cantos" in 1851. Gonçalves Dias became the major exponent of Brazilian Romanticism and the literary tradition known as "Indianism". See: Dom Máximo Biennès et al., "Y-Juca-Pirama, o Índio: aquele que deve morrer. Documento de Urgência de Bispos E Missionários," *Issuu* (n.p.: n.p., 1973), last modified 1973, accessed May 18, 2017, https://issuu.com/porantim/docs.

83 The Amnesty Law (6.683/79) was published in Brazil by the then military President João Figueiredo in August 28, 1979. The central idea was to provide amnesty to everyone who had committed any kind of political crime from September 1961 to August 1979. The final text has been interpreted as favoring the militaries responsible for torture practices during the period, especially against students, artists, writers, journalists or any opposition group.

84 Friar Mateus Rocha (1923-1985) studied theology at Saint Maximin, Provence, France, where he arrived soon after the Second World War (1948). Under the philosophical basis of Jacques Maritain and the religious influence of Marie-Dominique Chenu, the young Dominican was in touch with a renewed Christian-Philosophical thinking. For a comprehensive study on friar Mateus Rocha, see: Antônio Muniz Rezende, "Minhas Memórias Com Frei Mateus Da Rocha: Um Testemunho," *Pólemos* 2, no. 3 (2013): 220–234.

of Abadiânia), in *Emaús*,[85] a parish community in the outskirts of the town founded by the friar in 1972. The project was bestowed on the local people, realizing works such as primary healthcare posts in the town's rural area, prefabricated schools, a public library and a covered street market. Although Lelé considered himself an atheist, his strong links with friar Mateus – which traces us back to the creation of the University of Brasília (1961-62)[86] – were, in fact, based more on the role of ethics in political and social life than religious principles.

This brief introduction has served to place the political and social situation in context, but it mainly explains the circumstances that led a group of young professionals to follow a Dominican Brother and volunteer in the interior of Brazil. It also ought to be said that the AMA project could not count on any governmental support[87] and was practically[88] self-managed with scarce local funds from the city hall. Faced with budgetary constraints limiting the project's implementation, it is hard to believe that Abadiânia became one of the most important moments within Lelé's career and, at the same time, a source of great frustration[89] for the architect. When asked in 2012 about the political predisposition of Brazilian governments to carry on social initiatives in poor areas, Lelé was emphatic:

> So, it all ends in political will. Speaking of which, I recall the pilot project of Abadiânia, in Goiás. It was the experience that moved me the most, professionally. It was much richer from the viewpoint of community life than the projects for the favelas in Rio de Janeiro or Salvador. We lived amongst a very needy population, alongside whom we could establish better working conditions, because they were not susceptible to vices from the slum areas of large cities. Abadiânia was an important experience, within the reach of any young professional. I think I would still be in Abadiânia if Brizola had not invented the *Fábrica de Escolas* (School Factory) in Rio de Janeiro.[90]

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85 Friar Mateus chose to live in *Emaús* after he left Brasília in 1964, due to the military coup. The evangelic concept of "*Emaús*" is related to the idea of a place one can go to revive oneself spiritually and physically after sharing food, beverages and dreams, before getting down to work. [O conceito evangélico de 'Emaús" está relacionado a um lugar onde você vai, se abastece espiritualmente, come, bebe e se fortalece nos sonhos, e depois "mãos à obra"!] (my translation). Divina Benko. Interview with Adalberto Vilela on May 24, 2016 in Abadiânia.

86 This episode was addressed in Part I of the dissertation, under the section "The University Years (1961-1965)." It is known that thanks to friar Mateus, who intermediated between Darcy Ribeiro and the Pope John XXIII, it was possible to create a laic university in Brasília. See: Conceição Freitas, "A Utopia do Lelé," *Correio Braziliense* (Brasília, April 2, 2009).

87 The Abadiânia project for building prefabricated schools was presented to the then Governor of Goiás, Iris Rezende (1983-87), and his Secretary of Planning and was tacitly denied. "We are not going to finance any "*prima donna*", the governor is supposed to have said. Anonymous source.

88 The project in Abadiânia received some financial aid from the Catholic University of Goiás (UCG), at that time represented by the architect and professor Edgar Graeff.

89 Still today I feel great frustration for having abandoned that project (Abadiânia). [...] You know, in a certain way, that experience could have been multiplied, but it ended when I left. [Até hoje eu tenho uma frustração enorme de ter abandonado aquele projeto. [...] Mas sabe o que eu acho, assim... aquilo poderia, vamos assim dizer, se multiplicar. E acabou com a minha saída] (my translation). João Filgueiras Lima. Interview with Adalberto Vilela on May 04, 2011 in Salvador. In: Adalberto Vilela, *A Casa na Obra de João Filgueiras Lima, Lelé* (Brasília: Editora Universidade de Brasília, 2017), 281.

90 Interview with João Filgueiras Lima in: Hugo Segawa et al., "João Filgueiras Lima, O Lelé," *CAU/BR*, last modified 2012, accessed May 18, 2017, http://www.caubr.gov.br/entrevistajoaofilgueiras/. [Então, tudo acaba numa vontade política. Falando nisto, lembro-me da experiência piloto de Abadiânia (Goiás). Foi a que mais me comoveu profissionalmente, muito mais rica de convivência do que as favelas do Rio de Janeiro ou de Salvador. Convivemos com uma população muito carente, com quem podíamos trabalhar melhor, pois não tinha os vícios das comunidades dos grandes centros urbanos. Abadiânia foi uma experiência importante; ao alcance de qualquer jovem profissional. Acho que eu ainda estaria em Abadiânia se o Brizola

Fig. 2.46 Lelé supervising the start of building works in Abadiânia. Photograph by Mariana Chama. Marina Mange Grinover, PhD diss., Universidade de São Paulo, 2015, 382

Today, when visiting Abadiânia, one has the impression that friar Mateus' group managed to produce something quite extraordinary. Although the town still shows vestiges[91] of their utopia, what is perhaps more apparent is the mobilizing force that drew the local community together in a unique and promising project. The Action in the Municipality of Abadiânia failed in its main expectation of transforming that original experience into a pilot plan to be carried out across the borders of Goiás. Without a doubt, three aspects contributed to this: at first, the withdrawal of Lelé from Abadiânia in 1984 to take the lead at the School Factory in Rio de Janeiro; secondly, the premature death of friar Mateus Rocha in a car accident in 1985; and lastly, the failure of Mayor Vander Almada's re-election campaign in 1987.

But Abadiânia must be seen as a true turning point in Lelé's career. Not only because the prefabricated solutions found by the architect in the small town provided the technical basis for the implementation of major public school programs in Brazil over the next ten years, but mainly because it shows that Lelé's commitment to mass-produced architecture was originally born out of professional limitations and personal choices.

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não tivesse inventado a fábrica de escolas do Rio de Janeiro] (my translation).

91 In total, the AMA project managed to build four prefabricated schools in Abadiânia – two in timber (located in the districts of *São Jerônimo* and *Serenata*, disassembled), and two in argamassa armada (in the districts of *Varginha* and *Barreirinho*) – one covered street fair, seven health centers in the rural area, one children's library and one small bridge. Source: João Evangelista. Interview with Adalberto Vilela on May 24, 2016 in Abadiânia / Albineiar Plaza Pinto. Letter on Abadiânia (undated). Lelé also built a private residence there for the couple Gil Santini Pinto and Albineiar Plaza Pinto, both physicians. All the buildings visited during the interview appeared poorly preserved.

Limitation here refers to the modest environment Lelé was working in, without enough financial support for implementing each stage of the project or adequate training for the workers. Most of them had never heard about prefabrication prior to Lelé's arrival. This situation therefore forced the architect to put his ideas into practice differently. Instead of guiding the construction of small schools, for instance, with the help of a set of drawings for building execution, Lelé opted to instruct the workers personally, showing them how things should be done by doing. When I mention personal choices, I refer to his permanent decision to work as a public-sector architect. This decision was made shortly before Abadiânia (1980), when the architect's office in Brasília was still recovering from the effects of recent financial losses and operating expenses. According to Haroldo Pinheiro:

> That was a key moment in Lelé's career. He might have chosen to bolster his office's position through an international commission – such as the one from IBM[92] – or keep himself to this new strand of social projects, more closely linked to the government. Despite his awareness of the difficulties encountered in this type of work, such as payment delays and so forth, he frankly opted for this second path. It was a conscious decision. He was not led to this. He decided.[93]

The fact that Lelé went alone to Abadiânia – without the team of architects who assisted him in Salvador or Brasília – may legitimate this viewpoint. His professional isolation in the small town allied to the lack of local skilled labor somehow favored the development of a new prefabricated building system. We may see Lelé's disjointed decision to turn the focus of his work primarily towards the public sector as crossing the threshold to a practice more socially engaged and with a greater level of autonomy in a technical sense. Working for the government would give him the freedom to develop his creations independently without the restrictions imposed by the market.

Thus, Abadiânia at this juncture was the culmination of years of practice: Lelé drew from his technical background in *argamassa armada* acquired from the sanitation works developed in Salvador and put this into practice in Goiás through prefabricated schools on an experimental basis. It is time to get back to building in the hope that we can situate the problem of systems and components within Lelé's architecture and bring them into discussion.

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92 At the end of the project for the Sarah hospital in Brasíia, inaugurated in 1980, Lelé rejected the proposal to design the headquarters of the multinational computer technology company in the new capital.

93 Haroldo Pinheiro. Interview with Adalberto Vilela on May 3, 2016 in Brasília. [Aquele foi um momento chave na carreira do Lelé. Ele podia optar por ter um super escritório, pegar um projeto internacional como o da IBM, ou então se manter nessa vertente dos projetos de cunho social, mais ligados ao governo, mesmo com todas as dificuldades que às vezes esse tipo de trabalho traz, como a questão de pagamentos, ect. E ele francamente optou por esse segundo caminho. Foi uma decisão consciente. Ele não foi levado a isso. Ele decidiu] (my translation).

5.1 Manufactured schools: education on the production chain

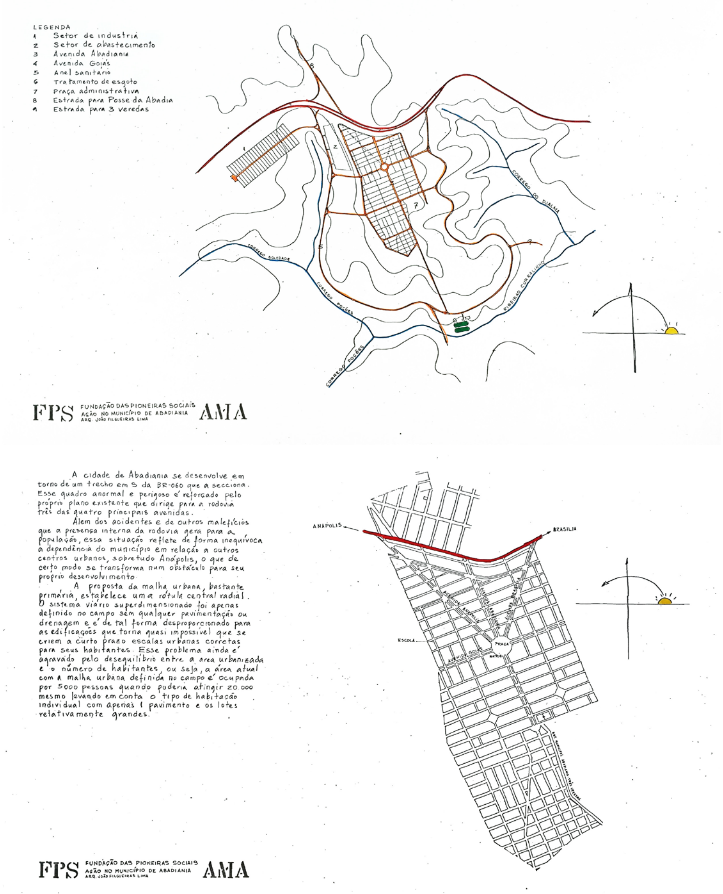

Fig. 2.47 Abadiânia's master plan (above) and urban fabric proposal (below) by Lelé. AMA project, 1982. Arquivo João Filgueiras Lima, Salvador

Rather than idealistic, the project for Abadiânia was in fact ambitious. Not at all in the sense that most of the actions were taken beyond the means of its promoters, but because external support was nowhere near enough to help achieve the desired objectives. It is well noted that Lelé was responsible for the infrastructure projects, and that his major accomplishment was the transitory school system,[94] which was created for the families of displaced field workers, forced to migrate during the growth cycles of plantations. However, we cannot ignore the fact that the architect was also engaged in the development of the town's master plan.

Lelé's proposal for improvements in Abadiânia – which involved the construction of schools, roads, bridges, a kindergarten, a hospital and the implementation of sanitary facilities – is strictly connected to a wider study on the town, conducted by the architect himself. It is more than likely that Lelé had acquired solid knowledge of all the relevant variables for city planning, as he had participated actively in the construction of Brasília. Surrounded by leading experts in the field of sanitation, building, roads and architecture – such as Saturnino de Brito Filho,[95] Israel Pinheiro,[96] Bernardo Sayão,[97] Oscar Niemeyer[98] and Eduardo Kneese de Mello[99] – Lelé might have absorbed more than he thought.

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94 João Filgueiras Lima, *Escola Transitória Modelo Rural* (Brasília: MEC/CEDATE, 1984).

95 Saturnino de Brito Filho (1899-1977) was a Brazilian engineer and professor at the Polytechnic School of Rio de Janeiro. Son of Saturnino de Brito – patron of sanitary engineering in Brazil – Saturnino Filho worked during the construction of Brasília together with other important names.

96 Israel Pinheiro da Silva (1896-1973) was a Brazilian politician and engineer. Born in Minas Gerais, he was a close friend of President Juscelino Kubitschek. This proximity and his severe character led Pinheiro to assume the chief position of the construction of Brasília (1956-1960).

97 Bernardo Sayão Carvalho de Araújo (1901-1959) studied agronomy in São Paulo and Minas Gerais, Brazil. He was the first executive director of the public company created to build Brasília (Novacap). In 1958, he was appointed by the President Juscelino Kubitschek to construct the north tranche of the Belém-Brasília road, where he died accidentally.

98 Oscar Ribeiro de Almeida Niemeyer Soares Filho (1907-2012) was a Brazilian architect and important figure in the development of modern architecture worldwide. He designed the main buildings in Brasília, including the palaces, the ministries, and the cathedral. Niemeyer worked with Lelé from Brasília (1957) until the CIEP public schools in Rio de Janeiro (1984).

99 Eduardo Augusto Kneese de Mello (1906-1994) was a Brazilian architect engaged in one of the first large-scale experiments with building prefabrication in Brazil: the construction of the student residential blocks of the University of

However, it is no coincidence that, besides major infrastructure works, Lelé also brought to Abadiânia part of Brasília's small-scale building solutions. Some of them, employed by the architect in Goiás, allude to certain construction details and parts designed during the erection of the university. This seems to be the case with the prefabricated column of the transitory schools,[100] an important component and integral element of the modular system created by Lelé. A closer look at the internal partition drawings of the ICC building (UnB) reveals that the column in Abadiânia retains a section that recalls the metallic stanchions of panels and doors of the university's main building. Thus, the Central Institute of Sciences building (ICC) – Designed by Niemeyer in 1962 and detailed by Lelé – still exerted an influence upon its former builders, even after 20 years.

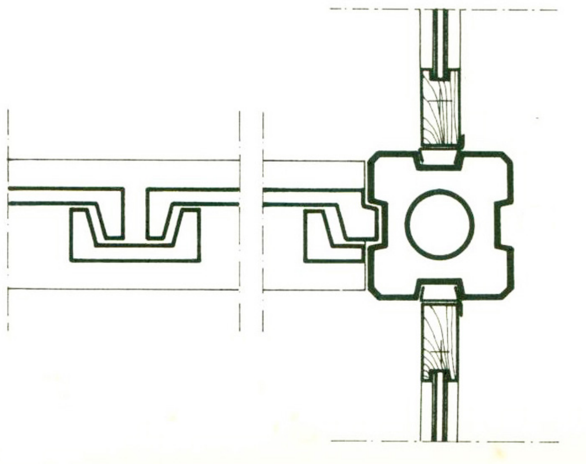

Fig. 2.48 Abadiânia's prefabricated column in *argamassa armada* and its connections with precast panels and standardized wooden door frames. João Filgueiras Lima. *Escola Transitória: modelo rural*. Brasília: MEC/CEDATE, 1984, p. 110

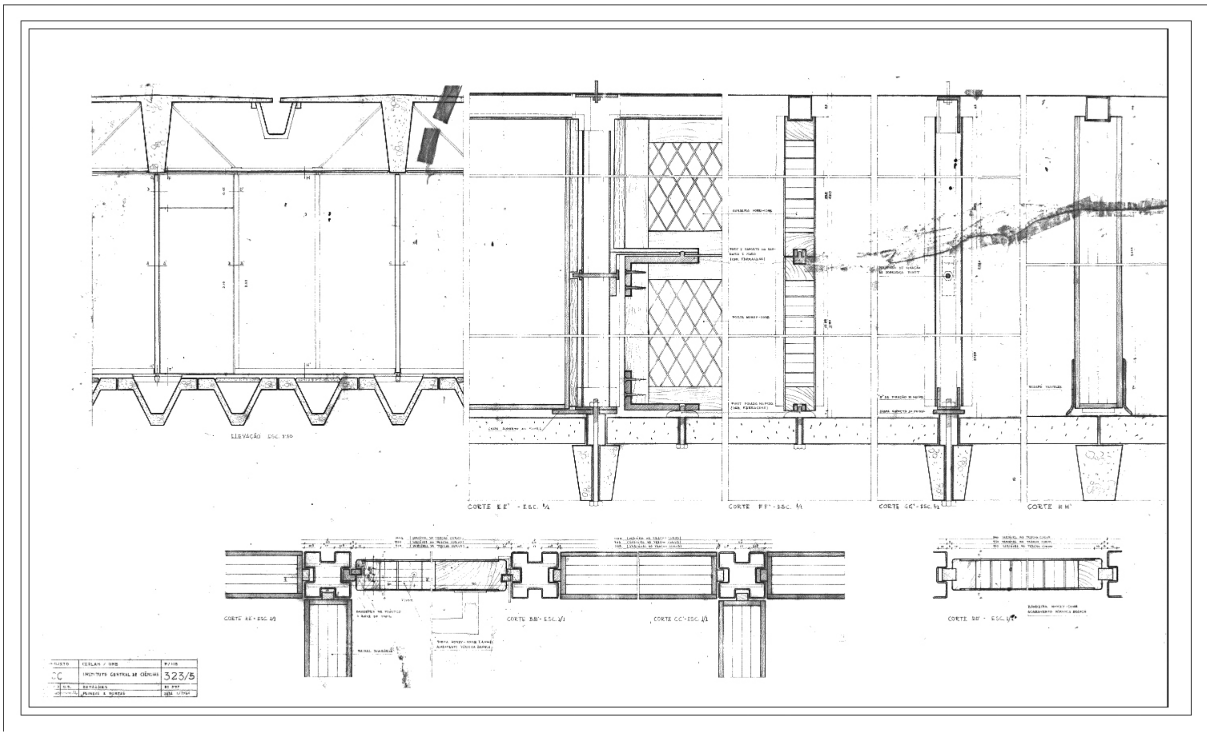

Fig. 2.49 Design for the panels and doors frames showing details of the metallic stanchions (below). Central Institute of Sciences building (ICC). Oscar Niemeyer, J. Filgueiras Lima, 1962. Detail no. 597, drawing board no. 323/5, July 1, 1964. Arquivo CEPLAN, Brasília

São Paulo (CRUSP, 1961). Kneese de Mello had a position at Novacap, where he served as architect during the first years of Brasília's construction. From 1953 to 1955, the architect directed a company of prefabricated houses in São Paulo, which failed commercially. See: Roberto Alves de Lima Montenegro Filho, "A Pré-Fabricação Na Trajetória de Eduardo Kneese de Mello" (Universidade de São Paulo, 2012).

100 I am indebted to Haroldo Pinheiro for this and so many other relevant stories.

Fig. 2.50 The Uni-Seco system. Assembly of prefabricated houses designed by the architect Eduardo Kneese de Mello (1954) in Jaboticabal, São Paulo state. During the inauguration event, a notice plate was hung at the end of each stage of the assembly process showing the respective time spent on construction. Roberto Montenegro, "A pré-fabricação na trajetória de Eduardo Kneese de Mello" (PhD diss., Universidade de São Paulo, 2012), 103. Arquivo FEBASP

By reminding us of the participation of the architect Eduardo Kneese de Mello in Niemeyer's team at the beginning of Brasília, Sylvia Ficher and Eduardo Duarte[101] point out that Kneese de Mello had been involved with building prefabrication experiences in Brazil from the early 1950s. The architect first applied the patented English system called "Uni-Seco"[102] in São Paulo state, where he designed houses for a new district in Jaboticabal[103] (1954) and a private residential prototype in Cotia (1955).

Fig. 2.51 Kneese de Mello (left) and Bernardo Sayão during the construction of Brasília. Roberto Montenegro, "A pré-fabricação na trajetória de Eduardo Kneese de Mello" (PhD diss., Universidade de São Paulo, 2012), 130

Although ultimately unsuccessful, Kneese de Mello and his business partners introduced a series of modifications[104] to the imported building system, adapting it to the local needs, and these changes are likely to have had further implications in Lelé's work. Although there is no register of the direct collaboration between the two architects in Brasília, it is striking that the internal partition joints of the ICC building feature practically the same section of the panel junction stanchions developed by Kneese in São Paulo in the mid-1950s. This possibility is not that remote when one considers that at the time of the UnB construction, Lelé was very aware[105] of Kneese's major prefabricated work at the University of São Paulo: the student residential blocks (CRUSP, 1961).

Naturally, the more we cross-reference significant experiments involving prefabrication in Brazil with their actors the more we discover that they cannot be dissociated from the disarray that beset industry and design. In this sense, initiatives of rationalized construction were more the fruit of individual practices (of industry, universities and professionals), than a result of a standardized building environment. Although the implementation of technical

101 Sylvia Ficher and Eduardo Duarte, "Parque CECAP. Freguesia: Um Partido Arquitetônico," in *IV ENANPARQ* (Porto Alegre: PROPAR/UFRGS, 2016), 2.

102 The Uni-Seco was a commercially developed and marketed system created in England in the 1940s. It was based on the organization of small standardized wooden panels that were used to set up emergency tents for the British Army during the war. For more information, see the section "Commerce and Standard" in: Barry Russell, *Building Systems, Industrialization and Architecture* (London, etc.: Wiley, 1981), 223–234.; and Montenegro Filho, "A Pré-Fabricação Na Trajetória de Eduardo Kneese de Mello," 78–130.

103 In 1954, during the mandate of the Governor of São Paulo Lucas Nogueira Garcez (1951-55), Eduardo Kneese de Mello was commissioned by the *Instituto da Previdência do Estado de São Paulo* (IPESP) [São Paulo State Social Security Institute] to design and build around 65 prefabricated houses for the municipalities of Jaboticabal and São Manuel. Ibid., 99.

104 According to Montenegro, the construction system developed by Kneese de Mello for the *Uni-Seco Comercial e Construtora do Brasil Ltda.* was based on the English patent, seeking viable technical solutions in the national building industry, which was quite different from the English one. In: Ibid., 82.

105 As already mentioned in Part 1, footnote n. 60.

standards in the construction industry would not be enough to change the situation,[106] at least this would promote the application of standardized building materials and dimensions.

In a way, this envisaged effect could account for the integration and regulation of the activities of the large number of prefabricated building companies[107] that emerged in Brazil from 1965 to 1986 during the activities of the National Housing Bank (*Banco Nacional da Habitação*, BNH).[108] Created to solve a housing deficit of 8 million, the bank was at the center of a wide discussion on the direction of civil construction in Brazil (in both the public and private sectors).[109] The primary focus was the political-ideological impasse between the industrialization of the construction processes and the maintenance of the conventional building systems.[110]

The large-scale production of schools was also on the agenda of the discussions, and not limited to the production of Lelé. Rather, it revealed an increased interest in multiple systems[111] adopted by both private companies and the government. One of these systems refers to the prefabricated school created by the architect João Honório de Mello in 1976, using a non-implemented study on modular coordination made for the BNH. By means of the São Paulo Company of School Construction (*Companhia de Construções Escolares do Estado de São Paulo*, Conesp), Honório de Mello enabled mass-produced schools based on systematized spaces, components, details and specifications. According to Ana Paula Koury, he "also allowed the incorporation of industrialized components, facilitating the administration, revision, budget and supervision of the contracted works."[112]

This was a moment for architecture in Brazil when the topic of building prefabrication reached the most expressive public debates. Many of the building companies engaged with

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106 In keeping with Paulo Bruna, the establishment of standards is a kind of passive contribution, undoubtedly necessary, but insufficient in practice. In the long run, it is necessary to make the use of standardized building materials mandatory, at least in the industrialized sectors and subject to housing financing programs. [O estabelecimento de normas é uma espécie de contribuição passiva, sem dúvida necessária, porém insuficiente na prática. É necessário com o tempo tornar obrigatório o emprego dos materiais normalizados, pelo menos nos setores industrializados e sujeitos ao financiamento do BNH] (my transaltion). In: Paulo Bruna, *Arquitetura, industrialização e desenvolvimento* (São Paulo: Editora Perspectiva, 1976), 115.

107 For a comprehensive list of the building companies that were in business during that period, see Chapter 1 (*Pré-fabricação no Brasil*) in: Augusto Carlos de Vasconcelos, *O Concreto No Brasil: Pré-Fabricação, Monumentos, Fundações* (São Paulo: Studio Nobel, 2002), 13–118.

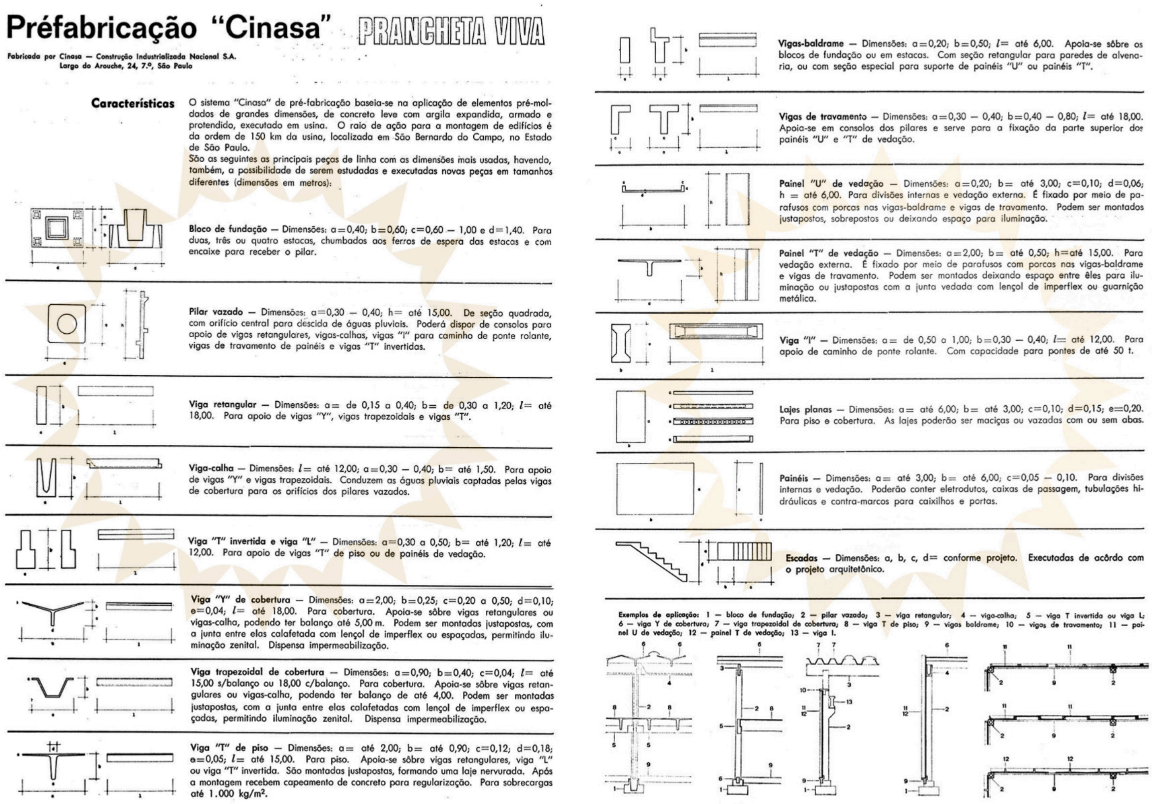
108 The National Housing Bank (BNH) was a public company in Brasil founded by the military government in 1964. Its main goal was to finance and promote real estate development. The bank closed in 1986 after several criticisms of the adopted model in managing the housing issue. For a discussion involving local architects, see: Sergio Bernardes et al., "Política do BNH, Tecnologia, Urbanismo," *Jornal Do Brasil* (Rio de Janeiro, November 29, 1981).

109 According to Ana Paula Koury, two research centers were organized to support the BNH in its attempt to rationalize the building methods between the public and private sectors in Brazil: the Brazilian Construction Center (CBC, *Centro Brasileiro da Construção*) and the National Center of Housing Research (CENPHA, *Centro Nacional de Pesquisas Habitacionais*). In: Ana Paula Koury, "Construção social e tecnologias civis (1964-1986): contribuição para um debate sobre política habitacional no Brasil," *Revista Brasileira de Estudos Urbanos e Regionais* 15, no. 1 (2013): 178.

110 See Edite Galote Carranza and Ricardo Carranza, "CECAP: Um Protótipo 1:1," *Arquitetura e Urbanismo*, no. 239 (2014): 64; Carlos Eduardo Comas, "O espaço da arbitrariedade: considerações sobre o conjunto habitacional BNH e o projeto da cidade brasileira," *Projeto*, no. 91 (1986): 21–28.

111 For a broad survey on various industrialized building systems used for erecting schools in Brazil, see: Eduardo Henrique Santos Teixeira, "Aqui, Alguns Sistemas Para as Construções Escolares," *Projeto*, no. 87 (1986): 116–124.

112 Koury, "Construção Social E Tecnologias Civis (1964-1986): Contribuição Para Um Debate Sobre Política Habitacional No Brasil," 179. [Permitiu também racionalizar e incorporar a produção de componentes industrializados, facilitou a administração, a revisão, o orçamento e a fiscalização das obras contratadas] (my translation).



Préfabricação "Cinasa"

PRANCHETA VIVA

Fabricada por Cinasa — Construção Industrializada Nacional S.A.
Largo do Arouche, 24, 7.º, São Paulo

Características O sistema "Cinasa" de pré-fabricação baseia-se na aplicação de elementos pré-moldados de grandes dimensões, de concreto leve com argila expandida, armado e protendido, executado em usina. O raio de ação para a montagem de edifícios é da ordem de 150 km da usina, localizada em São Bernardo do Campo, no Estado de São Paulo.
São as seguintes as principais peças de linha com as dimensões mais usadas, havendo, também, a possibilidade de serem estudadas e executadas novas peças em tamanhos diferentes (dimensões em metros):

Bloco de fundação — Dimensões: a=0,40; b=0,60; c=0,60 — 1,00 e d=1,40. Para duas, três ou quatro estacas, chumbados aos ferros de espera das estacas e com encaixe para receber o pilar.

Pilar vazado — Dimensões: a=0,30 — 0,40; h= até 15,00. De seção quadrada, com orifício central para descida de águas pluviais. Poderá dispor de consolos para apoio de vigas retangulares, vigas-calhas, vigas "I" para caminho de ponte rolante, vigas de travamento de painéis e vigas "T" invertidas.

Viga retangular — Dimensões: a= de 0,15 a 0,40; b= de 0,30 a 1,20; l= até 18,00. Para apoio de vigas "Y", vigas trapezoidais e vigas "T".

Viga-calha — Dimensões: l= até 12,00; a=0,30 — 0,40; b= até 1,50. Para apoio de vigas "Y" e vigas trapezoidais. Conduzem as águas pluviais captadas pelas vigas de cobertura para os orifícios dos pilares vazados.

Viga "T" invertida e viga "L" — Dimensões: a=0,30 a 0,50; b= até 1,20; l= até 12,00. Para apoio de vigas "T" de piso ou de painéis de vedação.

Viga "Y" de cobertura — Dimensões: a=2,00; b=0,25; c=0,20 a 0,50; d=0,10; e=0,04; l= até 18,00. Para cobertura. Apoia-se sôbre vigas retangulares ou vigas-calha, podendo ter balanço até 5,00 m. Podem ser montadas justapostas, com a junta entre elas calafetada com lençol de imperflex ou espaçadas, permitindo iluminação zenital. Dispensa impermeabilização.

Viga trapezoidal de cobertura — Dimensões: a=0,90; b=0,40; c=0,04; l= até 15,00 s/balanço ou 18,00 c/balanço. Para cobertura. Apoia-se sôbre vigas retangulares ou vigas-calha, podendo ter balanço de até 4,00. Podem ser montadas justapostas, com a junta entre elas calafetadas com lençol de imperflex ou espaçadas, permitindo iluminação zenital. Dispensa impermeabilização.

Viga "T" de piso — Dimensões: a= até 2,00; b= até 0,90; c=0,12; d=0,18; e=0,05; l= até 15,00. Para piso. Apoia-se sôbre vigas retangulares, viga "L" ou viga "T" invertida. São montadas justapostas, formando uma laje nervurada. Após a montagem recebem capeamento de concreto para regularização. Para sobrecargas até 1.000 kg/m².

Vigas-baldrame — Dimensões: a=0,20; b=0,50; l= até 6,00. Apoia-se sôbre os blocos de fundação ou em estacas. Com seção retangular para paredes de alvenaria, ou com seção especial para suporte de painéis "U" ou painéis "T".

Vigas de travamento — Dimensões: a=0,30 — 0,40; b=0,40 — 0,80; l= até 18,00. Apoia-se em consolos dos pilares e serve para a fixação da parte superior dos painéis "U" e "T" de vedação.

Painel "U" de vedação — Dimensões: a=0,20; b= até 3,00; c=0,10; d=0,06; h = até 6,00. Para divisões internas e vedação externa. É fixado por meio de parafusos com porcas nas vigas-baldrame e vigas de travamento. Podem ser montados justapostos, sobrepostos ou deixando espaço para iluminação.

Painel "T" de vedação — Dimensões: a=2,00; b= até 0,50; h=até 15,00. Para vedação externa. É fixado por meio de parafusos com porcas nas vigas-baldrame e vigas de travamento. Podem ser montados deixando espaço entre êles para iluminação ou justapostas com a junta vedada com lençol de imperflex ou guarnição metálica.

Viga "I" — Dimensões: a= de 0,50 a 1,00; b=0,30 — 0,40; l= até 12,00. Para apoio de caminho de ponte rolante. Com capacidade para pontes de até 50 t.

Lajes planas — Dimensões: a= até 6,00; b= até 3,00; c=0,10; d=0,15; e=0,20. Para piso e cobertura. As lajes poderão ser maciças ou vazadas com ou sem abas.

Painéis — Dimensões: a= até 3,00; b= até 6,00; c=0,05 — 0,10. Para divisões internas e vedação. Poderão conter eletrodutos, caixas de passagem, tubulações hidráulicas e contra-marcos para caixilhos e portas.

Escadas — Dimensões: a, b, c, d= conforme projeto. Executadas de acôrdo com o projeto arquitetônico.

Exemplos de aplicação: 1 — bloco de fundação; 2 — pilar vazado; 3 — viga retangular; 4 — viga-calha; 5 — viga T invertida ou viga L; 6 — viga Y de cobertura; 7 — viga trapezoidal de cobertura; 8 — viga T de piso; 9 — vigas baldrame; 10 — vigas de travamento; 11 — painel U de vedação; 12 — painel T de vedação; 13 — viga I.

Fig. 2.52 Cinasa system catalog. Prefabricated elements in reinforced concrete. *Acrópole*, no. 380 (1970): 41-42

prefabricated construction published their component catalogs in magazines of national circulation. If we take the "Cinasa"[113] system, for instance, presented by the homonymous company in the pages of *Acrópole*,[114] it becomes apparent that some of the principles and structural geometries later explored by Lelé were already there: such as the square hollow column and the I-beam.

By drawing the dots between unforeseen occurrences, I have tried to show the sequence of factors that might have impacted on the creation of the transitory schools in Abadiânia, in the following order: Lelé's previous knowledge of key parts of the system (columns, beams, wall panels[115] and foundations[116]), his contact with argamassa armada during the sanitation works in Salvador, and the political opportunity of elaborating a new proposal in Goiás. With this in mind, we can now develop a deeper comprehension of the transitory school's building concept.

113 Founded in September 1965, the Industrialized Construction S.A company (Cinasa, *Construções Industrializadas* S.A) played an important role in prefabricated houses in Brazil during the BNH activities. The company set up two factories in São Paulo (São Benanrdo do Campo and Jundiaí) to produce houses and public equipment, such as schools and hospitals. For a comprehensive story about the company, see: Vasconcelos, *O Concreto No Brasil: Pré-Fabricação, Monumentos, Fundações*, 34–41.

114 Pré-fabricação Cinasa. Prancheta viva. *Acrópole*, no. 380 (1970): 41–42.

115 Lelé practically started his career dealing with prefabricated panels in concrete. See the works of Ceplan, Colina and General Services buildings, all from the beginning of the 1960s.

116 The various bus shelter proposals developed by Lelé during the transportation works in Salvador provided the architect with wide knowledge about small prefabricated foundations.

5.2 The transitory school system

The transient character of the *argamassa armada* schools designed by Lelé between 1982-90 was originally related to the ephemeral functioning of rural schools in Goiás. Bound by the instability of the state's agricultural policy, Lelé focused on mobility as the main solution for the new buildings, as they could be disassembled and reassembled according to the displacement of cultivated land.

With this idea in mind, the architect erected two prototypes in Abadiânia – one in wood (September 1983) and another in argamassa armada (July 1984) – "in order to enable an accurate and fair comparison between the two experiments."[117] And the result stressed the significant advantages of one material over the other. "Our conclusion is that the model in *argamassa armada,* besides being more economic, … still offers additional benefits,"[118] such as: greater strength and durability, low maintenance cost, better control of temperature and ventilation, less need for products to be imported from big industrial centers, greater use of unqualified labor force, and increased speed of execution (the total duration of the experiment including manufacturing and assembly was 45 days).


Fig. 2.53 Prefabricated wooden school for 30 students. Lelé, Abadiânia, 1983. Arquivo João Filgueiras Lima, Salvador


Fig. 2.54 Precast *argamassa armada* school for 70 students. Lelé, Abadiânia, 1984. Marina Mange Grinover, "Laboratório de projeto e construção: prática da arquitetura na obra de Renzo Piano e João Filgueiras Lima", PhD diss., (Universidade de São Paulo, 2015), 364

However, even though the wooden school model ended up costing less,[119] Lelé decided to produce the prototype in *argamassa armada*, despite the heavy expenses incurred in the metallic formwork imported from Brasília. It must be remembered that both cement and wood were widely available in the region, countering, to some extent, the tendency to overvalue materials used in concrete fabrication, such as aggregates (sand and gravel) and cement itself. Therefore, Lelé's decision to pursue an *argamassa armada* prototype in Goiás can be perceived

117 Lima, *Escola Transitória Modelo Rural*, 25. [tornou-se possível estabelecer rigorosa comparação entre as duas experiências] (my translation).

118 Ibid.

119 The final cost of the wooden school model was estimated at USD 7,265 (budget provided on February 10, 1983). Source: João Filgueiras Lima. Transitory Schools [Escola Rural Transitória] – Abadiânia. Action in the Municipality of Abadiânia Project (AMA), drawing board unnumbered and undated. Arquivo João Filgueiras Lima. Although the price of the *argamassa armada* prototype has not been found, João Evangelista – foreman during the works in Abadiânia – confirmed that the precast model was more expensive. João Evangelista dos Santos. Interview with Adalberto Vilela on May 24, 2016 in Abadiânia.

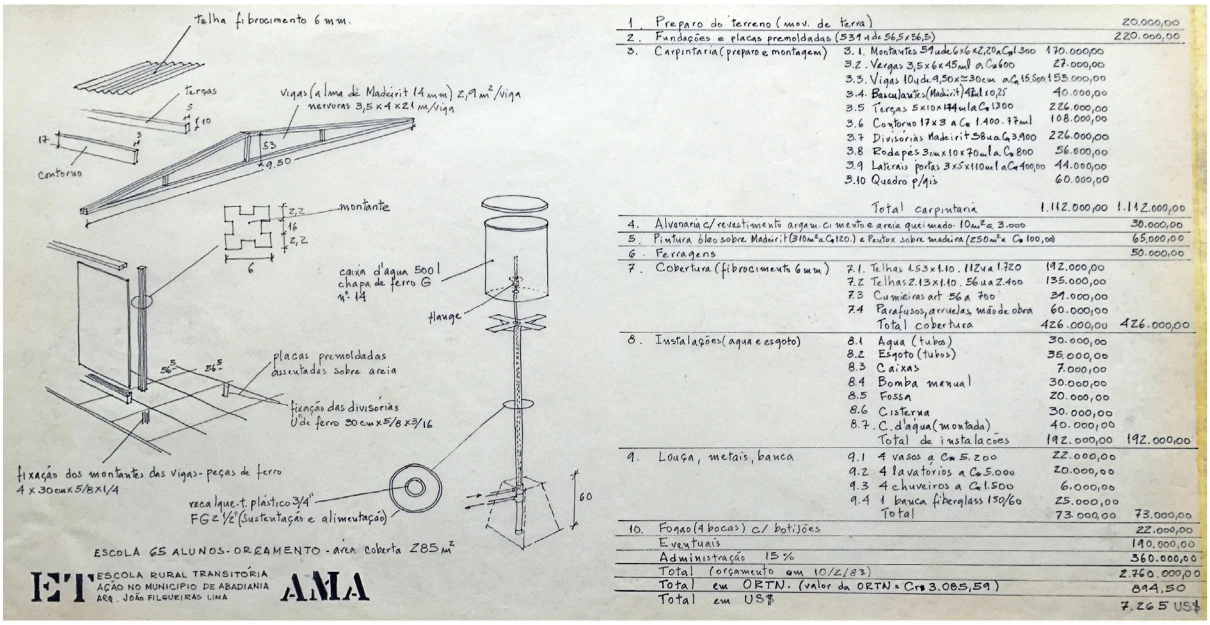


Fig. 2.55 Transitory school's wooden prototype. Lelé, 1983. Drawing board showing the building's basic principle and budget. Full cost US$ 7,265 (Feb. 1983). Arquivo João Filgueiras Lima, Salvador

as a veritable attempt to continue in his research on materials over the long term, an investigation which had started a few years previously in Salvador. But what, precisely, did the system of transitory schools consist of?

Basically, it was a light skeletal frame system[120] first planned to expand in only two directions (later it became three-dimensional). Both experiments – the wooden model and the *argamassa armada* prototype – kept the same structural principle: a sequence of portal frames with cantilevers arranged in parallel. The cross-section was made up of precast beams and columns, in the case of the prototype, and wood trusses in the first model. Despite the relative commonness of the structural proposal – given the adoption of similar models found in other Latin American and North African countries[121] –

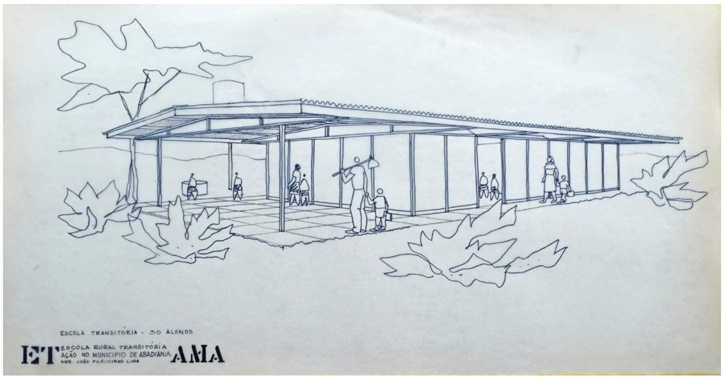


Fig. 2.56 Transitory school's wooden prototype. Lelé, 1983. Perspective from the covered play area (*recreio coberto*). Arquivo João Filgueiras Lima, Salvador

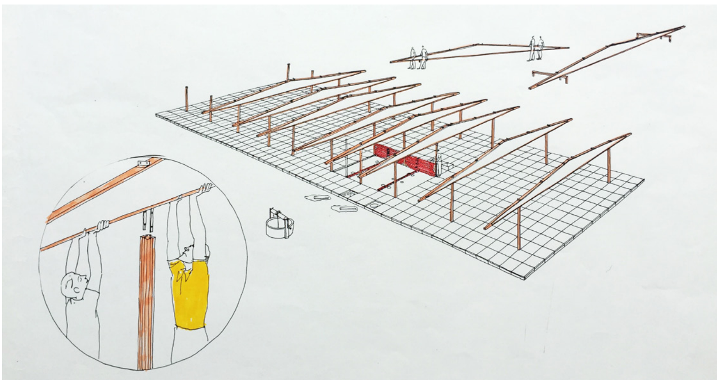


Fig. 2.57 Transitory school's wooden prototype. Lelé, 1983. Drawing board showing the building's assembly process. Detail of the connection between the cantilever trusses and the column. Arquivo João F. Lima, Salvador

120 In this work, I adopted the building system classification proposed by: Schmid and Testa, *Systems Building. Bauen Mit Systemen. Constructions Modulaires*, 36–42.

121 See the systems for prefabricated rural schools developed in Mexico and Morocco in: Ibid., 110–113.

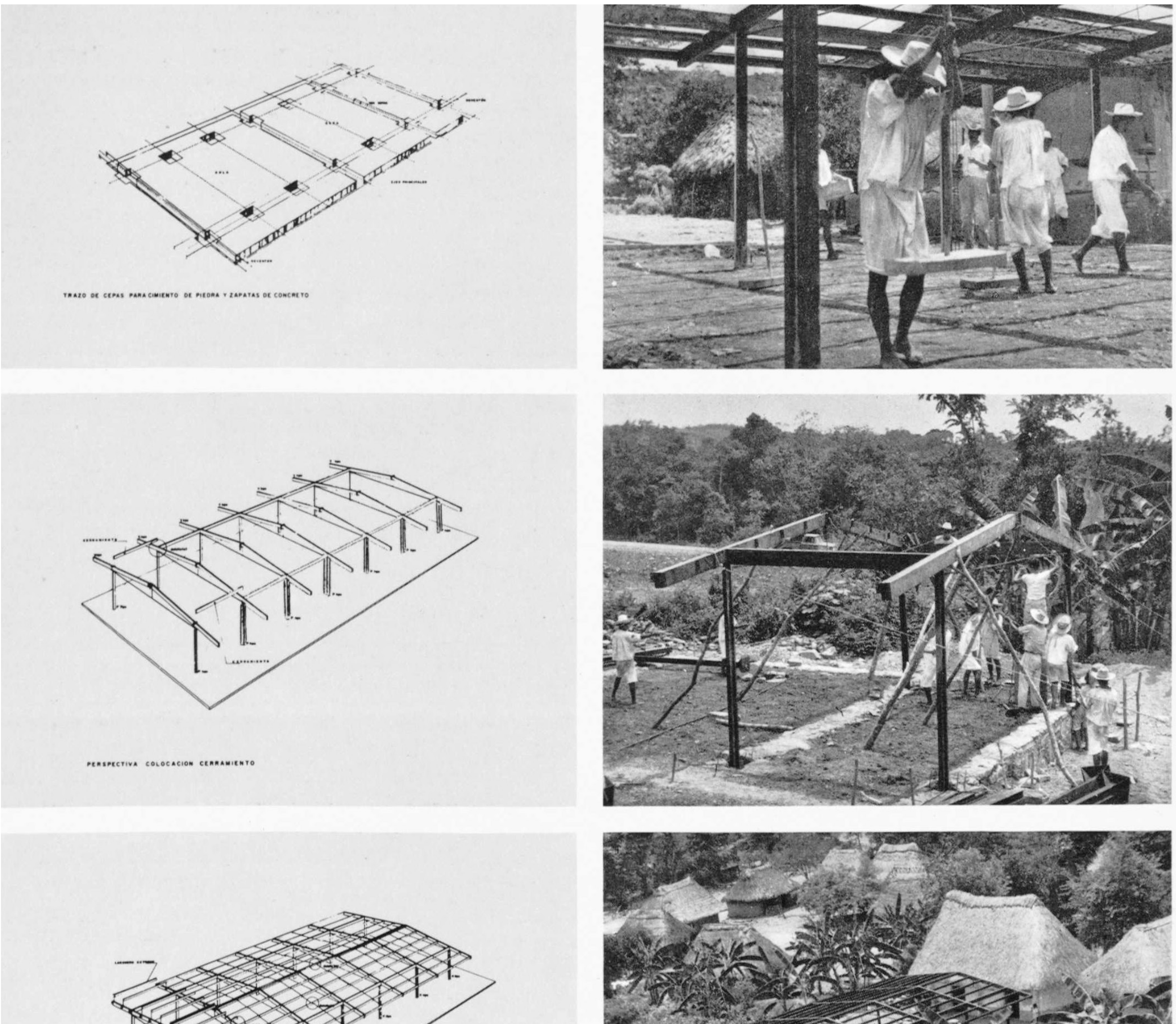


Fig. 2.58 System for rural schools in Mexico. The sequence of pictures shows the foundation blocks, the assembly and erection of the steel skeletal frame. Ministry of Education of Mexico, undated. Thomas Schmid and Carlo Testa. *Systems Building. Bauen mit Systemen. Constructions modulaires*. Zürich: Artemis, 1969, p. 111

Fig. 2.59 Transitory school prototype in *argamassa armada*. Abadiânia, Goiás. Lelé, 1982. Max Risselada and Giancarlo Latorraca. *A arquitetura de Lelé: fábrica e invenção*. São Paulo: MCB, Imprensa Oficial, 2010, p.62

the important point here is the set of changes Lelé promoted in the building system during the transition to the *argamassa armada* school.

The simple fact the architect moved from a gable roof to a flat-ceiling model implied the need for new mechanisms to solve the drainage issue, to mention the most obvious problem. Therefore, the revision of connections assumed a central role in this phase, not only because of the change of material required, but also because Lelé's investigation into *argamassa armada* had reached a certain stage of technical development that demanded further advancements.

We need to remember that Lelé had been involved with the construction of public schools since the works for RENURB in Bahia (1979-81).[122] In those schools the architect had adopted traditional building techniques (concrete and brick masonry) combined with a limited presence of prefabricated elements (some ground and roof slabs), but this approach would put the venture in Goiás at risk with some counterproductive results. Lelé's systematic involvement with *argamassa armada* had started few years before. It is natural that a certain level of enthusiasm can at first mislead one's efforts to create original solutions.

Hence, the architect started with a set of 26 different types of precast light elements in *argamassa armada*, applied to the school prototype in Abadiânia with an area of 285 m². Adopting the module of 57.25 x 57.25 cm as the basic unit of the building execution, Lelé proposed four models for the

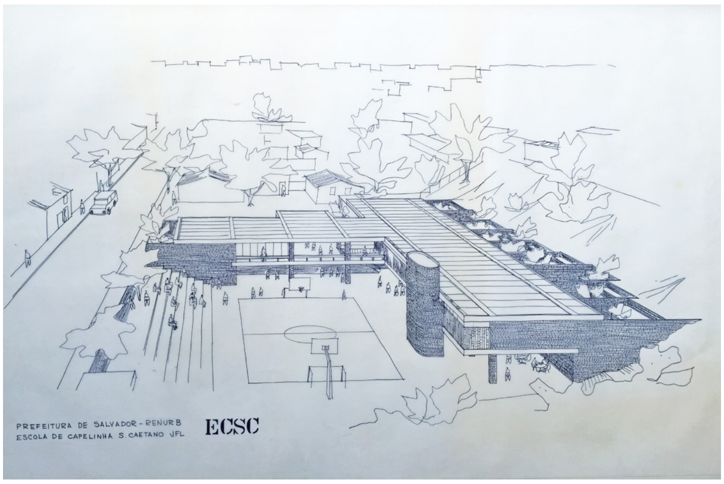


Fig. 2.60 RENURB School (*Escola de Capelinha*) in the district of São Caetano, Salvador. Design and drawing by Lelé, 1979. Arquivo João Filgueiras Lima

122 For more information about the Renurb Schools designed by Lelé in Salvador in the early 1980s, see: Ana Gabriella Lima Guimarães, "João Filgueiras Lima: o último dos modernistas" (Universidade de São Paulo, 2003), 128–130.

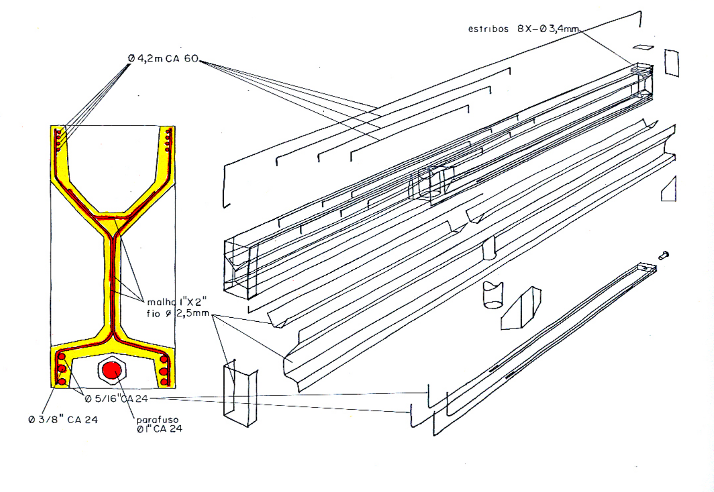


Fig. 2.61 The gutter-beam (viga-calha). Abadiânia, Lelé, 1982. The reinforcement cage and the distribution of steel bars. Arquivo João Filgueiras Lima, Salvador

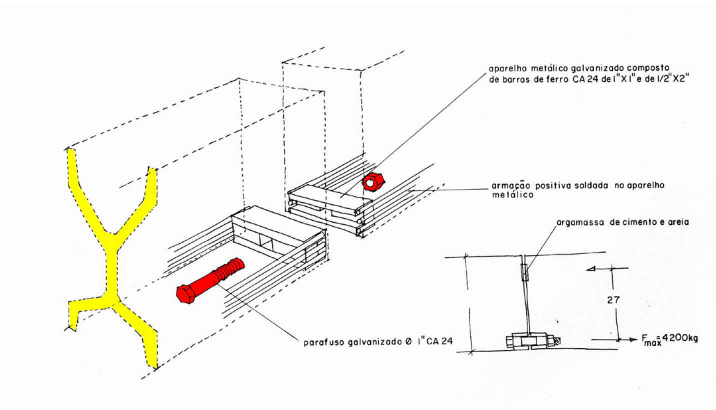


Fig. 2.62 The gutter-beam (viga-calha). Abadiânia, Lelé, 1982. The metallic device for joining the parts casted in the edge of the beam. Arquivo João Filgueiras Lima, Salvador

Fig. 2.63 The gutter-beam (viga-calha). Abadiânia, Lelé, 1982. A local worker joins the two halves of the beam by tightening the galvanized bolt. Arquivo João Filgueiras Lima, Salvador

prefabricated schools (to house 50, 70, 120, or 160 students) according to their capacity. The overall weight of the built prototype (including the flooring and pavements) was less than 45 tons, with components measuring no more than 5 m in length, which was convenient for transporting.

Nevertheless, what draws our attention in constructive terms is the development of some of the system's basic elements, such as the gutter-beam. By far the most complex component, Lelé gave the beam special attention due to its geometrical shape and intricate execution. The original idea came from the adaptation of an I-beam profile into a Y-beam, which allowed for the incorporation of the drainage function. The so-called *viga-calha* (gutter-beam) was designed with two equal 4.86 m long segments – web thickness measuring only 2.2 cm – joined at the centre of the span by a 1-inch galvanized screw.

Lelé knew from the beginning that his light prefabricated elements (each weighing a maximum of 100 kg) designed to enable manual handling would not be applied to all types of components. The beam was an example that went against the principle of manual handling. Weighing 380 kg in total, or 190 kg each segment, the element required a special assembly scheme based on the use of cranes and hoists.

Despite the importance of the weight of components when dealing with prefabricated parts, another aspect is crucial: the joints. Thomas Schmid gives us a sense of how important the development of effective joints is for precast buildings: "Whoever has mastered jointing techniques has mastery of system building."[123] Conscious that joints represent the riskiest (and weakest) part of assembled constructions – and that the lack of an adequate waterproof and resistant solution could be a drawback for the best of the building systems – Lelé followed the same logic of the prefabricated works developed in Salvador (RENURB) and adopted the simple fitting of modules with dry (and visible) joints.

In Abadiânia Lelé decided to employ a range of metallic elements as connectors, sharing the same view as Wachsmann who argued that "the joint is not a necessary evil. Accordingly, it does not need to be concealed with seal strips and so on, like an object of shame"[124]. Starting with the previously mentioned galvanized screw, the use of drainage tubes connecting pillars and beams – or the cross-shaped elements that jointed skirtings and panels – strenghthened the prop assembly and rendered the system more stable.

Many of these jointing solutions found for the transitory schools proved susceptible to modifications in subsequent experiments carried out by Lelé. The architect's effort to keep some of the principles established in Abadiânia is visible – such as the separation between the beam junction and the roof water drainage – even though he may have revised the component's design and the connection methods. Perhaps the unrealized and unpublished project for the *Banco do Brasil* agencies stands out as a good indicator of how the revision process unfolds and changes over time.

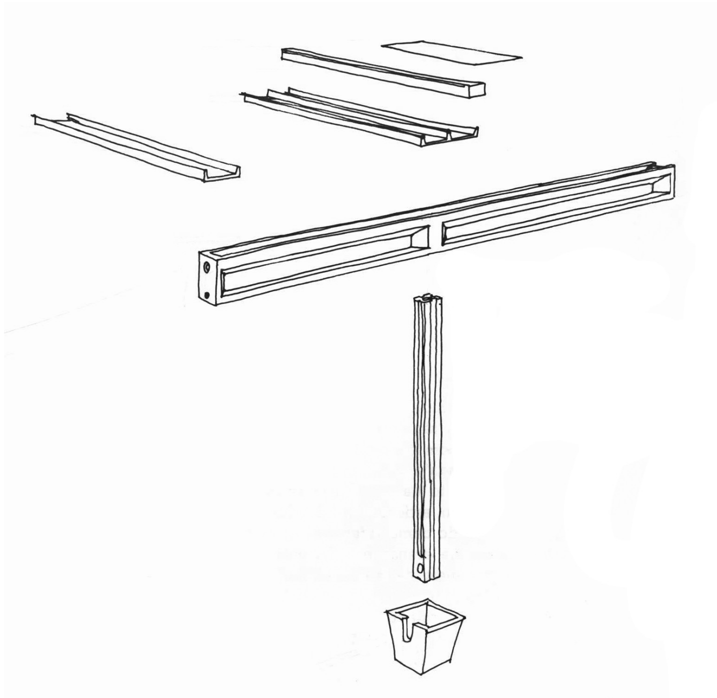


Fig. 2.64 Isometric view of Lelé's transitory schools system and its main components. From the roof thermic cover to the calyx foundation. João Filgueiras Lima. *Escola Transitória: modelo rural*. Brasília: MEC/CEDATE, 1984, p. 51

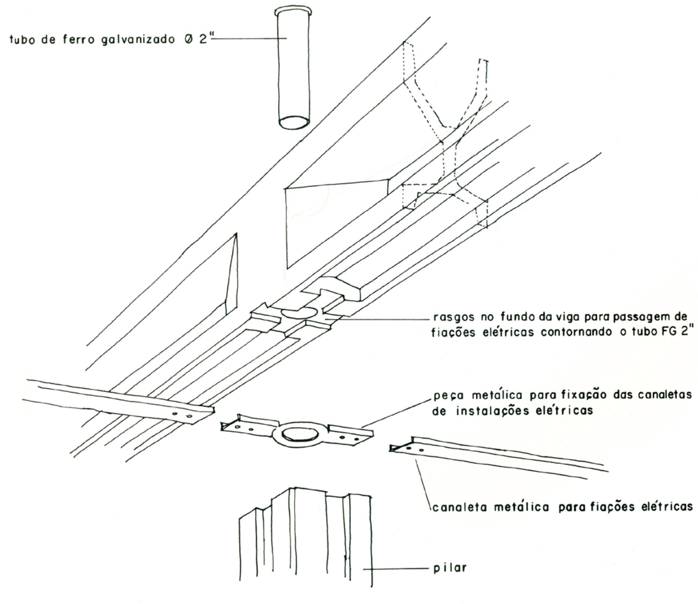


Fig. 2.65 The 2-inch galvanized iron tube for drainange which also works as a connector between beams, pillars and cable ducts. Lelé, 1982. João Filgueiras Lima. *Escola Transitória: modelo rural*. Brasília: MEC/CEDATE, 1984, p. 71

123 Schmid and Testa, *Systems Building. Bauen Mit Systemen. Constructions Modulaires*, 72.
124 Wachsmann, *The Turning Point of Building, Structure and Design*, 76.

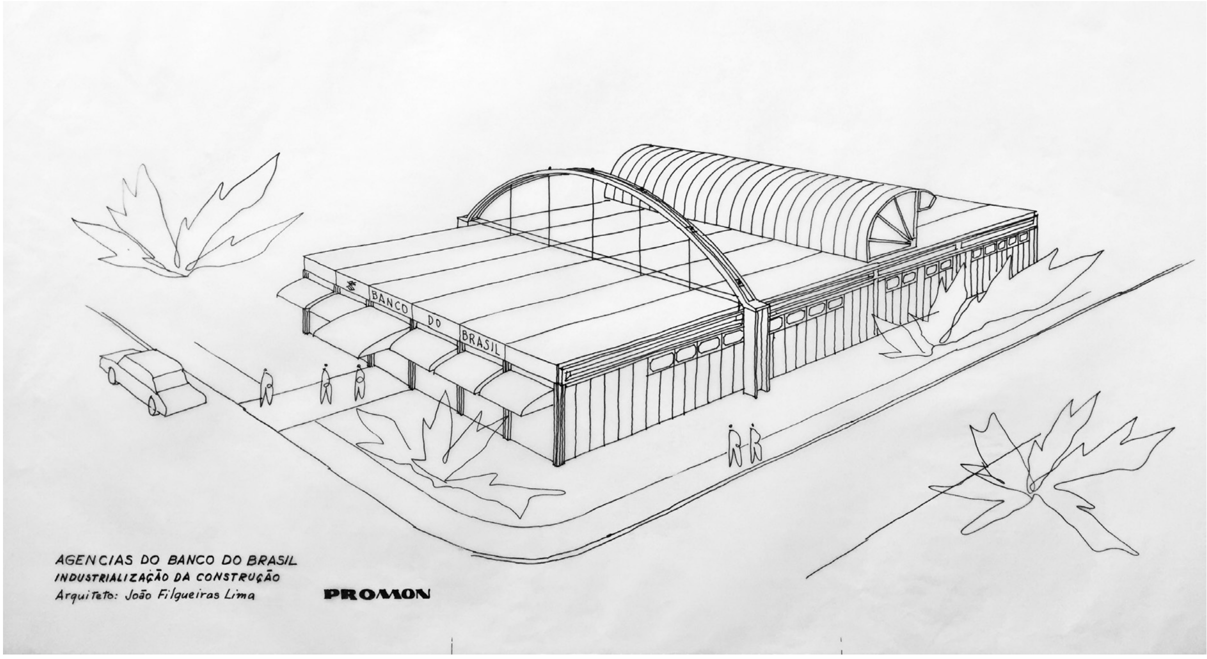


Fig. 2.66 The prefabricated *Banco do Brasil* agency proposal (unexecuted). Lelé, ca. 1989, in collaboration with the building company *Promon Engenharia*. Arquivo João Filgueiras Lima, Salvador

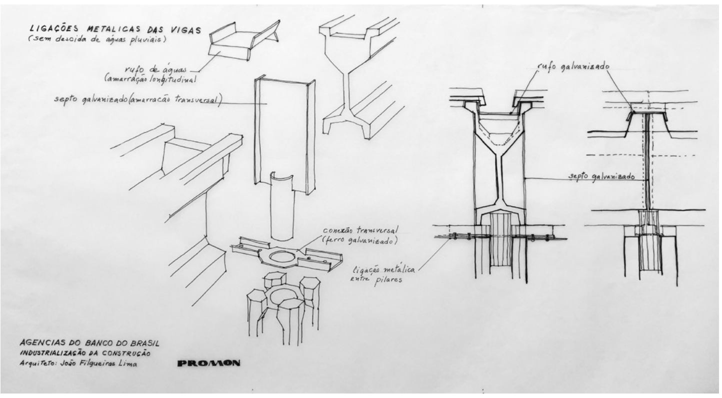


Fig. 2.67 Dissociation from drainage at the junction point between beams and columns. *Banco do Brasil* agency proposal, Lelé, ca. 1989. Arquivo João Filgueiras Lima, Salvador

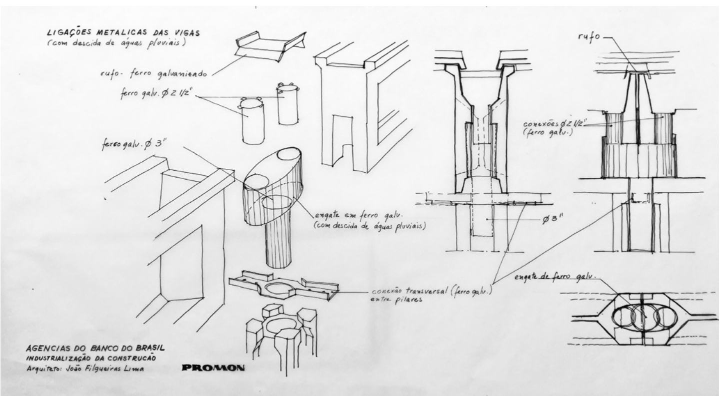


Fig. 2.68 Redesign of metallic connectors, such as the galvanized iron tube used for water drainage. *Banco do Brasil* agency proposal, Lelé, ca. 1989. Arquivo João Filgueiras Lima, Salvador

It is true that compared to the fluid and versatile spaces created for the small schools in Goiás, the bank branches adopted a more rigid and enclosed conception. However, the agencies enlarged the scope of application of a building system previously designed for schools. The modifications can be traced following two main aspects: first, a revaluation of the beam junction over the column axis (Fig. 2.67) to achieve more efficient water drainage (and Lelé used this drainage method throughout his career, including the Sarah hospitals), and secondly and most importantly, the decision of rethinking the roof subsystem (Fig. 2.68).

I stress the relevance of the roofing subsystem because it became an Achilles heel in most of Lelé's subsequent systems, as confirmed by his daughter: "the option for metal roofing (at the Sarah hospitals) was a response from Lelé to the numerous cases of difficult-to-solve leakage problems at the *argamassa armada* schools."[125] Athough Adriana's comment refers to a different moment – when the architect mainly began to adopt metallic structures in his work (from 1991 onwards) – in the end, one can say that the *Banco do Brasil* agencies reinforced the architect's own perception of architecture as a process, in which the building system is in permanent transformation. In this sense, we should forge ahead and examine the fruits of the Abadiânia experience.

6. Learning from further applications

The next phase of Lelé's career we are about to enter – from Abadiânia to the CIAC schools – is characterized by massive production and requires a preliminary explanation. Despite the premature termination of the transitory schools project in Goiás (1984), its system provided the constructive basis for the launch of numerous factories installed in different regions of Brazil: The School Factory (*Fábrica de Escolas*, Rio de Janeiro, 1984-86), the *Argamassa Armada* Factory (*Fábrica de Argamassa Armada*, Brasília, 1985-1993), the FAEC Factory (*Fábrica de Equipamentos Comunitários*, Salvador, 1986-88), the CEDEC Factory (*Centro de Desenvolvimento de Equipmentos Urbanos e Comunitários*, São Paulo, 1989-93), and the CIAC Factories (*Centro Integrado de Apoio à Criança*, spread over several states of the country, 1990-1994).

Apart from the CIAC, which included private companies in the school construction program, all the other initiatives were managed exclusively within the public sector. It is true that Lelé's personal involvement varied between one undertaking and the next, and that somehow, he had endorsed the programs that led to the construction of all of those plants. But since factories are not at the center of our discussion in this chapter – they are going to be addressed in the third and last part of the thesis – the narrative of this section will be structured around the development of school systems over the course of Lelé's industrialized work.

For now, it is pertinent to clarify the purpose of this section, within the framework of prefabricated components and building systems. My intention here is to show how Lelé's exacerbated belief in *argamassa armada* led to a practice that proved the material usage limitations and the subsequent discontinuation of an integral construction model based on *argamassa*. Although it is well known that after the CIAC schools the architect started adopting a mixed building system – relying on steel for the roof and main structure and *argamassa armada* for the internal partitions, floor slab and foundations – our main interest is to understand how this transition came to be.

By analyzing the development of some families of components and the succession of adjustments to the original system created for Abadiânia, it is clear that the abandonment of *argamassa armada* as a central material in Lelé's work was not due to a single motive, but to a

125 Adriana Filgueiras. Interview with Adalberto Vilela on April 10, 2016 in Rio de Janeiro. [A opção por cobertura metálica foi uma resposta de Lelé aos inúmeros casos de vazamentos difícies de resolver nas escolas de argamassa armada].

variety of reasons. For example, we could mention the excessive reliance on the properties[126] of the material (such as low permeability, good workability,[127] and suitable mechanical resistance), the extremely demanding production control and quality assurance[128] of the products, the overly slender parts, and finally, the component weight.

It was no longer possible to increase the span of the buildings without affecting the component's weight, therefore encumbering the production, storage, transportation, and assembly. The conclusion that *argamassa armada* is suitable for smaller-scale projects, as observed by Adriana Filgueiras,[129] unfortunately came too late. The architect's daughter, who had the chance to closely observe the ongoing construction process of the *argamassa armada* schools, realized that modifications were needed. The changes that were made to both systems and components, with or without Lelé's consent, are an excellent starting point for a wider comprehension of the limitations and advancements of the technology.

Finally, we cannot dissociate technical issues from the political, economic and social paths of a country just returned to democracy. In 1985, after the end of the military dictatorship, Brazil took an important step towards the evolution of basic rights through the promulgation process of the so-called "Citizen Constitution" (*Constituição Cidadã*, 1988).[130] In this sense, I invite the reader to embark on this new and turbulent phase for both Brazil and Lelé.

6.1 From the School Factory to the City Factory

Most of Lelé's works during the 1980s reflect his decision, taken in Abadiânia, to focus on the social dimension of architecture. Following the architect's experience with *argamassa armada* in Salvador, the construction of public works as a democratic exercise demonstrated relevant improvements in precast techniques. Lelé's growing involvement with populist[131]

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126 For an overview of the mechanical, physical, and chemical properties of argamassa armada (including durability and deformation), see: João Bento de Hanai and Mounir Khalil El Debs, "30 Years of Reinforced Mortar Experiences in Brazil," in *4th International Symposium and 3rd National Congress on Ferrocement*, 1991, J.40-J.49; Hanai, *Construções de argamassa armada: fundamentos tecnológicos para projeto e execução*, 77–97.

127 Workability of concrete (or *argamassa armada*) is the ease with which concrete can be placed and compacted in the form with minimum loss of consistency and homogeneity. In: Madan Mehta, Walter Scarborough, and Diane Armpriest, *Building Construction: Principles, Materials, and Systems* (Boston [etc.]: Pearson, 2013), 433.

128 See, Emerson de Andrade Marques Ferreira and João Bento de Hanai, "Directives for Quality Assurance on Industrialized Ferrocement," in *4th International Symposium and 3rd National Congress on Ferrocement* (Havana: University of Havana, 1991), C.1-C.13.

129 *Argamassa armada* is suitable for small projects and components, such as schools, bus shelters, kindergartens, etc. Bigger and more developed projects require a detailed and precise study with different materials. [A argamassa armada se adequa bem a projetos e componentes pequenos, como escolinhas, abrigos, creches, postos, etc. Um projeto maior e mais desenvolvido requer um estudo muito minucioso e preciso, geralmente envolvendo outros materiais] (my translation). In: Adriana Filgueiras. Interview with Adalberto Vilela on April 10, 2016 in Rio de Janeiro.

130 Promulgated on October 5, 1988, the current Brazilian Constitution sought to promote individual rights and reorganize the country around civil liberties and the democratic state, against the possibility of new coups d'état. New democratic mechanisms such as plebiscites and referendums were added to the supreme law, besides references to freedom of religion, and the defense of minorities and ethnic groups.

131 According to the American Heritage Dictionary of the English Language (online version), populism is a political

politicians was fundamental to the large-scale dissemination of his architecture, within certain parameters, as recalled by Zeca Franco: “the idea was to enable mass production with quality. The individual building did not mean much for him.”[132]

The problem was that most of the politicians who endorsed mass-produced schools designed by Lelé in Rio, Bahia, and many other Brazilian States, worked to keep their image associated with those buildings, as they emerged as a symbol of ambitious early educational policies. And why should this have been a problem? If we take into consideration the crisis in primary education in the public sector in Brazil during the 1980s,[133] it would have meant a great deal for governors to stand for the construction of schools. In this sense, they might have been more interested in increasing their popularity by expanding the number of inaugurated buildings, than in ensuring the quality of industrialized architecture.

Fig. 2.69 Brizola’s government logo showing education as the main motto of his campaign. Darcy Ribeiro. *O livro dos CIEPs*. Rio de Janeiro: Bloch, 1986, p. 99

Like Lelé, Niemeyer also had the foresight to see the benefits of a close collaboration with his political patrons. An example of this can be found when both architects participated in the Special Program for Education (*Programa Especial de Educação, PEE*), created in Rio de Janeiro during the mandate (1983-87) of Governor Leonel Brizola[134] and his Secretary of Culture, Darcy Ribeiro. The ambitious proposition was to organize what they called “the educational revolution”[135] of Rio. Two fundamental goals were proposed to meet the target: to build one thousand “Children’s Houses” (*Casa da Criança*) in poor and dense areas of the

philosophy supporting the rights and power of the people in their struggle against a privileged elite. Accessed March 19, 2018 http://www.ahdictionary.com/

132 Zeca Franco. Interview with Adalberto Vilela on April 8, 2016 in Rio de Janeiro. [A ideia era produção em larga escala com qualidade. O prédio individual não significava muito pra ele] (my translation).

133 The governor of Rio de Janeiro proposed that five hundred new public schools should be erected in the state, where, at the start of 1983, 700,000 of its school-age children were not served by the existing school system and 52 percent of all students never finished second grade. In: Underwood, *Oscar Niemeyer and Brazilian Free-Form Modernism*, 99. For the cultural reasons behind the failure of the Brazilian educational model, see: Darcy Ribeiro, “Aspectos Culturais do Fracasso Educacional Brasileiro,” in *O Desafio da Escola Básica: Qualidade e Equidade*, ed. Lígia Cademartori (Brasília: IPEA, 1991), 97–118.

134 Leonel de Moura Brizola (1922-2004) was a Brazilian politician who served as Governor of the Rio de Janeiro State twice, from 1983-87 and 1991-94. During his first mandate, Brizola launched an ambitious education program (CIEP – Integrated Centers for Public Education) involving the construction of prefabricated schools which would offer full-time instruction, food, medical assistance and recreational activities. He also implemented the School Factory in Rio to promote education in favelas and poor areas.

135 Expression used by Darcy Ribeiro in: Darcy Ribeiro, *O Livro dos CIEPs* (Rio de Janeiro: Bloch, 1986), 16. [A revolução educacional do Rio].

Fig. 2.70 CIEP primary school by Oscar Niemeyer (1983). Rio de Janeiro. Darcy Ribeiro. *O livro dos CIEPs*. Rio de Janeiro: Bloch, 1986, p. 44

Fig. 2.71 Lelé's *Casa da Criança* (Children's House) in a poor area of Rio de Janeiro (*Engenho da Rainha*). Arquivo João Filgueiras Lima, Salvador

city, a school project later designed by Lelé to receive children from 3 to 6 years old; and to erect five hundred "Integrated Centers for Public Education" (*Centros Integrados de Educação Pública*, CIEPs), a complex designed by Niemeyer destined to accommodate full-time students of various ages, providing food, medical support, and sports facilities.

Although both projects used precast modular elements, they were entirely different in many aspects, such as the built area, required land, construction technology, level of industrialization, architectural concept, means of production, and so forth. Half way through 1984 Lelé was still working in Abadiânia. His contact with Darcy Ribeiro – a friend from the Brasília period who was also serving as Vice Governor of Rio de Janeiro at the time – brought Brizola to the interior of Goiás to learn about the transitory schools project.[136] The good impression he received was confirmed by an official invitation for Lelé to assume the technical coordination of the School Factory in Rio de Janeiro, created to make the *Casa da Criança* schools possible.

In 1984 Lelé disembarked in Rio to organize the installation of the factory and launch its operational basis. The political program of Brizola and Ribeiro imposed the immediate start of production. There was not enough time to conduct in Rio de Janeiro a more detailed revision of the system developed in Abadiânia, which meant that the new model was reproduced with few modifications. This was the situation Lelé faced in Rio de Janeiro: two major school construction programs (CIEPs and *Casa da Criança*) being carried out at the same time – with the respective factories operating in different places – managed by the same government.

136 Brizola made an official visit to Abadiânia on August 8, 1984. The Governor of Rio de Janeiro went to the small town directly from Brasília. See, n.d., "Brizola vem hoje conhecer o projeto," *O Popular* (Goiânia, August 8, 1984).

The purpose here is not to take up the debate about the controversial issues raised by the construction of the CIEPs, but I could not forget to mention the elevated maintenance costs, the acoustic problems caused by internal walls that did not reach the ceiling, leaking roofs and, maybe the most polemic fact reported in numerous press articles: the number of schools in operation. "Out of the 500 proposed CIEPs, 109 were actually completed – and the numbers are exact, they were surveyed and are accessible – during the period from 1983 to 1987,"[137] denounced Fátima Cunha in a symposium coordinated by IPEA[138] together with the Federal Senate Education and Culture Commission in September 1990 in Brasília.

The number of *Casa da Criança* schools also sparked a wave of criticism in Rio de Janeiro. The government confirmed that more than 200 schools had been constructed in the city's favelas. However, irrespective of whether or not the official announced figure is correct, our major interest here is to look at those buildings and underscore the importance of technical changes, which were no longer exclusively centered on schools but focused on a wide range of urban equipment, like the bus shelters addressed previously.

Fig. 2.72 Public bench in *argamassa armada* with backrest. Lelé, 1984. Arquivo João Filgueiras Lima

Fig. 2.73 A bench's metallic formwork being set. Lelé and Mariano Casañas, 1984. Arquivo João Filgueiras Lima

Therefore, I cannot distance myself from the promising outcomes of precasting methods which were enabled by a variety of amendments introduced by Lelé in the *argamassa* mixture and mainly in the formwork, as highlighted by the architect in a conference at the Polytechnic School of São Paulo in 1986: "The technology of metallic formwork was most developed in Rio de Janeiro. Some of it was quite complex, designed to create sections with less inertia. In this way, parts with millimetric-precision fittings could be obtained, always with a view

137 Fátima Cunha, "O Projeto CIEP de 1987 a 1990: O Desafio Da Continuidade," in *O Desafio Da Escola Básica: Qualidade E Equidade*, ed. Lígia Cademartori (Brasília: IPEA, 1991), 30. [Dos propalados 500 CIEPs houve, na realidade – e os números são exatos, são números pesquisados e estão à disposição dos senhores – 109 concluídos, no período de 1983 a 1987] (my translation).

138 The Institute of Applied Economic Research (*Instituto de Pesquisas Econômicas Aplicadas*, IPEA) was created in 1964 to develop studies to orient the government to plan public policies in different areas of the Brazilian economy.

20 1º caderno domingo, 8/3/87 JORNAL DO BRASIL

CIEP: Um dia todas as nossas escolas vão ser assim.

Partindo da idéia de utilizar a técnica do concreto pré-moldado, que possibilita montar cada CIEP como um jogo de armar, em um prazo de apenas 4 meses, Niemeyer criou um projeto-padrão que é 30% mais barato que uma obra que utilize a técnica convencional de fazer a concretagem no próprio local da construção.

No passado, havia mais dinheiro para viadutos do que para escolas. A grande mudança introduzida pelo Governo Leonel Brizola foi estabelecer prioridade absoluta para a questão educacional, de modo a dignificar a Escola Pública, para que ela passe a formar mais pessoas letradas do que analfabetos, e não o contrário, que infelizmente é a realidade histórica em nosso País.

Posseiro Mario Vaz - R. Silvania J. Maravilha - C. Grande - Rio
Vital Brasil - R. Vital Brasil São Gonçalo
Thomas Jefferson - Av. Brasil c/ Estr. do Eng. Novo - Realengo - Rio
R. Gen. Americano Freire Realengo - Rio
Estrada do Taquaral - Parque Moça Bonita - Bangu - Rio
Portão do Rosa - Estr. da Conceição, 430 - S. Gonçalo
Ismael Nery - Av. Cesário de Melo Cesarão - Santa Cruz - Rio
Rua General Castrioto, 120 Barreto - Niterói
Djalma Maranhão - R. E com R. L Vila Margarida - Itaguaí
Anísio Teixeira - Alameda S. Boaventura - Fonseca - Niterói
Pablo Neruda - Rod. Amaral Peixoto Km 14 - Laranjal - S. Gonçalo
Rodovia BR-101 - Jardim Catarina São Gonçalo
Praia das Pedrinhas - Boa Vista São Gonçalo
Sto Agostinho - Lot. Volta Grande V. Redonda

CIEPs Especiais

Cultura, que atende centenas de crianças diariamente, colocando-as em contato com as diversas linguagens artísticas e estimulando-as ao prazer da criação e do conhecimento.

No horário noturno, funciona o Programa de Educação Juvenil. Todas as atividades educacionais são desenvolvidas sob uma única direção geral.

possibilitou a instalação de um projeto educacional mais abrangente: além dos cursos de pré-escolar, primeiro e segundo segmentos do 1º grau e do Programa de Educação Juvenil no horário noturno, a "Casa do Carnaval" abriga ainda uma Escola Normal, uma Escola de 2º grau e um Curso Supletivo.

Ipanema
Parati
Avenida dos desfiles

Canteiros de Obras

Nos parques e canteiros de obras das empreiteiras, é que são construídos os CIEPs. Essas peças pré-moldadas são transportadas para os locais de montagem dos CIEPs. Já estão prontos e pagos todos os pré-moldados de 446 CIEPs (montados, em montagem ou em depósitos), como estes que se vêem nas fotos. E os pré-moldados dos últimos 54 CIEPs também já estão contratados e em execução. Resumindo: são 219 CIEPs concluídos ou em acabamento final. Dos quais, 161 já estão funcionando com alunos, professores e pessoal de apoio.

Quanto às obras em andamento, 67 CIEPs estão 70% prontos, 116 estão na primeira metade das obras e 103 numa fase inicial de terraplenagem, fundações, transportes e fabricação dos pré-moldados.

O Programa dos CIEPs é considerado o maior e mais eficiente programa educacional em execução no Brasil ou em qualquer outro país.

Av. Brasil Santa Cruz - RJ (Empresa Sultepa)
Ilha do Governador - RJ (Empresa CBPO)
Rod. Presidente Dutra S. J. de Meriti (Empresa Carioca Engenharia)
Estr. dos Bandeirantes - Vargem Grande - RJ (Empresa Santa Bárbara)
Rod. Washington Luís - D. de Caxias (Empresa HO)

Governo Leonel Brizola

Fig. 2.74 Brizola's government advertising for the Special CIEPs. The newspaper's heading is the phrase: "CIEP: one day all of our schools will be like that." *Jornal do Brasil*, March 8, 1987. Arquivo Fundação Biblioteca Nacional, Rio de Janeiro

to quick and perfect assembly with small pieces of good workability."[139]

It was the possibility of obtaining higher precision that led to the redesign of urban furniture previously used in Salvador, like precast benches (with and without backrests), as well as the creation of new ones, such as footbridges. Although the execution of new benches in Rio kept the same principle as the old version from Salvador – that is to say, the upside-down casting of the main body with a cylindrical hollow molded by a steel tube removed in the sequence of the foundry process – the final thickness marked a great distinction between them. With a thickness of only 18 mm, the precast benches redesigned in Rio prove that Lelé was set to adjust the *argamassa armada* technology towards lighter elements in his constructive repertoire, no matter what the scale.

However, the uncertainty surrounding the political climate in Rio and the polemics involving the CIEPs affected Lelé's work and put an end to the expansion plan of the School Factory. The defeat of Darcy Ribeiro for the position of Governor in the state elections of 1986 seemed to contribute to demobilizing the achievements that had been made up until that point, as conveyed by Zeca Franco:

> What we needed, vitally, was the continuity with Darcy. Thus, we could have introduced the most important changes within that technological conception. It did not happen. We finished those schools as if they were ordinary constructions, in our very Brazilian practice of erecting and turning our backs on the buildings. Many of them deteriorated, by maltreatment, carelessness, ignorance, or lack of maintenance. And it seemed that technology was the only factor responsible. It was not! It never is…[140]

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139 João Filgueiras Lima, "A Industrialização da Argamassa Armada no Brasil," in *I Simpósio Nacional de Argamassa Armada* (São Paulo: Escola Politécnica da Universidade de São Paulo, 1986), 124. [Foi no Rio de Janeiro onde mais se desenvolveu a tecnologia de fôrmas metálicas para argamassa armada, algumas bastante complexas, para se conseguir seções com menor inércia. Conseguem-se assim peças com encaixes de precisão milimétrica, sempre tendo em vista uma montage rápida e perfeita com peças pequenas e de fácil trabalhabilidade] (my translation).

140 Zeca Franco. Interview with Adalberto Vilela on April 8, 2016 in Rio de Janeiro. [O que nós precisávamos, vitalmente, era a continuidade com Darcy. Assim, nós poderíamos introduzir as alterações importantíssimas dentro daquela concepção tecnológica. Não aconteceu. Nós ficamos com as escolas prontas, como se fossem construções clássicas, na nossa

In the middle of the negative political background, the need arose to create the so-called "special CIEPs", a group of schools that did not fit the building requirements for the standard constructions. This was the case of the CIEP in Paraty,[141] a protected 17^{th}-century colonial town between Rio de Janeiro and São Paulo. The strict regulations concerning the building's height led Niemeyer to delegate the project to Lelé, who redesigned the school in 1985. In doing so, Lelé took the opportunity and changed the school's building technology – from reinforced concrete to *argamassa armada* – and proposed a new sports gymnasium.

Two years later, this same project would be reintroduced by Darcy Ribeiro in Minas Gerais state, without success. The lack of interest on the side of the then Governor Newton Cardoso[142] forced Ribeiro to look for another patron of Lelé's idea. And he found one in Brasília. This was the foundation of a wider but short-lived experience called CIAC (1990-91). But before engaging in this episode, we should note how public works in Brazil are vulnerable to political and electoral cycles.

When Lelé conceived the CIEP schools for Minas Gerais (1987) – renamed NIEC by Darcy Ribeiro – he had already left Rio de Janeiro and occupied the position of technical coordinator of the FAEC factory in Bahia, otherwise known as "City Factory" (*Fábrica de*

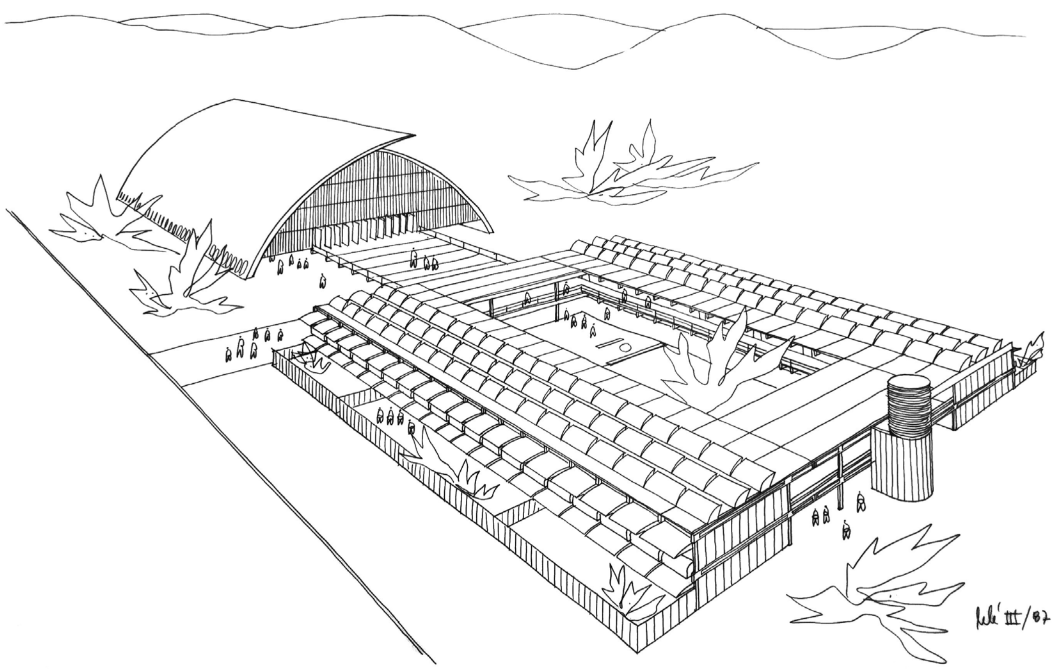

Fig. 2.75 The NIEC school complex designed by Lelé for Darcy Ribeiro when he served as Secretary of Social Development in Minas Gerais. Lelé, 1987. Arquivo João Filgueiras Lima, Salvador

prática muito brasileira de construir e dar as costas para o edifício. Uma boa parte delas se perdeu, por mal trato, por descuido, por ignorância, ou por falta de manutenção. E parecia que a tecnologia era a única responsável. Não era! Nunca é…] (my translation).

141 Both the landscape and the architectural complex of the city of Paraty, in the state of Rio de Janeiro, were inscribed on the Iphan list (National Historic and Artistic Heritage Institute) in 1958, and later recognized as a National Monument (1966). For further information, see: http://portal.iphan.gov.br/pagina/detalhes/381/

142 Newton Cardodo (1938) is a Brazilian politician who served as Governor of Minas Gerais from 1987 to 1991 and as Member of the Chamber of the Deputies in Brasília.

Fig. 2.76 Footbridge in Salvador (Paralela Avenue), Bahia. FAEC. Lelé, 1986. Arquivo João Filgueiras Lima, Salvador

Fig. 2.77 Intervention at *Ladeira da Misericórdia* in Salvador (in collaboration with Lina Bo Bardi). FAEC, 1987-88. Arquivo João Filgueiras Lima, Salvador

Fig. 2.78 Salvador City Hall in the historic center of the city. FAEC. Lelé, 1986. Arquivo João Filgueiras Lima, Salvador

Cidades).[143] At this moment, the architect's transfer from a factory in Rio to another in Salvador would have been pointless without a prior assessment of the viable alternatives for sustaining his constructive research. Only by analyzing the transformations induced in Lelé's prefabricated systems we will be able to understand the changes he operated on the component level. From the foundation elements of the schools to the vaulted-roof subsystem for the public daycares, the FAEC factory seemed to have opened a large range of possibilities for Lelé's distinct architectural creations.

Created during the second mandate of Mário Kertész as Mayor of Salvador (1986-1988), the City Factory was a result of a government plan that maximized the interaction between three key layers: building technology research, industrialized construction and a historic, social and cultural commitment. Basically, Kertész's new administration was ideologically and politically supported by the same group that accompanied him during his first tenure (1979-1981).

Over three years of activity (1986-1988), the Community Equipment Factory (*Fábrica de Equipamentos Comunitários*, FAEC) promoted significant changes to the cityscape. Three projects from this period – which had been heavily criticized,[144] to a lesser or greater extent – clearly acquired a symbolic meaning, beyond their original function. I refer to the footbridges, the works for the historic center, and the headquarters of Salvador City Hall.

143 The concept of city factory was created by the anthropologist Roberto Pinho and was widely disseminated by the media. See Bob Fernandes, "Salvador fabrica 'cidades' para o Brasil," *Folha de São Paulo* (São Paulo, July 4, 1988).

144 The public opinion of Salvador condemned the project for the footbridges mainly due to security issues. At night, the equipment could serve as shelter for homeless people or thieves. For a wide overview of the footbridges, see: Márcio Correia Campos, "Sistema e adaptação: as passarelas projetadas para Salvador," in *A Arquitetura de Lelé: Fábrica e Invenção*, ed. Max Risselada and Giancarlo Latorraca (São Paulo: Imprensa Oficial SP, MCB, 2010), 72–101. Lina Bo Bardi's recovery plan for the historic center of Salvador was also criticized by the National Historic and Artistic Heritage Institute (Iphan) in Brazil. See: Cecília Rodrigues dos Santos, "Assim, nas bordas e por dentro, os ratos foram roendo toda nossa cidade da Bahia," *Projeto* julho, no. 133 (1990): 47–48. The polemic against the construction of the Salvador City Hall in the historic center of Salvador was the subject of a long-lasting debate in newspapers, television and journals. See: Risério, "Um Mestre da Precisão e da Delicadeza Estética e Social."

Fig. 2.79 The condition of Salvador's historic center in August, 1978. *Pelourinho*. Photograph by Agliberto Lima. Fundação Gregório de Mattos, 2016

Although we have already addressed in Part I the collaboration between Lina Bo Bardi and Lelé during the interventions in the historic center of Salvador[145] (1986), it is relevant to reiterate here the poor physical condition of the ensemble of colonial buildings at the beginning of the 1980s, understood as a trigger for the sociocultural approach proposed by Kertész's administration. The dramatic situation of the buildings and their need for conservation may have inspired Lina Bo Bardi to analyze the very essence of her intervention. And she was categorical:

> The case of the Historic Center of Bahia is not about the preservation of important architecture (as the case would be in Minas[146]) but the preservation of the Popular Soul of the City. In short, the plan must be socio-economic in order to avoid repeating the mistakes of well-known interventions in illustrious cities such as Rome, Bologna, Venezia, and countless marvelous places of the Old World that have changed the social base of whole regions, with the long-standing inhabitants moved away and the middle-class coming to occupy the area.[147]

145 As a typical example of Portuguese urban planning overseas, the historic center of Salvador was designated a place on the UNESCO World Heritage list in 1985. Since 1938, the National Historic and Artistic Heritage Institute (Iphan) has worked towards the conservation of the historic ensemble.

146 In reference to the famous barroque churches found in Minas Gerais state, Brazil.

147 Lina Bo Bardi, in: Marcelo Carvalho Ferraz, *Lina Bo Bardi*, 3rd ed. (São Paulo: Instituto Lina Bo e P.M. Bardi, Imprensa Oficial SP, 2008), 270. [O caso do Centro Histórico da Bahia é: não a preservação de arquiteturas importantes, (como seria em Minas) mas a preservação da Alma Popular da Cidade. Em poucas palavras: o plano deve ser sócio econômico para não repetir os erros de conhecidos interventos em cidades ilustres, como Roma, Bologna, Venezia, e inúmeras maravilhosos

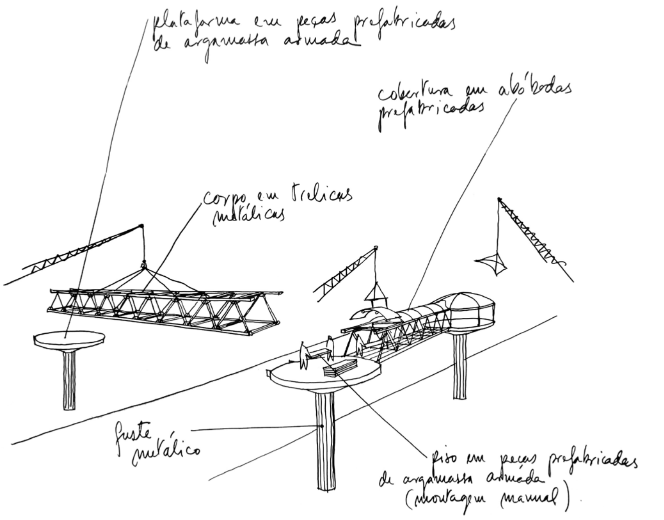

Fig. 2.80 Assembly process of the footbridges. FAEC, Salvador. Lelé, 1986-88. Arquivo João Filgueiras Lima

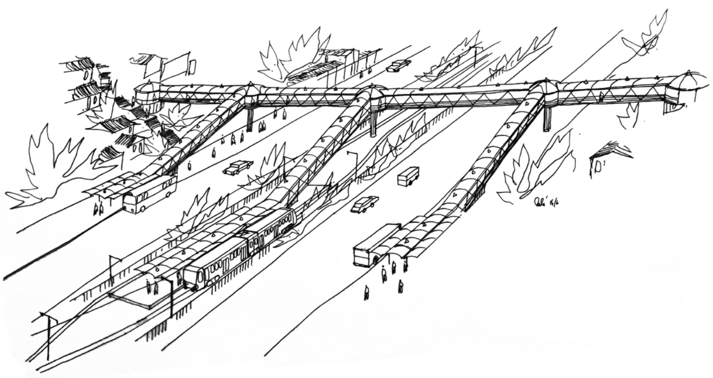
Fig. 2.81 Typical implementation of a footbridge over the valley avenues in Salvador. FAEC. Lelé, 1986-88. Arquivo João Filgueiras Lima

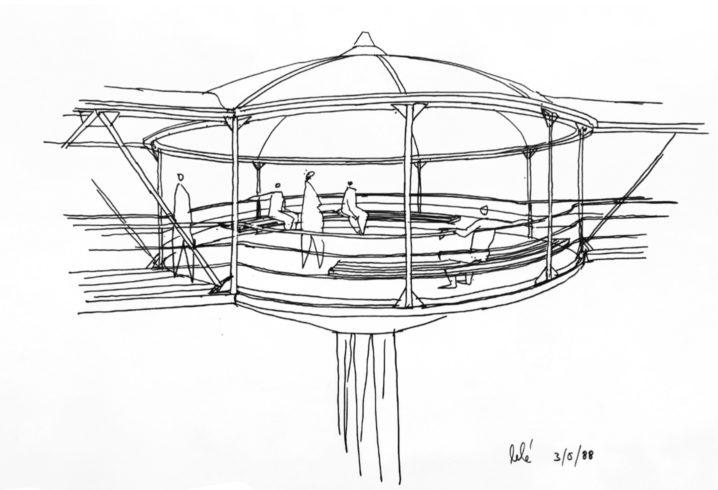

Fig. 2.82 "Mushroom pillar" of a footbridge in Itabuna, Bahia. FAEC. Lelé, 1988. Arquivo João Filgueiras Lima

I have the impression that Lelé understood what Lina meant about "the popular soul of the city" when he designed the footbridges. Those metallic trusses – whose origins go back to Rio de Janeiro – not only distribute passengers along the different sides of the valley avenues, but they connect residents living on the hillsides with bystanders in a lively urban interaction. His idea of using architecture to encourage meetings and exchanges was also explored in the development of the footbridges, as shown in the gathering point created on the so-called "mushroom pillar" of a *passarelle* for Itabuna (1988), Southern Bahia.

Besides the social dimension, the question of weight was so crucial for the footbridges, that its fundamental principle – an equipment compatible with the loads it transports (people)[148] – might have impacted on the design and weight distribution for new component outcomes in Lelé's work. This is how we should perceive the changes promoted by the architect in the school system imported from his previous experience in Rio de Janeiro (*Fábrica de Escolas*). The return of Lelé to Salvador brought diversification to his constructive vocabulary; but this move also conveyed a new level of confidence on the part of Lelé, which was needed if the architect was to be daring in his search for new building solutions: "Only when the technology (of *argamassa armada*) was mastered did I feel comfortable to present such a proposal as the nursery schools,

recantos do Velho Mundo que mudaram a base social de inteiras Regiões, com os moradores de anos e anos jogados longe e media-classe-média, tomando conta] (my translation).

148 I am indebted to Fábio Savastano for sharing his understanding of Lelé's work.

Fig. 2.83 Vaulted-roof kindergarten in the district of Bom Juá, Salvador. Design by Lelé, 1987. Photograph by Celso Brando. Integrated arts by Athos Bulcão. Arquivo João Filgueiras Lima, Salvador

because I was not starting from scratch."[149]

The implementation of the new daycare system[150] and the updates performed on the school system were only possible thanks to significant production changes. The creation of a metallurgy sector within FAEC was the first step taken by Lelé towards the subsequent incorporation of prefabricated steel to his practice. The new sector allowed not only for the production of metallic formwork – which used to be manufactured in Brasília by the Gravia metal company – but also the fabrication of metallic structure. Thus, a variety of shapes (vaults, tents, and trusses), new materials (translucent canvas and steel) and more structural possibilities (larger spans[151]) led to the most creative and fruitful period of Lelé's work.

149 João Filgueiras Lima, in: Lívia Pedreira, "Estética da Repetição," *Arquitetura e Urbanismo* 4, no. 20 (1988): 35. [Mas no momento em que se domina a tecnologia, me sinto à vontade para sair com uma proposta como esta das creches, pois não parti do zero].

150 In 1987, Lelé was commissioned to design 27 daycare centers aimed at receiving around 4,000 underprivileged children. The proposal originally came from the then First Lady of the state of Bahia, Yolanda Pires, and it was implemented by the Integrated Social Action Movement of Bahia (*Movimento de Ação Integrada Social da Bahia*, MAIS). For further information, see: Adalberto Vilela and Fábio Savastano, "A Roof Subsystem for a New Identity," Transfer. Last modified 2018. Accessed March 19, 2018. http://www.transfer-arch.com/materiality/lele/

151 The translucent tensile roof structure that covered the Salvador Aeroclub building (1986) had an internal span of 43.75m. The unexecuted project developed by Lelé during the FAEC activities also envisaged a sea museum and infrastructure support for camping. See: Latorraca, *João Filgueiras Lima, Lelé*, 185.

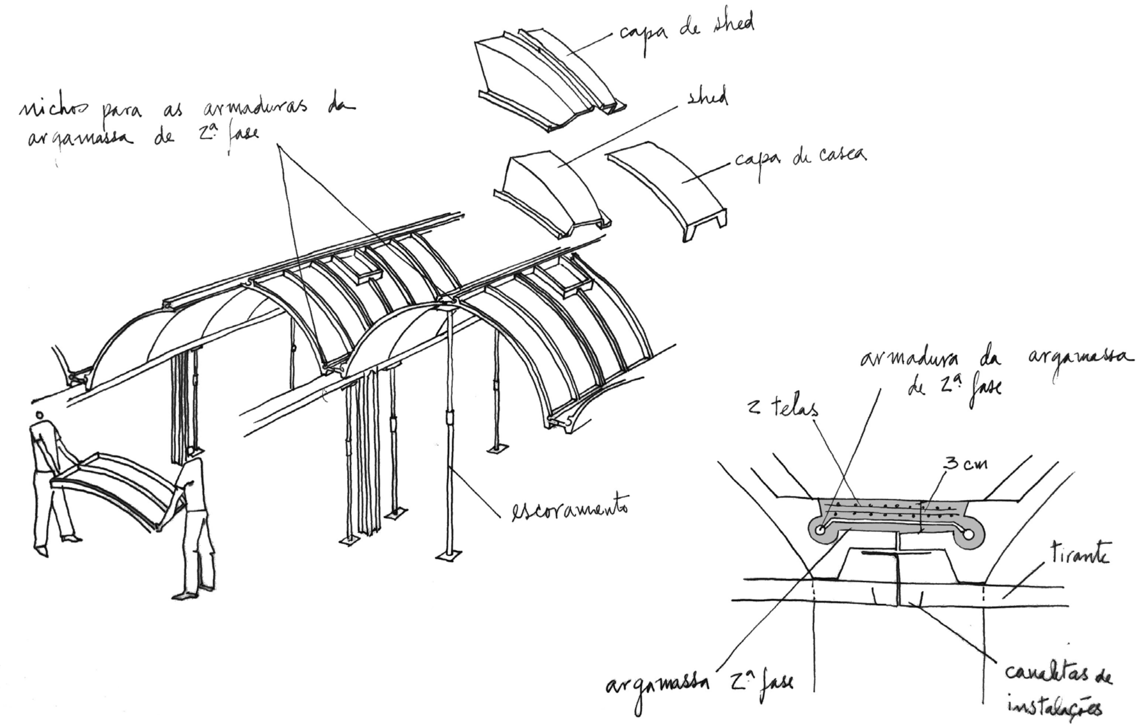

Fig. 2.84 Kindergarten MAIS (Integrated Social Action Movement of Bahia). Assembly process, system's elements and detail of the 2nd-phase-*argamassa-armada* joint. Design and drawing by Lelé, 1987. Arquivo João Filgueiras Lima, Salvador

As Haroldo Pinheiro recalls, the success of FAEC led to a business expansion beyond the limits of Salvador.[152] From a certain moment on, the factory started to produce and deliver components to cities like Belo Horizonte (1.372 km), Florianópolis (2.682 km) and Brasília (1.446 km), in addition to towns in the countryside of Bahia state. On the production line, there were three distinct building systems: the flat-ceiling schools, the vaulted-ceiling daycare centers, and the hospitals.[153] Bearing in mind that all of these systems were still bound to the conception of integral construction in *argamassa armada*, it would seem appropriate to base the conclusions of this section on the major changes implemented by Lelé to increase the system's reliability.

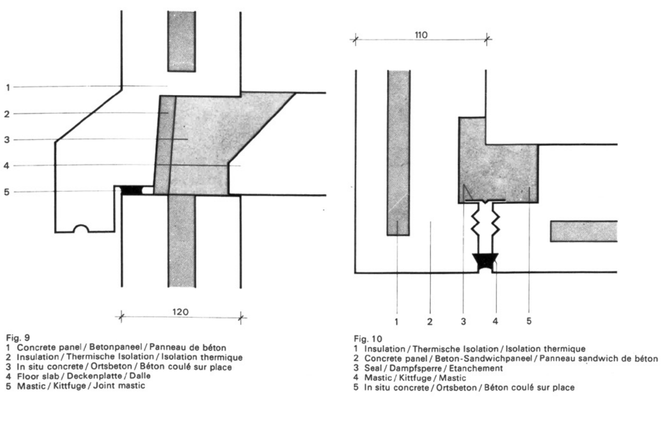

Fig. 2.85 Joints between panels in France showing the concrete poured in situ. Carlo Testa. *Some practical construction details of building systems*. In: T. Schmid and C. Testa. *Systems building*. Zürich: Artemis, 1969, p. 101

Hence, key points were affected, such as joints, foundations and roofs. The in situ grouting lines between the roof components at the lower and upper parts of the kindergarten's domes (Fig. 2.84) brought good results ensuring impermeability and structural solidity. The solution of adding mortar or in situ concrete to unify precast

152 Haroldo Pinheiro. Interview with Adalberto Vilela on May 3, 2016 in Brasília.

153 The *argamassa armada* hospitals designed by Lelé in the late 1980s in Salvador led to another experience – the Technology Center of the Sarah Chain – which will be addressed in the seventh and last chapter of Part II.

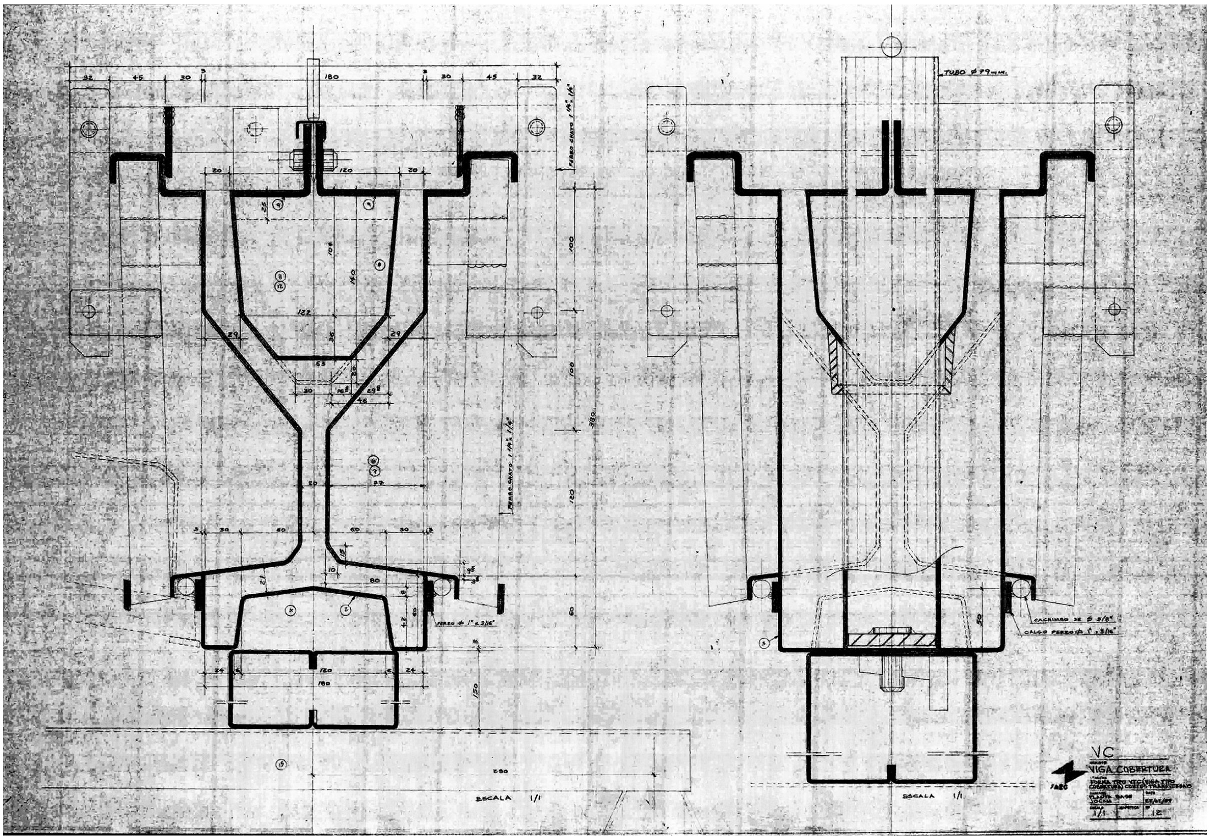

Fig. 2.86 Design of the metallic formwork for the gutter-beam of the primary schools in Salvador. FAEC factory, 1986-88. Architecture by Lelé, molds by Mariano Casanãs. Arquivo UFBA (Federal University of Bahia), courtesy of José Fernando Minho and Sérgio Ekerman.

parts was nothing new, as we can see from the range of joint solutions presented (and tested) by Carlo Testa.[154] The great novelty, in the Brazilian context,[155] lay in the fact that by moving from dry to wet-joint procedures, Lelé could improve certain construction details, designing grooves not only to be filled with insulation materials, but also to receive reinforcement bars, thus participating actively in the structural system.

The sophisticated geometric configurations of grooves and connections were supported by the visible advances obtained in the field of formwork. According to José Fernando Minho, in a project using metallic molds, the adequate release of air needs to be foreseen in order to ensure the complete fill of the form and avoid imperfections; and the definition of precise angles are of paramount importance to allow for the demolding process. However, the previewed demolding angle[156] (called *ângulo de arrasto,* in Portuguese) did not always work as expected.

154 See Carlo Testa, "Some Practical Construction Details of Building Systems," in *Systems Building. Bauen Mit Systemen. Constructions Modulaires* (Zürich: Artemis, 1969), 96–106.

155 In England, after the collapse of flats in the Ronan Point building (May 16, 1968), in Canning Town, London, the joints of prefabricated buildings started to be designed as structural elements. Built by the Danish company Larsen-Nielsen in the early 1960s, the construction failure caused by a gas explosion also provoked profound changes in building regulations, with special attention to joints for precast elements. For a wide picture of the situation, see: José A. Fernández Ordóñez, *Prefabricación: Teoría y Práctica. Tomo 1* (Barcelona: Editores Técnicos Asociados, 1974), 277–283.

156 The demolding angle or *ângulo de arrasto*, is the angle between the internal faces of the formwork. Using demolding surfaces with a slope greater than 90 degrees is fundamental for detaching the components successfully.

Fig. 2.87 A cure tank with a series of star-shaped foundation elements made of *argamassa armada*. A major feature of the primary schools. FAEC factory, Salvador. Design by Lelé, 1986. Arquivo Fundação Gregório de Mattos, Salvador, 2016

Lelé’s modifications to the design of the foundation component for the prefabricated schools are representative of the difficulties encountered during its production process. The confirmation that the chalice-shaped foundation used in Abadiânia had a more complex execution than the subsequent model – the elaborated star-shaped one applied in Salvador – might seem surprising and contradictory. “It was a struggle to demold the foundation element in Abadiânia. The formwork had to be made several times until we were able to remove the component. After that, he (Lelé) changed its design and started adopting another version,”[157] recalls Minho. This is proof that a simpler component design does not necessarily mean easier formwork for the element’s execution.

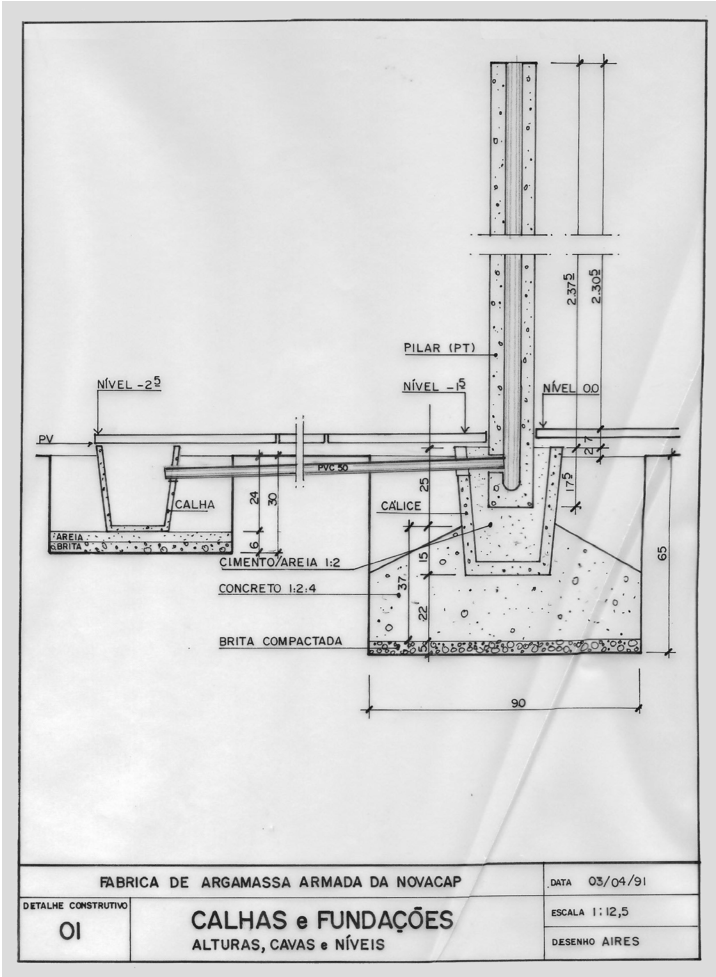

Fig. 2.88 Cross section of the chalice-shaped foundation element and its connection with the precast drainage gutter. Drawing by Aires Carvalho. Constructive detail no. 1, *Calhas e fundações*, April 3, 1991. Arquivo Aires Carvalho, Brasília

Finally, the modifications promoted on the component level also reached the primary schools. Despite the disparity between the number of prefabricated buildings produced at the School Factory in Rio de Janeiro (roughly 200) and at the FAEC factory in Salvador (around 40), what stands out are the adjustments in the component design that were required to enable the transition from a ground-floor to a one-floor school system. The addition of a new floor in the project also affected the school’s spatial organization. Basically, Lelé placed all the classrooms on the first floor, leaving the teachers’ room, services and refectory on the ground floor. The new organization impacted on elements such as sheds (which became a unitary component), panels (whose thickness increased from 18 to 20 mm), beams (now divided into two categories, the roof beams and the floor beam), and pillars (whose design was modified due to the new conections), among others.

Lelé was in fact convinced about the future potential of his building method, although he was fully aware[158] of the limits of *argamassa armada*, especially in severe environments like

157 José Fernando Minho. Interview with Adalberto Vilela on April 20, 2016 in Salvador. [Era uma luta desformar a peça de fundação em Abadiânia. A fôrma chegou a ser feita algumas vezes até que se conseguiu retirar a peça. Depois ele (Lelé) mudou e passou a adotar outro modelo] (my translation).

158 There was a general belief that, thanks to the impermeability properties of *argamassa armada*, neither water nor

Salvador. Even so, the architect was able to improve both the aesthetic and tectonic results of his precast buildings. The collaboration with Athos Bulcão,[159] for instance, brightened up the monochromatic schools and nurseries with vibrant and colorful surfaces on pivoting doors. But art has never managed to soften the folly of politics in Brazil.[160] And again, the discontinuity brought about by the termination of Mário Kertész's tenure affected the direction of Lelé's architecture, also provoking the downfall of transportation, health and education policies already initiated in Salvador. Seen in these terms, Antônio Risério gives a good outline of the course of events:

> But the governor was then Waldir Pires, and FAEC also produced several works for the government (of Bahia) and Antônio Carlos (Magalhães) was Waldir's enemy. Soon afterwards, FAEC was closed down. Closed by political misery and brutality. Not directly, of course. But Antônio Carlos acted successfully to deprive the factory of the works and, therefore, the resources indispensable to its existence.[161]

Obviously, it is tempting to assume that the triumphant success of the Sarah Chain[162] – founded after the demise of the FAEC factory – was void of political influences. This was not so. Names such as José Sarney[163] and Antônio Carlos Magalhães himself were predictably linked to its board of directors. Fortunately for the *Rede Sarah*, the construction of its subsequent subsidiaries was not impacted by the unviable project "*Minha Gente*"[164] (My People), created by

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saltpeter would affect the parts. However, Lelé was aware of the limits of the material and empirically knew that micro-cracks would increase the vulnerability of the steel reinforcement to corrosion. According to José Fernando Minho, the architect was already studying a solution to replace the traditional reinforcement bars by a synthetic material, such as nylon. In: José Fernando Minho. Interview with Adalberto Vilela on April 20, 2016 in Salvador.

159 Athos Bulcão (1918-2008) was an important Brazilian artist who collaborated with Lelé and many other architects like Oscar Niemeyer, Hélio Uchoa, Milton Ramos, Sérgio Bernardes, Glauco Campello, and Sérgio Parada. He worked with Cândido Portinari during the Pampulha works (Belo Horizonte, 1940), before moving to Brasília. In Brasília, Athos Bulcão mastered the technique of ceramic tiles, adopting geometric motifs as the basis of his artistic language. See: Cláudia Estrela Porto, "Athos Bulcão: A Linha Tênue Entre Arte e Arquitetura," in *Athos Bulcão* (Brasília: Fundação Athos Bulcão, 2009), 34–48.

160 From what we see from the recent events in Brazil (2015-2018), nothing has changed.

161 Risério, "Um Mestre da Precisão e da Delicadeza Estética e Social," 41. [Mas o governador era então Waldir Pires, a Faec fazia algumas obras para o governo e Antônio Carlos era inimigo de Waldir. Logo, a Faec foi fechada. Fechada pela miséria e a brutalidade políticas. Não diretamente, é claro. Mas com Antônio Carlos agindo, com êxito, para privá-la das obras, e assim, dos recursos indispensáveis à sua existência].

162 The Sarah Rehabilitation Hospitals Chain (*Rede Sarah de Hospitais de Reabilitação*) was created in 1991 and is managed by the *Associação das Pioneiras Sociais* (APS), a foundation created in Brasília by the former First Lady of Brazil, Sarah Kubitschek, in 1956. The hospitals in operation in many parts of Brazil (Brasília, Salvador, Belo Horizonte, São Luís, Fortaleza, Rio de Janeiro, Macapá, and Belém) became a symbol of quality, efficiency and good management in public health.

163 José Sarney de Araújo Costa (1930) is a Brazilian politician who served as President of Brazil from 1985-1990. During the military dictatorship period (1964-85) Sarney was affiliated to the government party (ARENA). During his public life, the former president has faced multiple allegations of nepotism and corruption. Still today, Sarney remains influential within Brazilian politics.

164 The "*Minha Gente*" project was created on May 14, 1991 in Brasília. It aimed to assist primarily children from low income families in Brazil, offering educational support, healthcare, food and sports facilities in full-time schools and nurseries. The project was coordinated by the Ministry of Health (Alceni Guerra), incorporating actions and programs from the Ministries of Education, Social Security, Labor, and Culture/Sports. The project's primary goal was to build 5,000 primary schools (Ciacs) throughout Brazil over four years to assist approximately six million children at a global cost of US$ 6.8 billion.

Fig. 2.89 Two-story prefabricated school produced and assembled by FAEC in Salvador (1986-88), Beirú district. Design by Lelé, photograph by Celso Brando. Arquivo João Filgueiras Lima, Salvador

the then President Fernando Collor[165] (1990-92). Inspired by the CIEPs model adopted by Leonel Brizola in Rio de Janeiro, the CIAC schools were Lelé's last effort to improve and maintain an entirely prefabricated system in *argamassa armada* before the advent of steel structures in his practice. It is well known that the project did not finish on a good note, but perhaps a careful look at the school system and its components would reveal more about the material downturn in Lelé's work.

Fig. 2.90 Typical interior of a precast school's classroom. FAEC, Salvador. Design by Lelé (1986-88), photograph by Celso Brando. Arquivo João Filgueiras Lima, Salvador

165 Fernando Collor de Mello (1949) is a Brazilian politician and former President of Brazil (1990-1992). Collor was the first president directly elected after the 21 years of military dictatorship in the country. His involvement in corruption and political scandals resulted in his impeachment in 1992.

6.2 CIAC, or what's left for *argamassa armada*?

The only moment when Lelé took the risk of delegating his responsibilities as designer, manufacturer, and builder, the results were so disastrous that he had to reformulate the criteria of his production methods. With the CIAC schools, manufacturing was regarded as a separate domain from design. Yet delegating the production of a highly-specialized artifact should require not only the transfer of technology, but also professional commitment on the part of the contractors involved in construction. However, this was not the case.

In May 1991, when the President Fernando Collor launched the national educational program *Minha Gente*, he envisaged the construction of 5,000 primary schools over the four years spanning his mandate. These schools – also known as Integrated Centers for Assistance to Children (*Centro Integrado de Apoio à Criança*, CIAC) – were designed by Lelé and his team, based on the continuous improvements that had been observed in the prefabricated system created in Abadiânia (1982) and modified in Rio de Janeiro (1984) and Salvador (1986). But at that moment, it was no longer a question of designing a new school with minor adaptations. Rather, the full-time educational program imposed a conception for a new project, larger and more complex, with a wide range of new components.

Even though Lelé's CIACs were inspired by Niemeyer's CIEPs, the only factor that united these two experiences, besides the political failing, were the program characteristics: integrated social service in one place, full-time child care, community involvement, child development and family protection programs, decentralized management, and the main feature, the implementation of physical units. Originally called "national CIEPs," to distinguish them from the experience in Rio, the CIACs basically offered the same service as the schools implemented by Brizola, as explained by Lelé:

Fig. 2.91 The CIAC project is presented to the President Fernando Collor (to the right of the First Lady) in Brasília (1991). Among those present were Antônio Carlos Magalhães and Leonel Brizola. Paulo Eduardo Fonseca de Campos, "Da argamassa armada ao microconcreto de alto desempenho: perspectivas de desenvolvimento para a pré-fabricação leve" (PhD diss., Universidade de São Paulo, 2002), p. 67

> The concept of the national CIEPs program reproduces the fundamental principles of the school chain of the state of Rio de Janeiro, with the alteration of the constructed area to 2,800 m^2 and a unit capacity from 1,000 to 700 students in a 9-hour regime. The chain will offer the children breakfast, lunch and snacks at the end of the day after bath. It will also provide an indoor gymnasium, library and accommodation for 20 residents.[166]

166 João Filgueiras Lima, in: "Programa Nacional de 5000 Cieps," dossier "*Projeto Minha Gente, programa nacional*

Fig. 2.92 Official poster of the CIAC project (*Minha Gente*). Aerial view of the first prototype assembled in the outskirts of Brasília. Design by Lelé and his team (1991), photograph by Edgar Marra. Arquivo Aires Carvalho, Brasília

In fact, the CIACs were a strategic move on the part of Collor. He had found a way of associating his political image with an alleged solution to a major problem in Brazil at that moment: the highly vulnerable socio-economic situation in which children and adolescents found themselves. Although the recently promulgated Federal Constitution (1988) increased the emphasis on promoting the rights of children, the real situation showed that there was still much to do. According to data from the National Survey of Household Samples (PNAD / IBGE), "in 1990, the country had a population of 60 million children and adolescents in the age group from zero to 17 years, which represents 41% of the total population. Of this amount, 15 million were on the indigence line, spread throughout the national territory." [167]

The "*Minha Gente*" program not only failed to improve the social situation of a small group of beneficiaries in Brazil, but it also failed to reach the established goal in terms of school construction. Of the 5,000 schools promised by the end of 1994, according to a study

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de 5000 Cieps", undated. Arquivo João Filgueiras Lima. [O programa conceitual dos Cieps nacionais reproduz os princípios fundamentais da rede do Estado do Rio de Janeiro, com a alteração da área construída para 2800 m2 e capacidade unitária de 1000 para 700 alunos em regime de 9 horas diárias. A rede oferecerá café da manhã, almoço e lanche ao fim do dia após o banho, sendo igualmente dotada de ginásio coberto, biblioteca e alojamento para 20 internos] (my translation).

167 José Amaral Sobrinho and Marta Maria de Alencar Parente, *CAIC: Solução Ou Problema?* (Brasília: IPEA, 1995), 5. [Em 1990, segundo dados da Pesquisa Nacional de Amostra por Domicílios (PNAD/IBGE), o país contava com uma população de 60 milhões de crianças e adolescentes na faixa etária de zero a 17 anos, o que representa 41% do total de habitantes. Desse total, 15 milhões encontravam-se na faixa de indigência, disseminados por todo o território nacional] (my translation).

developed at the Institute of Applied Economic Research in Brazil (IPEA), only 359 CIACs were implemented by 1995. [168] History was repeating itself, but this time on a national scale.

To understand the lessons learned by that "tragic moment," [169] as Lelé referred to the CIACs, it is necessary to split the narrative into two distinct, though overlapping, directions: the first deals with the primary school's project organization, and the second with the school building system per se. In what follows, I attempt to summarize both aspects, hoping that in the end we might highlight new paths towards a better comprehension of the CIACs and their implications within Lelé's work.[170]

It should be said at the outset that the CIACs were put up for bids in the private sector in large numbers.[171] The winning company of the public auction would not only be responsible for the construction of a given number of schools – for example, 50 CIACs, 200 CIACs, and so forth – but also the implementation of a factory and the execution of a wide range of metallic formwork necessary for precasting the multiple components.

In an attempt to lower production costs and enhance competitiveness, Lelé estimated the construction of 21 factories across Brazil.[172] The architect, who had already gained a good deal of experience with long-distance transportation of precast elements, established the areas of influence where the companies' operations would be carried out. The plan involved different roles: Lelé himself would oversee the technology transfer, his collaborators would follow and control the assembly activities, the company *Promon Engenharia S/A* would be hired to manage the project, the public tenders (building companies) would be called and the lowest bidders would be awarded the job: to build the factories, produce the elements and assemble the schools.

It did not work out that way. The construction companies did not approve the intervention of the 21 teams of architects appointed by Lelé to manage the assembly process of the factories and schools. According to Haroldo Pinheiro, "that was the only option Lelé found to ensure the building quality."[173] In fact, what the contractors did not like was the idea of meeting the technical needs while operating within a tight budget and therefore ruling out the possibility of overbilling. It was unconceivable – the contractors might have thought – that a Federal Government undertaking work of such dimensions could have such rigid standards of quality, cost and scheduled goals.

The simplest proof of this small-minded and self-interested reasoning is that the initial public bidding promoted by the government to erect the first CIAC prototype[174] in Brasília ended up with no tenders. The rise and fall of the see-saw between the state and the building

168 Ibid., 13.

169 João Filgueiras Lima, "Mestre da Surpresa," *Arquitetura e Urbanismo*, no. 82 (1999): 29. [momento trágico] (my translation).

170 I thank the architect Haroldo Pinheiro in advance for his information on this matter.

171 See Marcos de Sousa, "Camisas da Educação." *Construção São Paulo*, no. 2276 (1991): 4–7.

172 Of the 21 factories planned, 14 were effectively implemented.

173 Haroldo Pinheiro. Interview with Adalberto Vilela on May 3, 2016 in Brasília.

174 Two prototypes were executed, one in Brasília (Paranoá district) and another in Rio de Janeiro (Cajú district).

companies forced the federal government to build the physical prototype itself.[175] Therefore, the structure of the already existing factory in the federal capital was overhauled to support the new demand. Even if subsequent public bidding took place without further problems, the risk now centred on the strong indications of fraud and corruption within the program. As reported by Lelé:

> I deceived myself, perhaps a little consciously, and it was very difficult to get out of that process... I had to fight with Brizola, I had to break ties with many people. I noticed that the commercial interests of the building companies were much stronger. When I was setting up the prototypes, we fixed the cost at US$ 200/m^2; then I consented to increase this to 240/m^2 at the request of the companies. Then I realized that they were fixing the prices at US$ 500 per square meters. The problem is that, strictly speaking, construction is not the main business of large building companies. They maintain huge corruption schemes, lobby, apply political pressure... they fund the elections. Most of the money spent on elections comes out of construction. And this happens not only in Brazil. In Italy, the Mafia controls 38% of the construction. It is a type of activity that attracts corruption.[176]

In the face of the negative picture and the emphatic insistence of some building companies to make the CIAC project more "flexible,"[177] in January 1992 Lelé decided to withdraw from the program, claiming in his letter that the technical conditions for the technology transfer to the factories' staff were not being met. Although there was no political content in his letter, Lelé knew that his decision would directly affect the government. Indeed, shortly after the media had reported the architect's resignation, the Governor Brizola wrote an article accusing him of a political manoeuvre: "in fact, this architect was weak. He was unsettled by the Globo[178] campaign against the CIACs. The only thing about the CIAC project that collapsed was he himself."[179] Shattered, Lelé took refuge in Salvador and remained discreet in the face of the

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175 The first CIAC prototype was built on the outskirts of Brasília (Paranoá district, at that time called Vila Paranoá) and inaugurated on October 18, 1991. Originally estimated at 600 thousand U.S. dollars, the complex was erected by the building company Engemax in 82 days at a cost of around 1 million U.S. dollars. See: n.d., "CIAC é inaugurado com bênção papal," *Correio Braziliense* (Brasília, October 18, 1991).

176 Lima, "Mestre Da Surpresa," 29. [Eu me iludi, talvez um pouco conscientemente, e foi muito difícil de sair daquele processo... tive que brigar com o Brizola, tive que romper com muitas pessoas. Notei que os interesses comerciais das construtoras eram muito mais fortes. Quando eu estava montando os protótipos, fixamos o custo em US$ 200/m^2; depois consenti em aumentar para 240/m^2 a pedido das construtoras. Quando me dei conta, eles estavam acertando os preços em 500 dólares por m^2. O problema é que a rigor a construção não é o principal negócio das grandes construtoras. Elas mantêm enormes esquemas de corrupção, fazem lobby, pressionam políticos... são elas que sustentam as eleições. A maior parte do dinheiro gasto nas eleições sai da construção civil. E isso não é só no Brasil. Na Itália, a Máfia controla 38% da construção. É um tipo de atividade que atrai a corrupção] (my translation).

177 This was the term used by the building companies involved in the construction of the CIACs to make structural changes in the schools' original project, such as transforming shallow foundations into deep ones, replacing wall panels by brick masonry, making changes to the gymnasium's conception, and so forth.

178 The TV station *Rede Globo* founded in 1965 is the largest TV network in South America and the second-largest commercial TV network worldwide. Launched by the media proprietor Roberto Marinho, *Rede Globo* has always been identified as a right-wing TV station.

179 Leonel Brizola, "Um império acima da lei," *Correio Braziliense* (Brasília, January 13, 1992). [Na verdade, este

Fig. 2.93 Student movement (*caras-pintadas*) demonstration in front of the National Congress in Brasília aimed at ousting the President Fernando Collor (September, 1992). Photograph by Sergio Lima/ABr, 1992. *Fotos Públicas* digital repository.

national scandal, which culminated in the president's impeachment in 1992.

Now we will see to what extent the CIAC system also contributed to the program's failure. And a good way to start is to question the pertinence of a primary school project designed to be repeated 5,000 times across the whole of the Brazilian territory. Naturally, the first question raised by local architects was about the need for the project to have regional application. Regarding this matter, Lelé proved later that it had been possible to adopt a standardized and nationwide proposal when he successfully implemented the Sarah rehabilitation hospitals (1991-2009) in the most diverse parts of the country.

Unlike the CIACs, the hospitals used a mixed building system composed of *argamassa armada* and steel, which was adaptable to every hospital program, climate and topography. Each project within the Sarah Chain was unique, while employing a common language and identity. In contrast, the CIAC schools were based on a single project – with variations only in area[180] and planning organization – without the possibility of alterations, although the architect argued otherwise.

arquiteto foi um fraco. Perturbou-se diante da campanha da Globo contra os CIACs. No fundo, a única coisa no projeto dos CIACs que desmoronou mesmo foi ele próprio] (my translation).

180 Three versions of the CIACs were presented according to the available plot area: Alternative n.1 with 4.321 m^2, alternative n.2 with 4.060 m^2, and alternative n.3 with 3.846 m^2. Arquivo João Filgueiras Lima.

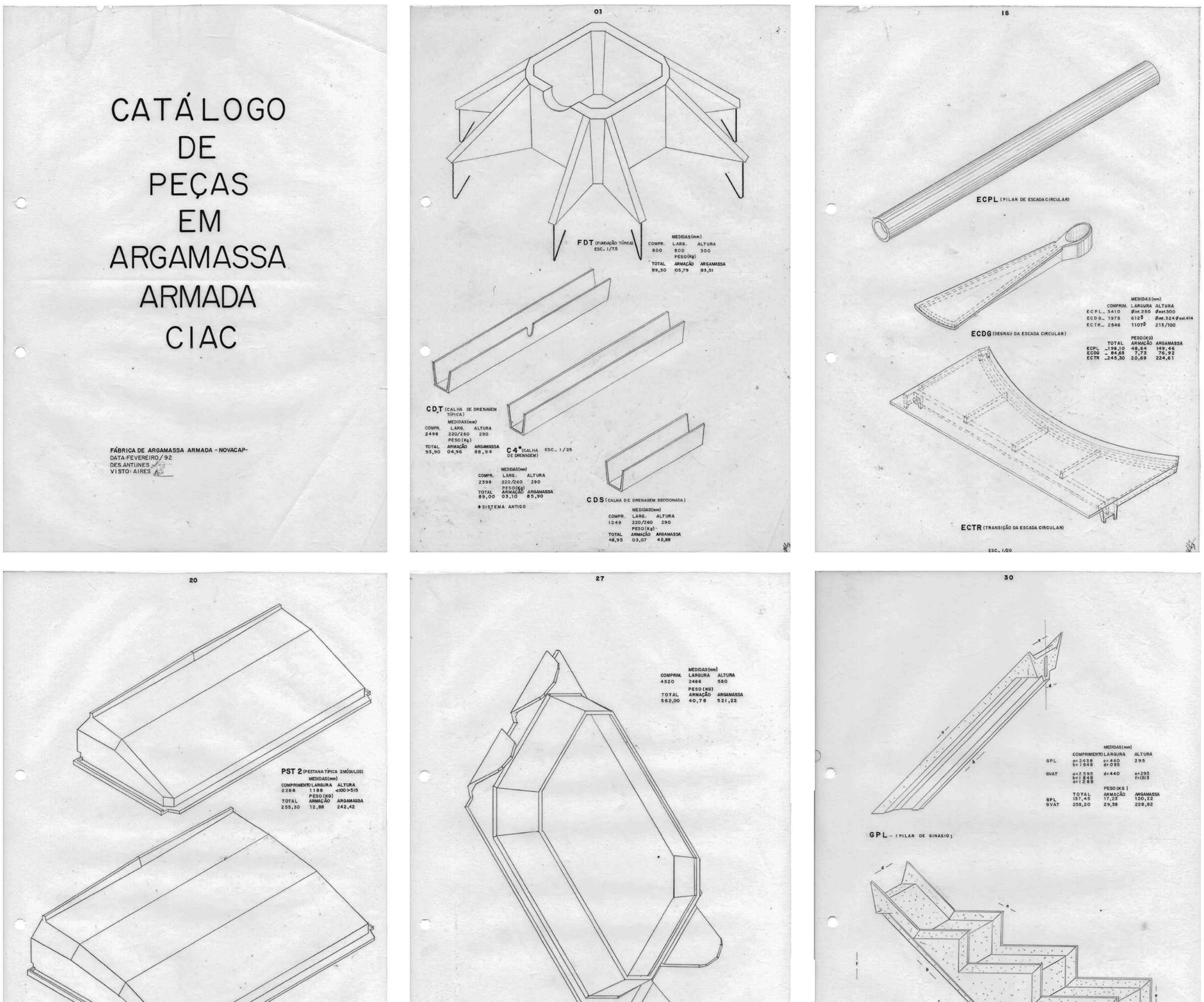


Fig. 2.94 Catalog for the CIAC's *argamassa armada* components. Each precast element of the school complex is presented with its corresponding dimensions and weight. Design by Lelé, drawings by the Novacap team in Brasília (February, 1992). Arquivo Aires Carvalho, Brasília

Fig. 2.95 The CIAC's spiral staircase reflected the variety of the new constructive vocabulary introduced by the schools. From left to right (unknown collaborator, Kristian Schiel and Frederico Schiel). Concept by Lelé, developed by the CIAC team. Arquivo Kristian Schiel, Brasília

Lelé justified the substantial increase found in the number of components (from 26 in Abadiânia to 189 for the CIACs)[181]; it was due to the need for a more adaptable project which would fulfill all of the function's demands. Clearly, the architect and his team's efforts to accept a commission of major proportions – carried out in the short term and during a period of ill health for Lelé[182] – was a great challenge in itself. However, not at any moment did the new precast elements call for alterations such as a different roof system, or modifications to the building installations or foundations. In this context, it was more a case of proceeding "with or without that component" rather than considering any real changes to the building's overall configuration.

One of the main points raised by the architects from São Paulo[183] against the CIACs was the lack of availability of suitable plots of land. Even in their reduced version, the schools required large urban areas and flat lots. It should be remembered that Lelé built his primary schools in Rio de Janeiro and Salvador in the middle of poor areas, mostly on flat land. The difference here is that the scale of the CIAC program, together with the requirement of a horizontal complex, led to an often-sloppy building deployment. Lelé was always very attentive to these issues, as proven by his pedestrian footbridges in Salvador, or his primary schools and kindergartens. Indeed, each Sarah hospital by itself is a lesson in building deployment. But in the construction

181 According to the CIACs' component catalogs produced by Novacap, the school complex was designed with 158 different parts in *argamassa armada* and 31 metallic elements embedded in the reinforced mortar parts. In total 189 different components. In: *Catálogo de Peças em Argamassa Armada*. Brasília: Fábrica de Argamassa Armada (Novacap), Fev. 1992 and *Componentes Metálicos Embutidos nas Peças em Argamassa Armada*. Brasília: Fábrica de Argamassa Armada (Novacap), Jan. 1992. Arquivo Aires Carvalho.

182 At the beginning of 1990, Lelé had a heart attack and was hospitalized for 30 days. The CIAC primary schools were designed during his recuperation in Salvador. See, Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes*, 86.

183 The Brazilian Architects Institute considered the CIAC's initiative a waste of effort and resources. In: Ana Lúcia Busch, "Arquitetos de SP criticam CIAC," *Folha de São Paulo* (São Paulo, June 9, 1991).

of the CIACs, for some reason, it was not uncommon to see large slopes at the end of a piece of rectified land.

What is curious is that Léle himself often recognized the need to review some issues related to the application of standardized solutions in architecture and urban infrastructure. When referring to the experience of a factory implemented in São Paulo based on his systems, the architect stated the following:

> I had great admiration for Mayumi (de Souza Lima), who ran the factory in São Paulo, but I think it was a mistake to use the same components that I had designed for other locations. Each urban context poses different problems. There are some aspects we can adapt, and others we cannot. Otherwise, mass production can be attained, but both application and satisfaction of local demand might fail.[184]

The adaptation also required giving up the idea of an integral system in *argamassa armada* and adopting a combination of different and lighter materials, such as steel, for instance. This brings us back to a question raised at the beginning of Part 2, which highlights the overestimation of weight as a decisive factor for the architect's decisions regarding precast systems. Although it occupies a central theme in the field, there were other reasons that led Lelé not to choose the lighter alternative on a constant basis. Otherwise, what would the reason be for using a precast 500 kg brise-soleil if not for an absolute trust in the unity and potentiality of an integral *argamassa armada* system?

Let us not forget that Lelé had already built the headquarters of the Portuguese Association in Brasília (1984) and the City Hall of Salvador (1986) – including its sun shades – both in steel. Of course, the material was not an alien concept for the architect in building construction. Nevertheless, even though he was aware of the Brazilian tradition of neglecting the maintenance of buildings (regardless of whether they were public or private), Lelé opted for a heavy element attached to the façades, without any structural function. Not long after the first sign of structural failure, these elements were replaced by metallic sun breakers, and this happened during the disastrous reforms implemented in many CIAC schools over the following years.

Another fundamental point in this process was the small cover dimensions of the precast elements in *argamassa armada*. Even with minor adjustments made over the course of ten years (from Abadiânia to the CIACs), the cover problem remained crucial. Lelé's attempt to produce sturdy and extremely slender components within a construction market not very receptive to his industrialization ideas cost the architect dearly: his plans for high-quality mass-produced

184 Lima, "Mestre Da Surpresa," 30. [Eu tinha grande admiração pela Mayumi (de Souza Lima), que dirigia a fábrica de São Paulo, mas acho que foi um equívoco a utilização dos mesmos componentes que eu havia desenhado para outros lugares. Cada contexto urbano coloca problemas diferentes. Alguma coisa é possível adaptar, outras não. Senão, pode-se ganhar na produção em escala e fracassar na aplicação, na adequação à demanda local] (my translation).

Fig. 2.96 The CIAC's sun canopy in *argamassa armada* just demolded from the metallic formwork. Brasília, 1991. Arquivo Kristian Schiel, Brasília

Fig. 2.97 Workers carrying the CIAC's sun-canopy in Brasília (1992) during the assembly of the first prototype. Arquivo Kristian Schiel, Brasília

schools spread across Brazil were dashed. It was not possible to maintain the same standard of quality – essential to the correct execution of the works – without carefully controlling the manufacturing process of the elements.

Delegating the manufacturing process to third parties proved to be a terrible mistake for two reasons: first, the contractors that took over the factories were not used to the material (*argamassa armada*) nor were they committed to the quality of the final product. Second, the making of the metallic formwork – essential within this process – proved to be a major problem. Even with the so-called transfer of technology, the results left much to be desired. As Zeca Franco summed up: "There was no *Gravia* for everyone,"[185] in reference to the company that for decades produced the metallic molds for Lelé with excellent quality.

Even in the face of these failures, we cannot neglect the technical advancement promoted by the CIACs. The stage of development that Lelé achieved with *argamassa armada*, exhausting its possibilities, made him realize that expanding the material's applications to new programs – with larger spans and with a more sophisticated aesthetic – required new research. The CIACs continued to be produced for a few more years after Lelé's resignation. In one way or another, the architect managed to set boundaries for a constructive technology in Brazil.

185 Zeca Franco. Interview with Adalberto Vilela on April 8, 2016 in Rio de Janeiro. [Não havia Gravia para todo mundo] (my translation).

7. Steel and the technological change in Lelé's approach

The transition from *argamassa armada* to the architect's systematic adoption of steel did not happen as a natural consequence of the rupture with the CIAC program. Like any other new building technology, the emergence of steel within Lelé's work came from a favorable context, where the growing role of the metallurgic sector of his factory (FAEC) provided more liberty for building experimentation. We know that it was through the Sarah rehabilitation hospital in Salvador, designed between 1987 and 1991, that this transition took shape. Originally planned in *argamassa armada*, the medical complex ended up being built with steel (1991-1994).

Fig. 2.98 Aerial view of the Hospital Sarah Kubitschek in Salvador, a project which began in 1987. Design by Lelé. Arquivo Instituto Brasileiro de Tecnologia do Habitat (IBTH), Salvador

However, during the process of technical adjustment between the two distinct constructive systems, one aspect remained unchanged: the building organization. Principles such as the drainage of the rainwater through the columns, installations running in a lengthwise direction along the beams, and the sequence of roof openings to provide air circulation reaffirmed the validity of solutions which had already been implemented in Abadiânia (1982). However, retaining these principles to fit within another building logic (steel structure) required a global revision of the project and its weak points, such as the joints.

At the center of this change, sheds and marquees played a crucial part in the development of a new roof system. This chapter aims to illustrate how this important moment within the architect's career, namely the transition from *argamassa armada* to a metallic structure, is strongly related to the shed and marquee development. By retrieving the origins of the metallic element in Lelé's practice, I intend to show more than their application and functional advances over the years. Symbols of Lelé's architecture, the two elements represent the architect's incessant search for the continuous improvement of his components, processes and techniques.

7.1 Beyond the curves of time: perspectives on Lelé's sheds

Lelé's systematic investigation into sheds dates back to the architect's second official trip to Europe in 1969, as already mentioned in Part 1. In many of his interviews, Lelé described the impact that Finnish architecture had on his designs, at least on a conceptual level, since few constructive and aesthetic parallels can be found between them. It was during a visit to the Tampere City Hospital[186] that Lelé became overwhelmed not only by the effect of zenith lighting on healthcare spaces, but also by the treatment they offered on a very human scale.

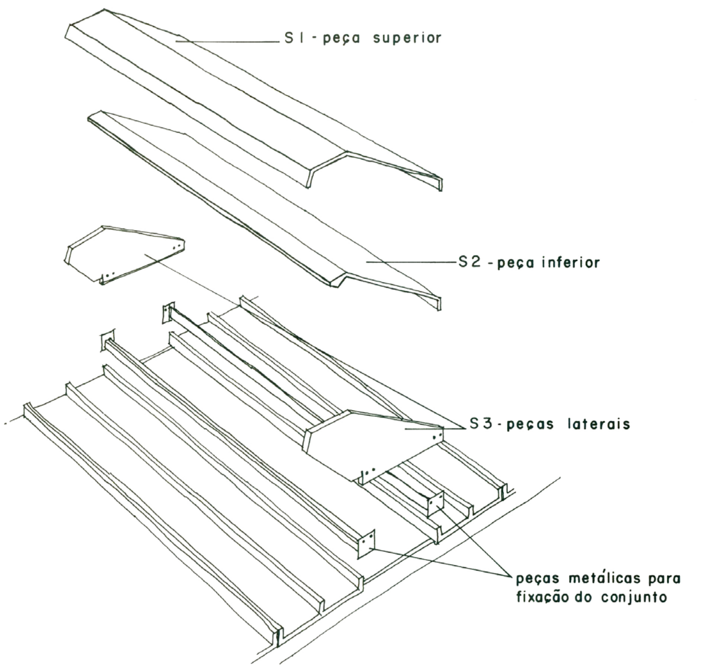


Fig. 2.99 Shed solution implemented in Abadiânia (1982) showing its four main components. João Filgueiras Lima. *Escola Transitória: modelo rural*. Brasília: MEC/CEDATE, 1984, p. 79

> "When I visited the European hospitals, in 1969, under the aegis of the Brasília hospital foundation, I was dazzled by the Finnish establishments, which seemed more human and better than all those I had seen all over the world. This was particularly true of Tampere Hospital (Bertel Strömmer, 1935), in which the light entered by the roof, which had me in awe."[187]

On his return to Brazil, Lelé drew upon a wide range of sheds in his practice, exploring the element in a variety of shapes, sizes and materials. The first attempts showed a modest opening size, as we can see at the *Planalto de Automóveis* building (1972), in Brasília. Later, the architect redesigned the element, splitting it into four different parts: two side panels, an upper part and a lower one. This version launched in Abadiânia (1982) evolved over time, mainly in the schools and kindergartens Lelé created from 1982 to 1992.[188]

186 See Bertel Strömmer, "Tampereen Kunnalliset Sairaalat," *Arkkitehti* 1, no. 1 (1936): 5–9. Courtesy of the Finnish Museum of Architecture.

187 João Filgueiras Lima, in: Susana Olmos and Chango Cordiviola, "L'Humain au Cœur de la Fabrique Architecturale / The Human at the Heart of the Architectural Factory," *L'Architecture d'Aujourd'hui*, no. 396 (2013): 59.

188 For an overview of the shed evolution in Lelé's work, see Walter Afonso Rigueti, "Os Sheds na Obra de Lelé Sob a Ótica do Conforto Ambiental" (Escola da Cidade, 2011); Daniel J. Mellado Paz, "Sol, Espaço e Verde: Alguns Temas

The critical change occurred when the architect abandoned the disposition of multiple sheds placed side by side in a row, to unify them all into a single element with greater proportions. The adoption of a new roof system – basically composed of metal roofing sheets fixed onto the top of roof trusses – solved two main dilemmas: the recurrent leaking problems with the *argamassa armada* ceilings and the insufficient upward ventilation flow observed from inside the schools. The former was settled by the advent of metal tiles, which meant less joints, and the latter by the significant increase in the roof opening's size.

Fig. 2.100 Roof trusses. Sarah Rehabilitation Hospital, Salvador (1991-94). Max Risselada and Giancarlo Latorraca. *A arquitetura de Lelé: fábrica e invenção*. São Paulo: MCB, Imprensa Oficial, 2010, p.119

The long-standing necessity of increasing the shed's dimensions within Lelé's work became more apparent during the FAEC contract with the Federal District Government[189] to erect two public hospitals in the metropolitan area of Brasília: The Psychiatric Hospital of Taguatinga (1987-88) and the Ceilândia City Hospital (1987, unexecuted).[190] It is curious to observe how the two propositions – designed by Lelé practically at the same time and using the

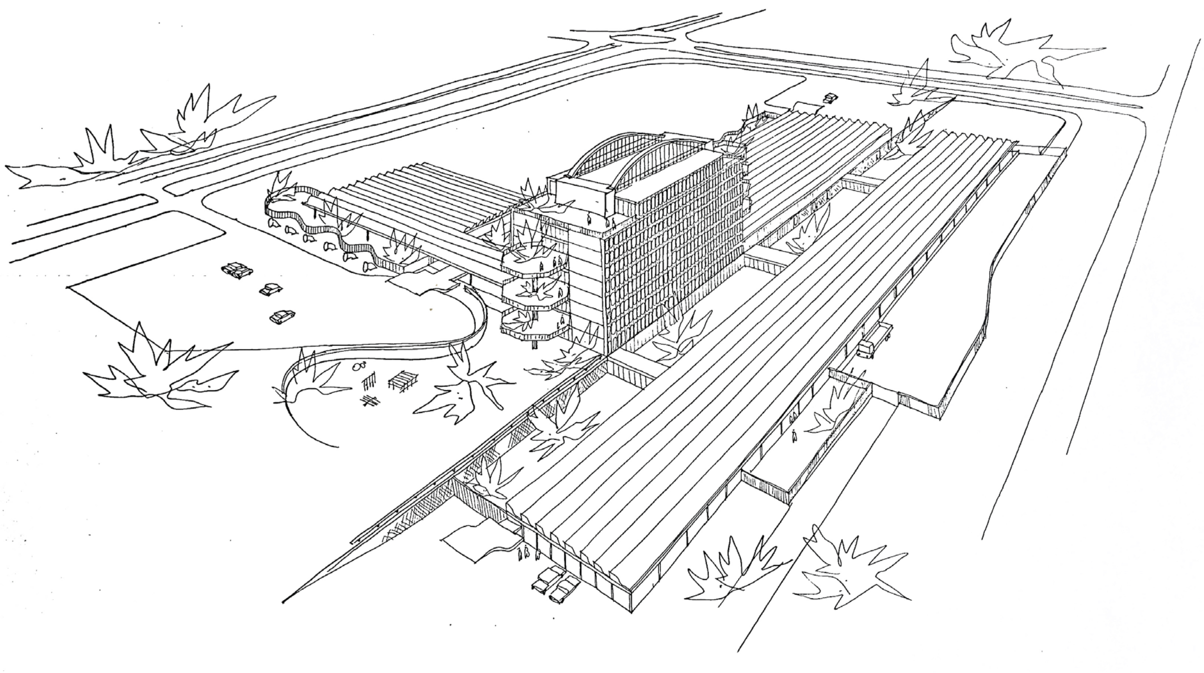


Fig. 2.101 Ceilândia City Hospital and its continuous stripes of sheds. Design by Lelé, 1987. Ceilândia, Distrito Federal. Promon Engenharia and FAEC, unexecuted. The solariums presented in this project would later be incorporated and built at the Sarah Hospital in Belo Horizonte (1992-97). Arquivo João Filgueiras Lima, Salvador

Modernistas na Obra de João Filgueiras Lima, o Lelé," in *11th Seminário Docomomo Brasil* (Recife: Docomomo, 2016), 1–19.

189 During the tenure of the then Governor José Aparecido de Oliveira (1985-88), the Federal District invested in the construction of many prefabricated buildings. Besides initiating the procedures to put Brasília forward as a UNESCO World Heritage Site (a title acquired in 1987), Oliveira (1929-2007) was also Ambassador of Brazil in Portugal and a founder member of the Community of Portuguese Language Countries (CPLP).

190 The design for the Ceilândia City Hospital was published in: Fernandes, "Salvador fabrica 'cidades' para o Brasil."

Fig. 2.102 Psychiatric Hospital of Taguatinga. Main façade showing the sequence of isolated roof sheds. Architect João Filgueiras Lima. Taguatinga, Distrito Federal, 1987-88. Giancarlo Latorraca, ed. Marcelo Ferraz, *João Filgueiras Lima, Lelé* (São Paulo: Instituto Lina Bo e P.M. Bardi; Lisboa: Editoral Blau, 2000), p. 165

same technology (*argamassa armada*) – ended up being so different from each other. Despite the visible horizontal/vertical contrast between both complexes, the Ceilândia City Hospital adopted curved and continuous "stripes" of sheds, while the Psychiatric hospital in Taguatinga kept isolated angular roof openings.

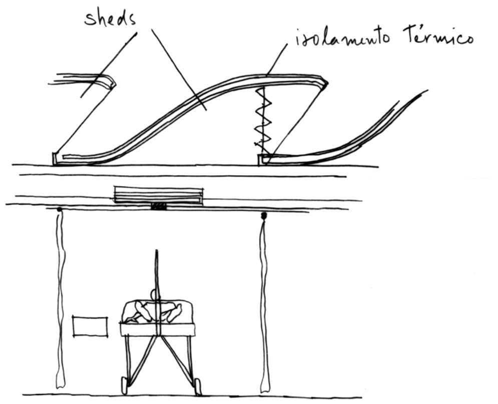
This apparently irrelevant detail marked not only a shift in Lelé's hospital designs but also contributed to the architect's reconsideration of the applied materials, so far exclusively based on the use of *argamassa armada*. As we will see in this final chapter, the shed simplification was a decision which led to a change of technology. In other words, merging a sequence of isolated sheds of *argamassa armada* into a single roof-opening "stripe" required a continuous covering material, with fewer joints. From this point on Lelé started to consider the use of metallic tiles. Furthermore, the architect realized that changing the building's roof yet keeping the structure in *argamassa armada* would not make much sense. Thus, the whole roof system and structural parts were later redesigned to incorporate a metal system.

We cannot exclude the impact of the FAEC Factory's closure in 1988 on Lelé's closer relationship with steel structures. However, contrary to common understanding, this could not be taken as the main argument for the architect's prioritization of metal systems in his work from 1992 onwards. The central idea here is that, by smoothing the components' edges – from angled to curved models – Lelé took the first step towards the adoption of steel structures. The more sophisticated the curved shapes in *argamassa armada* became, the more complex the formwork needed to be for integrating the new components. This difficulty might have contributed to his decision to leave behind precasted structural parts.

But how did these curves take shape? Close observation of the development of sheds within Lelé's work will reveal that the architect had been searching for a curved prefabricated solution for the roof openings since 1976. In the Sarah rehabilitation hospital in Brasília (1976-80), the first of a series of 10 units spread across Brazil, Lelé had already previewed a precast *ferrocemento* element[191] in the roof for natural lighting and ventilation. At that moment, the architect had not yet realized that sheds were more suitable for providing indoor air circulation[192] – such as a cooling system using natural convection – than for illumination. This issue would later become a central question for his future designs regarding natural strategies of ventilation.[193]

Another attempt to use a curved shed was verified during the works for the Creche MAIS, the public childcare center erected by the Government of Bahia in Salvador in 1987. For the project in question, Lelé created the solution of attaching a prefabricated curved shed onto the top of a precast vault, creating a sequence of isolated roof openings from the inside. In the very same year, this conception started to change. The introduction of a precast shed of double curvature at the Ceilândia hospital was the sign of a new generation to appear in metallic shape, even if the element's material stayed the same – *argamassa armada*.

And it is curious, to put it mildly, that these "roof waves", so much present in this phase of Lelé's work, literally originated in an environment of water and vessels. Allow me to explain. During the



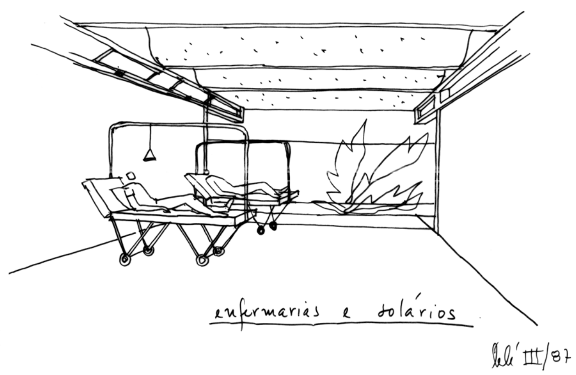


Fig. 2.103 Double-curvature shed solution still in *argamassa armada*. Lelé, General Hospital (study applied at the Ceilândia City Hospital), 1987. Arquivo João Filgueiras Lima

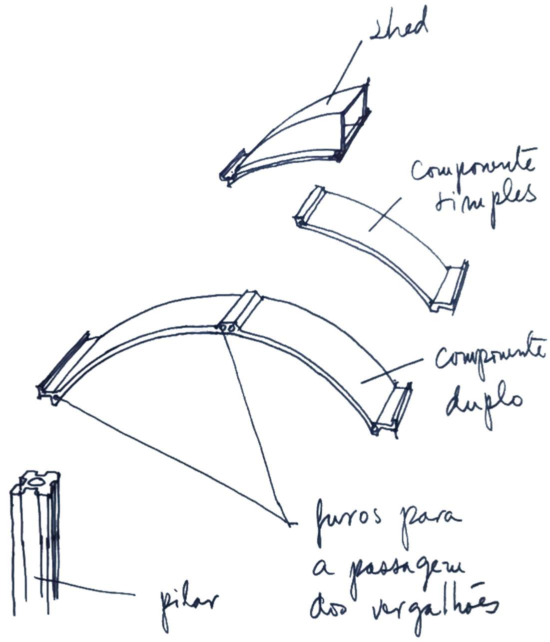


Fig. 2.104 Creche MAIS (right). Basic components of the kindergarten system. Vaulted roof and sheds. Lelé, Salvador, 1987. Arquivo João Filgueiras Lima, Salvador

191 See HDAL – *Hospital de Doenças do Aparelho Locomotor* (Hospital for Diseases of the Locomotor System), Fundação das Pioneiras Sociais, Anteprojeto, drawing board no. 13. Arquivo João Filgueiras Lima.

192 Cross ventilation in a hospital helps to disseminate undesired contaminating agents. For this reason, the vertical solution, through air convection, is more appropriate.

193 For a comprehensive study on Lelé's incorporation of natural light and ventilation in his work, see Jorge Isaac Perén Montero, "Ventilação e Iluminação Naturais na Obra de João Filgueiras Lima 'Lelé': Estudo dos Hospitais da Rede Sarah Kubitschek Fortaleza e Rio de Janeiro" (Universidade de São Paulo, 2006).

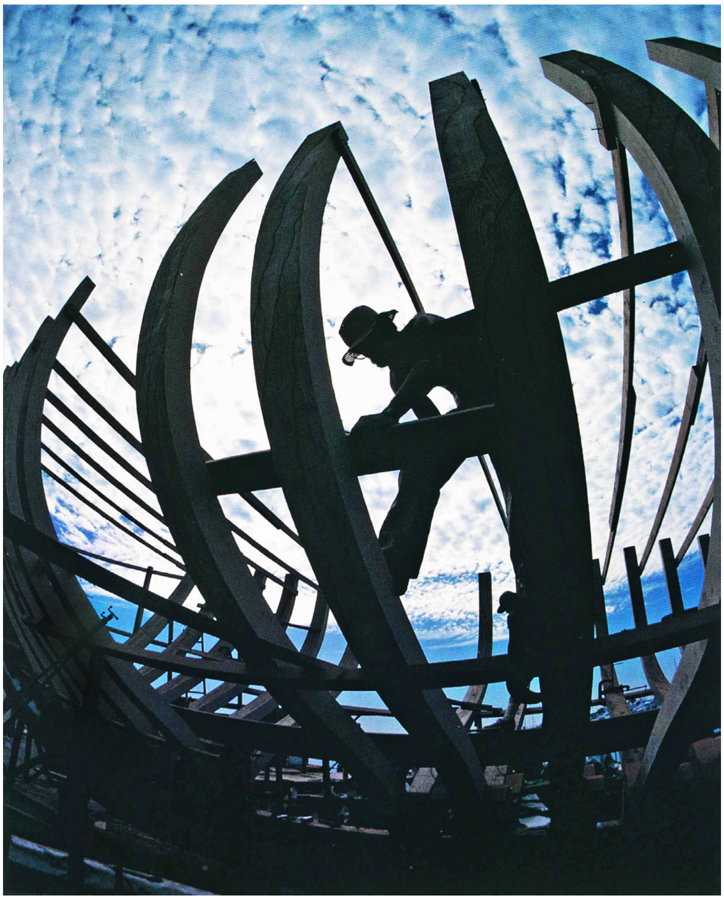


Fig. 2.105 Shipbuilding. Ribbed structure (*Cavername*). Joseph Gribbins, *Woodenboats: vom Ruderboot zur Luxusyacht* (Stuttgart: Pietsch, 2004), 41

Fig. 2.106 Children's Rehabilitation Center. Roof trusses under construction. Sarah Hospital at Pombeba Island. João Filgueiras Lima, Rio de Janeiro, 2001. Arquivo João Filgueiras Lima, Salvador

long-lasting discussions about the land on which the works of the Sarah hospital of Salvador would be carried out, Lelé called his collaborator Haroldo Pinheiro in Brasília and asked him:

> Do you know how boats are built? I said, "more or less". I had some previous knowledge because I lived in *Ilha do Governador* (in Rio) when I was a kid, and Lelé was born there. I remember seeing shipbuilding and small-size construction sites for boats. Then he asked me about the *cavernames* – the ribs that embody the transversal structure of a boat – and said: "I was thinking about the roof and, instead of using profiles of folded metal sheets to cover it, we could make some trusses, like the boat ribs, placed at a short distance from each other, and then lay a corrugated tile covering on top."[194]

Like Lambot,[195] who sought to replace timber structures in the construction of small boats when he introduced *ferciment* in 1848, Lelé used the local nautical construction expertise as a structural model to promote his technology change. However, while Lambot was entering the early-stage development of *ferrocemento* technology in mid-19th-century France, Lelé was abandoning a refined

194 Haroldo Pinheiro. Interview with Adalberto Vilela on May 3, 2016 in Brasília. [Você sabe como são feitas essas barcas grandes, veleiros? Eu disse, mais ou menos. Eu morei na Ilha do Governador quando criança, sabe? E o Lelé nasceu lá. Lá tinha estaleiros e fábrica de barcos também. Eu vivia por ali. Então ele me perguntou sobre o conceito de cavername – aquelas vigotas de madeira que dão forma ao barco – e disse: Eu estava pensando que essa cobertura ao invés de chapa dobrada a gente podia fazer umas treliças feito uns cavernames, a uma distância pequena de uma para outra, e depois assentamos em cima uma telha ondulada] (my translation).

195 Joseph-Louis Lambot (1814-1887) was a French material scientist who invented ferrocement in the middle of the 19th century in France. In 1848, he constructed his first boat, which he patented in 1855 before presenting it at the Paris Exposition Universelle that same year. The boat was recovered more than a hundred years later and is today housed in the Brignoles Museum in France. For different approaches to the history of concrete, see: Cyrille Simonnet, *Le Béton: Histoire d'un Matériau. Économie, Technique, Architecture* (Marseille: Parenthèses, 2005); Adrian Forty, *Concrete and Culture: A Material History* (London: Reaktion Books, 2012).

Fig. 2.107 Prototype of a new roofing system for the Taguatinga Psychiatric Hospital. João Filgueiras Lima, Taguatinga, Distrito Federal, 1988. Produced by FAEC in Salvador, Bahia. Arquivo João Filgueiras Lima, Salvador

product in the late 20th century in Brazil, at least for the superstructure of his buildings.

But before abandoning the use of *argamassa armada* in his works, Lelé resorted to producing a new shed as a last attempt to perpetuate the material. This time with much bigger dimensions, as shown by the prototype of a new roofing system for the Taguatinga psychiatric hospital, produced by FAEC in 1988. However, the shed solution designed for the psychiatric hospital of the satellite city of Brasília considerably enlarged the same element used during the prefabricated schools. Even with a whole new set of components, one can say that until that moment Lelé was still attached to previous solutions. For this reason, I reject the idea that the Psychiatric Hospital of Taguatinga was the materialization of the unbuilt project (in *argamassa armada*) for the Sarah Hospital in Salvador.

A careful and close look at the preliminary drawing boards of Salvador's rehabilitation center project reveals that there was already an intention, on the part of the architect, to work with curved sheds. In this sense, it is more pertinent to link the roof solution of the Sarah in Salvador with the Ceilândia City Hospital – with which it shares the double curvature shed solution – than the Taguatinga sanatorium. But assuming the new design of the roof openings presented at the Ceilândia and Salvador hospitals appeared practically at the same moment, between 1987 and 1988, what could have led to the effective modifications?

The alterations to the aerodynamics of the new sheds were made for good reason. They were connected to a ventilation system whose origins dated back to colonial times in Brazil. Basically, Lelé's decision to set the buildings (or part of them) at a higher elevation (permitting

Fig. 2.108 Shed development over Lelé's practice. Shed version of the ground-floor school, 1984 (on the left) and its redesign for the two-story prefabricated school, 1986 (below). Arquivo Aires Carvalho, Brasília

Fig. 2.109 Assembly process of a shed in Rio de Janeiro. Lelé modified the element before it entered mass production at the School Factory. An acrylic shutter was designed to protect the roof opening from direct sunlight. Marina Mange Grinover, PhD diss., (Universidade de São Paulo, 2015), 346

the prevailing wind to cool down the high temperatures inside) was based on the colonial farms in Bahia. According to the architect: "It is not a question of creating complex ventilation control, sun penetration or protection mechanisms, but rather of applying simple principles, especially those of aerodynamics so well observed in most of our houses of colonial architecture in Bahia and increasingly forgotten in our modern buildings."[196]

In effect, what Lelé was defending was the use of air convection as a cooling strategy for his buildings. In the hospitals he designed from 1987 onwards, Lelé added other mechanisms, such as the evaporative cooling effect used to dampen the air flow that crosses underground channels. The air insufflation inside the building is ensured through small ventilation grates located at the bottom of the walls. Therefore, the use of a vertical flux is guaranteed via natural convection, as the heated air becomes less dense and rises, directing the airflow upward towards wind outlets, or sheds (Fig. 2.110).

The vertical flux of air inside the Sarah in Salvador was a deliberate choice by Lelé to better reduce infection rates. Inspired by the conviction that design can contribute to preventing healthcare-associated infections, the architect avoided using cross-ventilation and

196 João Filgueiras Lima. Preliminary study for the Sarah rehabilitation hospital of Salvador. HDAL Nordeste. Drawing board unnumbered and undated. Arquivo João Filgueiras Lima. [Não se trata de criar mecanismos complexos de controle de ventilação, de penetração ou de proteção do sol, mas de apenas aplicar princípios simples, sobretudo os de aerodinâmica tão bem observados já na maioria de nossos casarões de arquitetura colonial baiana e cada vez mais esquecidos em nossos prédios modernos] (my translation).

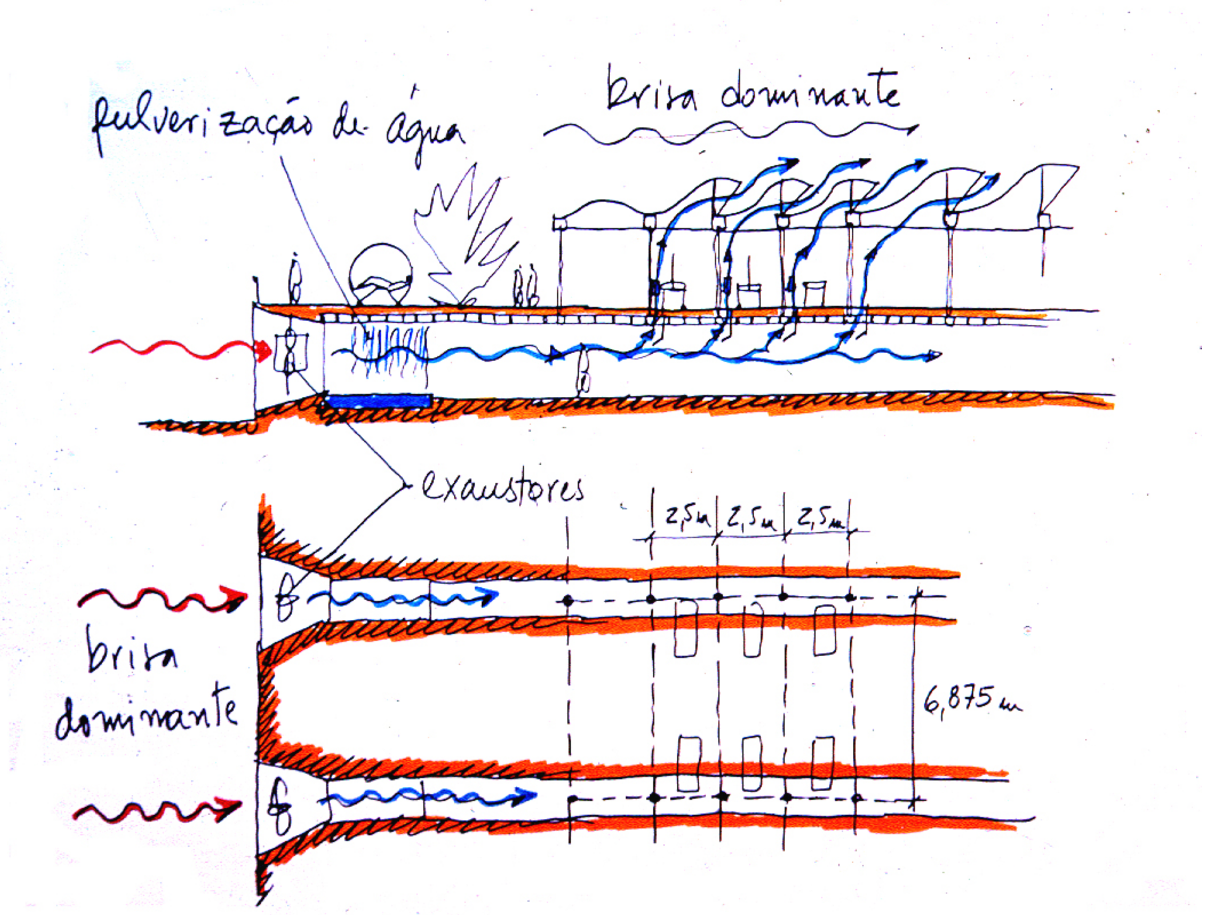


Fig. 2.110 Ventilation system proposed by Lelé for the Sarah Hospital in Salvador, 1987-91. The drawings show how the evaporative mechanism dampens the air flow before its release through the roof sheds. Arquivo João Filgueioras Lima

air-conditioning in most of the treatment centers' spaces. When applied indiscriminately in favorable indoor environments, such as hospitals, these solutions tend to self-perpetuate airborne pathogens. In this way, Lelé reconciled the air quality question and the thermal comfort of the users with his architectural decisions.

Although the idea of a refrigerating device using wind power does not contain anything new – as windcatchers can be found in some vernacular architecture – Lelé succeeded in establishing an efficient method for naturally cooling down ventilated buildings in Brazil. Over the course of more than 40 years of redesigning his sheds, the architect showed that it is possible to make a metal-framed architecture in a wet tropical climate without resorting to building envelopes or air-conditioning:[197] "The shed, a natural lighting system, is not something that was born yesterday. It comes from the beginning of my professional training. Since then, I have been trying to better understand and deal with this issue that is paramount for the buildings in the tropical climate regions in which we live."[198]

197 In specific cases, Lelé adopted air-conditioning, for example in the surgery centers and morgues of the hospitals. Tribunals located in the torrid climate of Brazil and far from the see breeze, like Terezina and Cuiabá, also operate with air-conditioning central systems.

198 João Filgueiras Lima. Interview with Maria Cecília Loschiavo on May 14, 2007 in Salvador (unpublished).

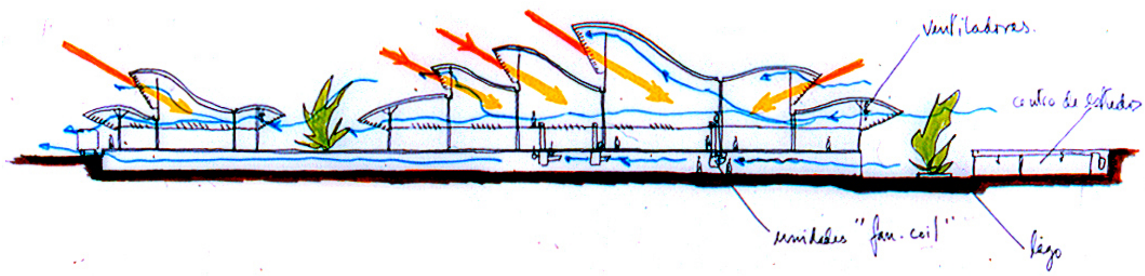


Fig. 2.111 Cross section of the Sarah Hospital in Rio de Janeiro (2009) showing the incidence of natural light in the rooftop and natural air circulation within the building. Drawing by Lelé. Arquivo João Filgueiras Lima, Salvador

However, these solutions have so far shown considerable variations. The scholar Reyner Banham – who defends the co-existence of a wider choice of environmental methods – tends to criticize techniques in architecture that become a "unique and inevitable solution to environmental problems."[199] In his text he mentions, ironically, the fact that thermal techniques become risky when they are controlled too tightly; users might be confronted with confusing, inadequate or inefficient solutions. "Thus, the rules of orientation and plan-organisation for breeze, sectional organization for cross ventilation and cooling, that apply to structural solutions in hot, humid climates, can become a tyranny that makes the sealed and necessarily mechanized envelope of a glass slab office tower an extremely attractive solution."[200]

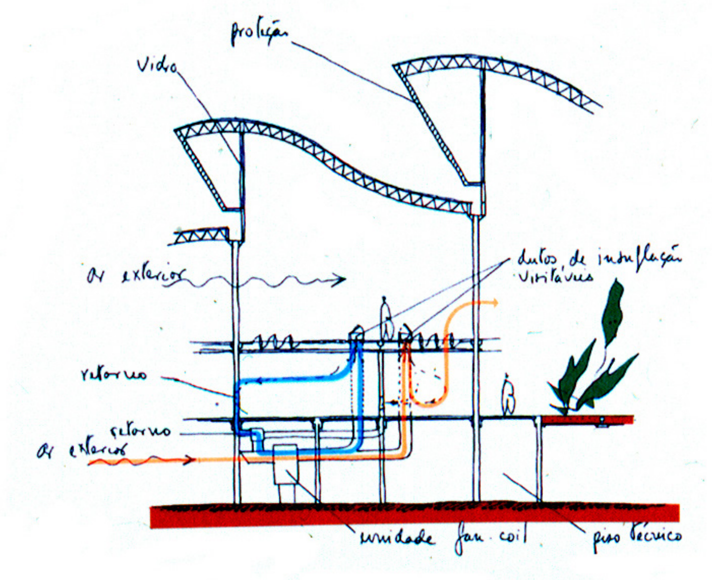


Fig. 2.112 Cross section (amplified) of the Sarah Hospital in Rio de Janeiro (2009). Detail showing the air-conditioning scheme as an available option for the users. The thermal control of the hospital (intermediate floor) is guaranteed thanks to the integrated functions of the technical floor (ground floor) and the space under the roof. Arquivo João Filgueiras Lima, Salvador

It is evident that not all refrigerating mechanisms designed by Lelé worked as expected. Indications of high temperatures[201] in some environmental controlled spaces of the Sarah in Salvador (1991) showed that there was a certain thermal discomfort in areas like the inner nursing wards of the hospital. These guidelines proved so important for the architect that the upgrades regarding the thermic performance of the spaces implemented in the Sarah in Rio (2009) achieved much better results. In the more recent unit of the Sarah rehabilitation

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Arquivo Maria Cecília Loschiavo, São Paulo. [O shed, sistema de iluminação natural, não é uma coisa que nasceu ontem, vem desde o princípio da minha formação profissional que eu venho tentando entender melhor e praticar essa questão que é primordial para os edifícios no clima tropical em que nós vivemos] (my translation).

199 Reyner Banham, *The Architecture of the Well-Tempered Environment* (London; Chicago: The Architectural Press; University of Chicago Press, 1969), 289.

200 Ibid., 288.

201 For a detailed study on the thermal comfort of the Sarah hospitals designed by Lelé, see: Marieli Azoia Lukiantchuki and Rosana Maria Caram, "Análise do Conforto Térmico na Obra de João Filgueiras Lima , Lelé : Hospitais Sarah de Salvador e do Rio de Janeiro," *Paranoá*, no. 12 (2014): 33–44.

Fig. 2.113 Medical wards of the Sarah Rehabilitation Hospital in Rio de Janeiro, Lelé, 2009. When the motorized air dumper ceiling is opened (as in the picture above) it means that there is an exchange of air between the airflow from the rooftop and the space bellow. Photograph by Celso Brando. Arquivo João Filgueiras Lima

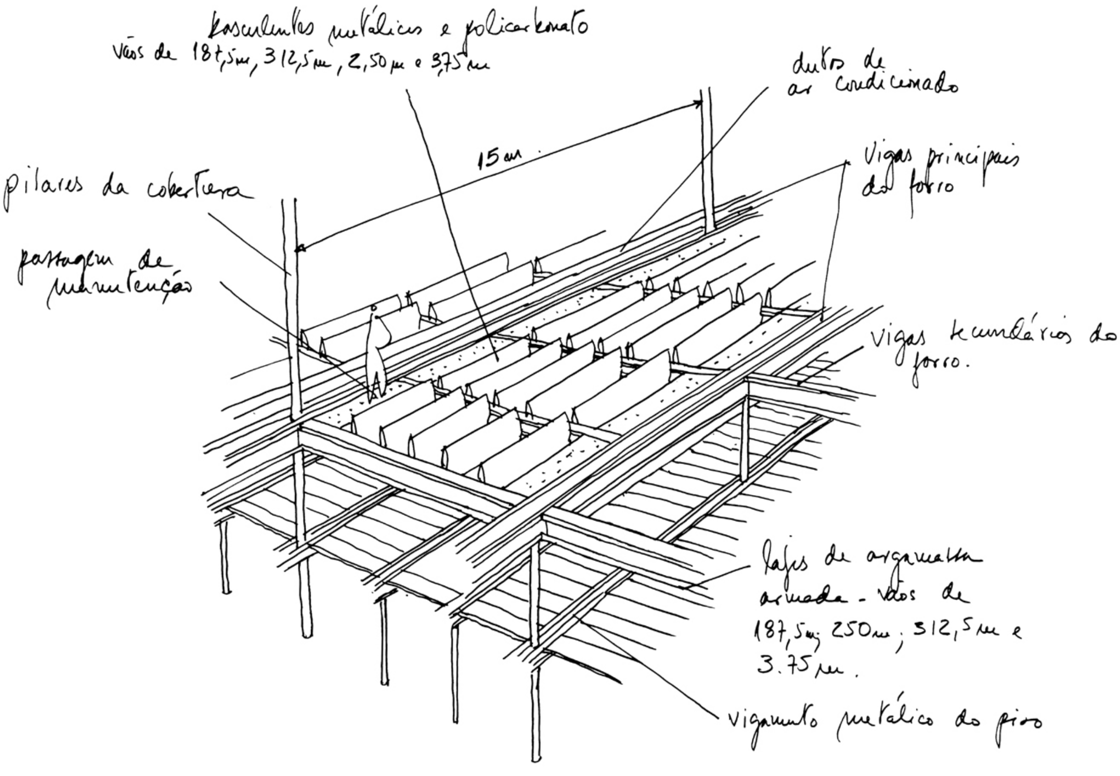

Fig. 2.114 Sarah Rehabilitation Hospital of Rio de Janeiro. Lelé, 2009. The drawing shows the structural scheme of the hospital with the motorized air dumper ceiling. When the polycarbonate flaps are closed the hospital operates exclusively with air conditioning. Drawing by Lelé. Arquivo João Filgueiras Lima

hospitals, the space (approximately 4 m) that separates the roofing sheds from the motorized ceiling air damper is big enough to allow for more efficient thermal protection.

Lelé's environmental concerns were expressed in numerous buildings the architect constructed outside the Sarah Chain of Rehabilitation Hospitals, like the Auditor Courts (*Tribunais de Contas da União, TCU*)[202] and the Regional Electoral Court of Bahia (*Tribunal Regional Eleitoral da Bahia*, 1997). In all of them, except for the TCU in Maceió which was designed with a flat ceiling, sheds not only played an important role in the thermal comfort of their users, but they also contributed to developing a new language for Lelé's work. All this thanks to the implementation of the CTRS (*Centro de Tecnologia da Rede Sarah*) – the Technology Center of the Sarah Chain (1992-93) – the factory that allowed Lelé to produce and export metallic parts all over the country, an issue which will be addressed in the third and final part of the thesis.

What is at the center of the discussion here is the technological transition from *argamassa armada* to steel structures observed within Lelé's work at the beginning of the 1990s in Brazil. Taking some early examples of his hospital architecture, I have tried to show that this important moment in his career is directly related to the development of sheds, as we saw here, and marquees, which will be addressed in detail in the next chapter. The underlying factor that has contributed to this change, I have argued, was the curve, obtained from the smoothing process of the elements' edges.

But the curve in question here, it must be said, is not at all the same as the one that became part of the collective imaginary when it comes to Brazilian architecture. The irregular undulations found in the roofs of the buildings erected throughout this new phase of Lelé's work broke with the tradition of the curve within Brazilian modern architecture. Ideologically associated with geographical and feminine references – "the curves that I find in the mountains of my country, in the sinuousness of its rivers, in the waves of the ocean, and on the body of the beloved woman"[203] – the curves in Lelé were introduced as a response to structural and environmental conditions. As Luiz Recamán has written: "it is as if the well-known curves of Brazilian architecture acquired, we might say, a more architectonic sense."[204]

The notion of the "curve" as a trigger for technological change in Lelé can also be expanded to other components, such as marquees. Together with the sheds, marquees also imply more than a simply prominent element in the architectural composition. Usually painted in primary colors, they trace back to structural aspects of the architect's material transition to steel, such as cantilevered spans and slender shapes. The next and final section of this chapter provides an overview of these investigations, while examining their implications.

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202 Lelé designed and built, via CTRS, the following Audit Offices in Brazil: TCU in Salvador (1995), TCU in Natal (1996), TCU in Aracajú (1997), TCU in Belo Horizonte (1997), TCU in Maceió (1997), TCU in Teresina (1997), TCU in Cuiabá (1997), and TCU in Vitória (1998).

203 Oscar Niemeyer, *The Curves of Time: The Memoirs of Oscar Niemeyer* (London: Phaidon, 2000), 3.

204 Luiz Recamán, "Lelé e a Arquitetura Moderna Brasileira," *Trópico* (São Paulo, 2003). [É como se as conhecidas curvas da arquitetura brasileira adquirissem um sentido, diríamos, mais arquitetônico] (my translation).

7.2 The delimitation of the ordinary: marquees

Another emblematic element that confirms our hypothesis associated with the rupture of the hegemonic use of *argamassa armada* within Lelé's work is the marquee. The element that appeared in the architect's first designs assumed unprecedented proportions (and shapes) after the advent of the CTRS (1992-93), and more specifically, after the Sarah hospital in Salvador (1991). But as we go back in time, we discover that marquees started to be assembled in parts – still in *argamassa armada* – even before the first model to turn up in steel years later. But how does this fact affect the technology change? I would say in the extent of its construction method.

If we examine, for instance, the Disbrave expansion project in Brasília and the bus shelter model for Rio de Janeiro, both designed by Lelé in 1985 with a similar structural solution, we realize that despite their *argamassa armada* cantilevered ribs – of different spans and curvatures – they distinguish themselves by their building technique. While the urban equipment was precast as a single component (the shelter roof), the car dealership's marquee was divided into several parts, with each rib premolded separately. In addition to the immediate advantage of a less expensive investment in formwork, as the Disbrave marquee (Figs. 2.115 and 2.116) used a single mold for the ribs, it opened the way to new forms of assembling longilinear and curved components.

It is no coincidence that the marquee designed for the Ceilândia hospital (1987) – and later reproduced at the Sarah in Salvador – had a direct influence on the Disbrave solution. Lelé's adjustments to the marquee's structural design – changing its curvature and eliminating

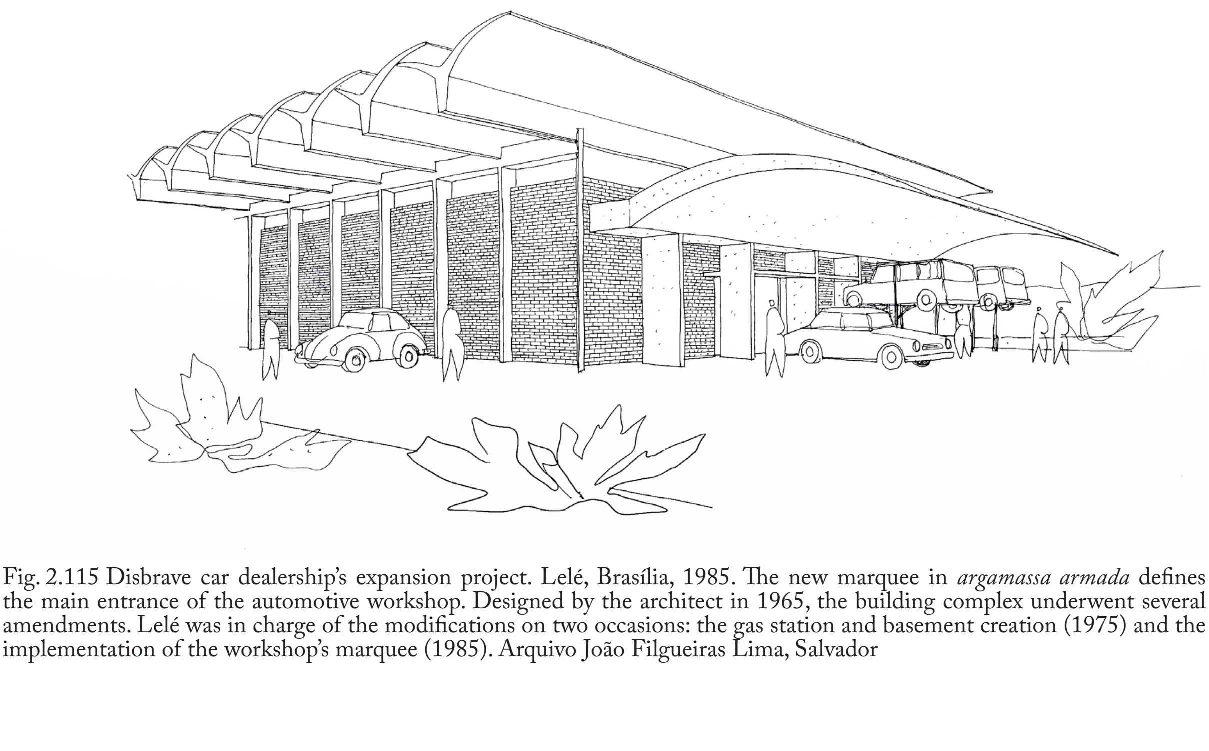


Fig. 2.115 Disbrave car dealership's expansion project. Lelé, Brasília, 1985. The new marquee in *argamassa armada* defines the main entrance of the automotive workshop. Designed by the architect in 1965, the building complex underwent several amendments. Lelé was in charge of the modifications on two occasions: the gas station and basement creation (1975) and the implementation of the workshop's marquee (1985). Arquivo João Filgueiras Lima, Salvador

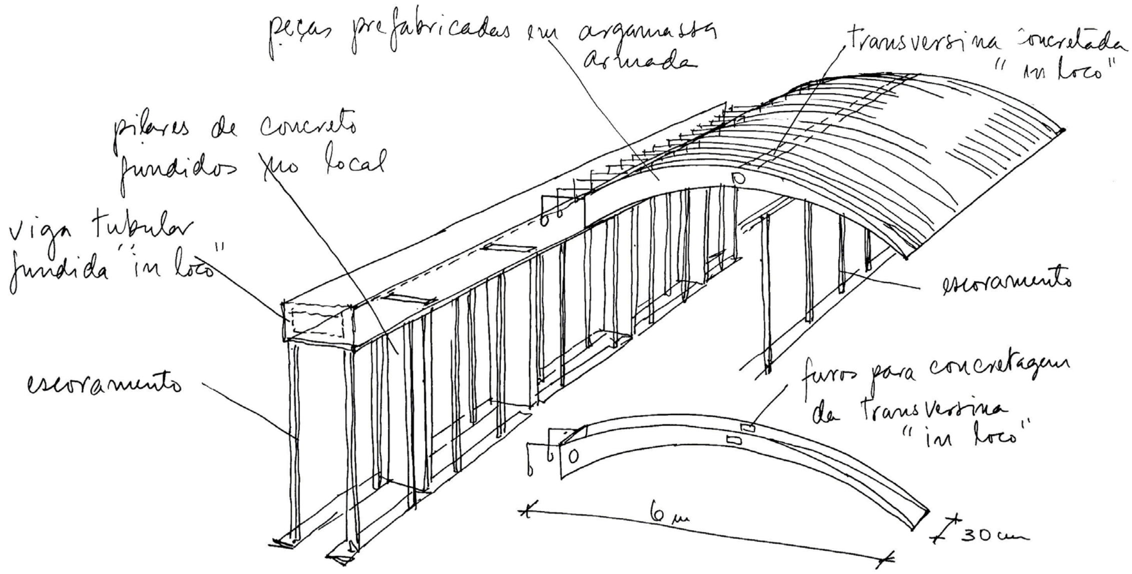


Fig. 2.116 Workshop entrance marquee. Disbrave car dealership. Design and drawing by Lelé, Brasília, 1985. Assembling method of the *argamassa armada* ribbed structure of the marquee. Arquivo João Filgueiras Lima, Salvador

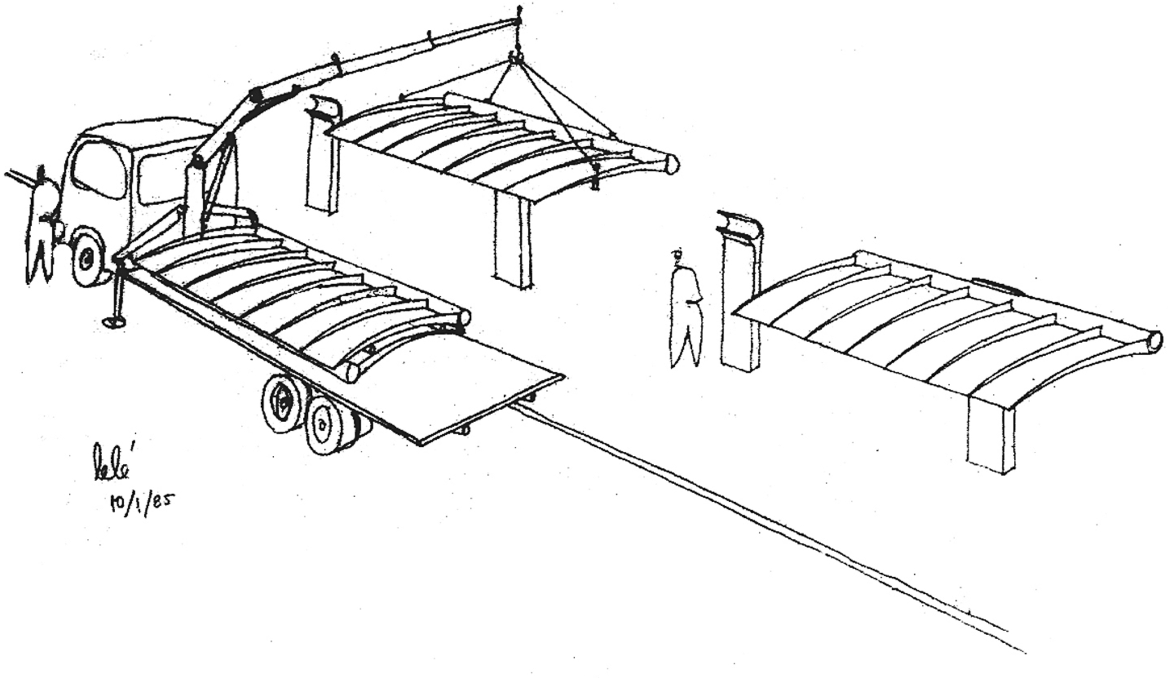


Fig. 2.117 Rio de Janeiro bus shelter model in *argamassa armada*. Design and drawing by Lelé, Rio de Janeiro, 1985. Assembling process on site with the help of a Munck truck. Arquivo João Filgueiras Lima, Salvador

the transversal beam that previously connected all the ribs – led to a complex structural solution explained by the architect but never implemented: "They (the hospital marquees) consist of ribs with a width of 31 cm and a variable height attached to a hollowed cast-in-place beam under twist loading. This beam, in turn, rests on neoprene plates found on the top of round-conic concrete pillars also cast in place. The system is balanced by back extensions of the concrete beams anchored in steel rods."[205]

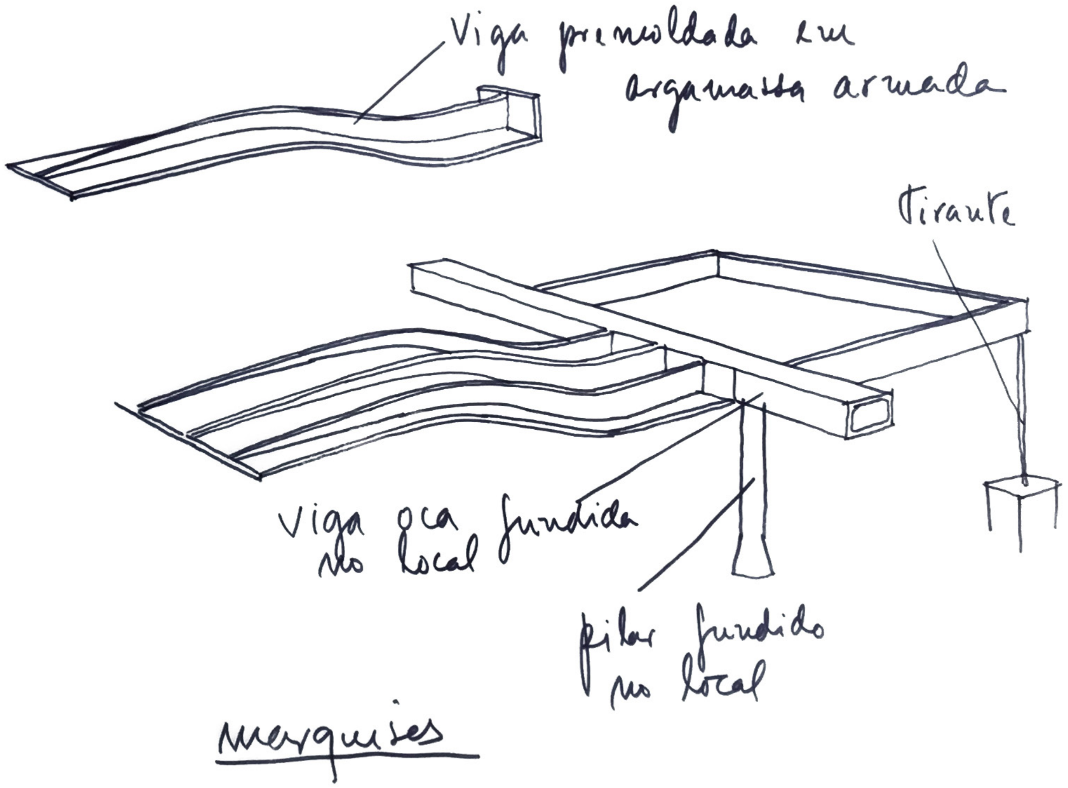


Fig. 2.118 Entrance marquee of the Ceilândia City Hospital in *argamassa armada*. Lelé, Ceilândia, Distrito Federal, 1987 (unexecuted). The project would be carried out as a collaboration between the Federal District Government in Brasília, Promon building company and the FAEC factory, in Salvador. Arquivo João Filgueiras Lima, Salvador

However, if we take the first metallic marquee produced for the Sarah in Salvador, we realize not only that the Ceilândia hospital marquee shaped the steel version in Bahia – with its reproduced profile – but also that the architect simplified the element using a similar structural concept to reach the desirable equilibrium. Put differently, the technological change – from *argamassa armada* to a steel structure – made possible the execution of the element's delicate

205 João Filgueiras Lima. Drawing board of the Ceilândia City Hospital project, 1987. Unnumbered. Governo do Distrito Federal, Secretaria de Saúde, Promon Engenharia S/A. Preliminary Design, Faec Salvador. Arquivo João Filgueiras Lima. [Marquises: São constituídas de peças com 31cm de largura e altura variável engastadas em vigas de torção ocadas fundidadas no local e que por sua vez se apoiam em placas de neoprene sobre os pilares de concreto em tronco de cone também fundidos no local. O sistema é equilibrado pelos prolongamentos posteriores em concreto armado ancorados em tirantes de aço] (my translation).

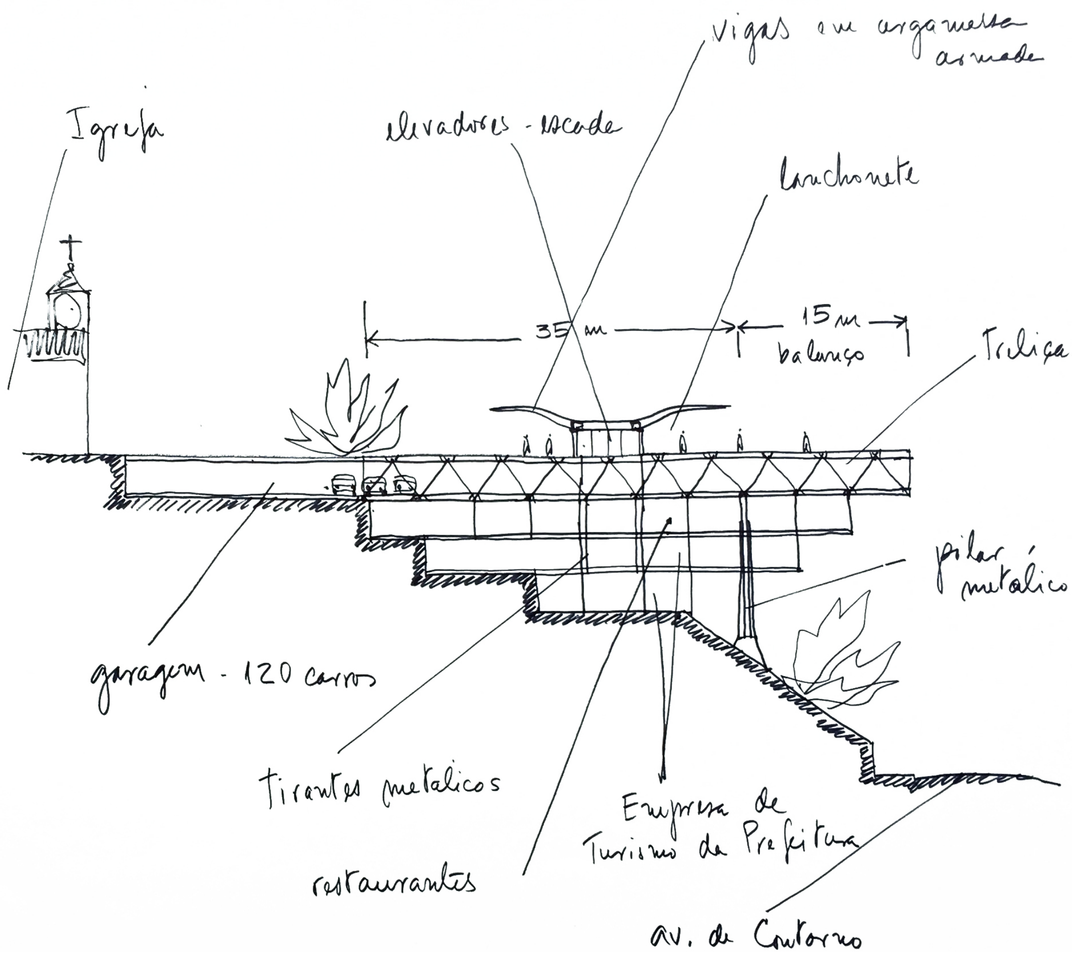
Fig. 2.119 Entrance marquee of the Sarah Hospital in Salvador, Bahia. The curvature of the element allows the shuttle bus (designed by Lelé's team) to get closer to the entrance, therefore making it easier for the patient to board. Arquivo JFL, Salvador

design in a lighter way and with less material consumption. This is evidenced in the reduced section of the steel columns that support the metallic marquee at the hospital entrance in Salvador.

It was exactly this strong visual appeal (modern design, lightness and prominence) that impelled Lelé to assign the marquees an important role in his most recent architecture. In fact, the marquee's employment as a key element in the composition had already been tested during the FAEC works (1986-88), for instance as part of the urban intervention at *Largo dos Aflitos* (Largo of the Afflicted), in Salvador. The unexecuted project designed in 1988 to house the headquarters of the local tourism office basically proposed the continuation of the Aflitos Church square towards the hillside. The inverted staggered building would keep the roof level as an extension of the old square, placing the double marquee (cafeteria) – designed in *argamassa armada* – in focal evidence.

Like a big platform that advanced in the direction of the slope, the four-storied building was in fact Lelé's second attempt to build a belvedere overlooking *Todos os Santos* Bay. The unsuccessful enterprise of Mario Kertész in erecting the Sé Belvedere in 1979 as part of the RENURB project for the historic center of Salvador had already proposed large overhangs (in concrete) topped by an imposing marquee. Located between two colonial buildings, the idea was to install the Bahiatursa offices underneath the terrace. There could not have been a more appropriate setting for the state tourist office, close to one of the most visited areas of the city, the *Pelourinho*.

Fig. 2.120 Lelé's proposition for the *Largo dos Aflitos* square in Salvador, 1988. Above: Scale model showing the inverted staggered structure built into the hill, with a marquee at the center. Below: Longitudinal section. Arquivo João F. Lima, Salvador



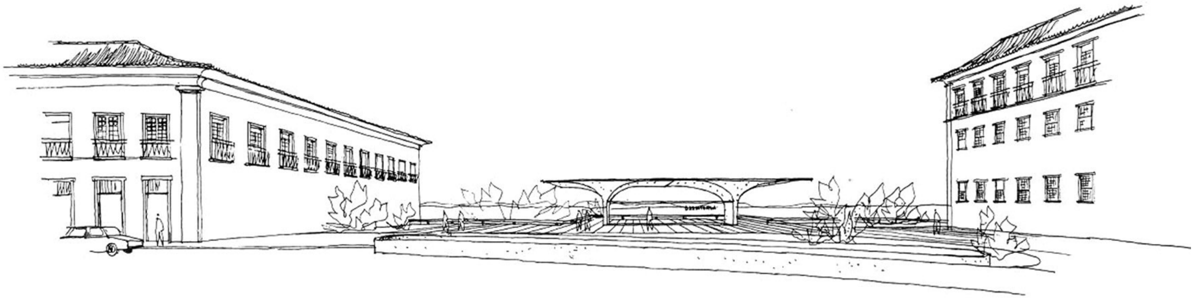


Fig. 2.121 Sé Belvedere and its marquee access element, historic center of Salvador (*Pelourinho*). In order to prevent blocking the view of the *Todos os Santos* Bay, Lelé placed the building on a semi-buried floor. João Filgueiras Lima, Salvador, RENURB, 1979. Giancarlo Latorraca, ed. Marcelo Ferraz, *João Filgueiras Lima, Lelé* (São Paulo: Instituto Lina Bo e P.M. Bardi; Lisboa: Editoral Blau, 2000), p. 110.

Fig. 2.122 Sé Belvedere scale model (1979) showing Lelé's effort to design a building integrated into the steep topography between the *Cidade Alta* (Upper City) and the *Cidade Baixa* (Lower City) of Salvador. Giancarlo Latorraca, ed. Marcelo Ferraz, *João Filgueiras Lima, Lelé* (São Paulo: Instituto Lina Bo e P.M. Bardi; Lisboa: Editoral Blau, 2000), p. 110

However, the project's failure[206] and the architect's unrealized desire to erect a multi-story building on the edge of the scarp that limits the upper and lower city of Salvador yielded an obvious change in the marquee theme in Lelé. The imposing element acting as a monument surrounded by a generous urban space – as in the case of the Disbrave gas station (Brasília, 1975) – gave place to a more modest and immediate approach. From the arrival of the metal structures in his work, Lelé started to adopt and produce marquees as simple permanent shelters over the entrance to his buildings.

Fig. 2.123 Disbrave gas station under construction. The imposing marquee is part of the building complex expansion project designed by Lelé in 1975, in Brasília. Arquivo João Filgueiras Lima

Thus, as long as marquees were disseminated and popularized throughout Lelé's architecture, their symbolic value increased depending on the way they were bestowed in the composition. As a rule that applied almost without exception, marquees started to adopt a highlighted position among the building complexes, either through the use of colors – generally red – or by assuming different shapes. This became more evident during the expansion of the Sarah Chain of rehabilitation hospitals, from 1991 to 2009. During this phase, Lelé adopted a

206 Despite the failure of the project at the hands of Lelé, Lina Bo Bardi came to implement her proposal for the Sé Belvedere during the second tenure of Mário Kertész as Mayor of Salvador (1986-88). Bo Bardi's proposition (1986) consisted of a group of concrete tables with yellow ombrellones, a small bar in the corner and a stage for public presentations. See: Ferraz, *Lina Bo Bardi*, 274–275. Today, the place is occupied by a sculpture of doubtful taste entiltled "Cruz Caída" (The Fallen Cross). Created by the local artist Mário Cravo (1923) in 1999, the object is a reference to the old "Catedral da Sé", demolished in 1933.

chromatic pattern for his buildings, based on the extensive use of white for the main edifications and primary colors (red, yellow and blue) for elements such as marquees, water reservoirs, vertical circulation towers, hood exhaust fans, and sheds.

Fig. 2.124 Entrance marquee of the Sarah Hospital in Belo Horizonte, Minas Gerais (1993). Access to the ambulatory. Giancarlo Latorraca, ed. Marcelo Ferraz, *João Filgueiras Lima, Lelé* (São Paulo: Instituto Lina Bo e P.M. Bardi; Lisboa: Editoral Blau, 2000), p. 211

It is important to note here that around that time, Niemeyer had already ventured out to explore his own shape and color conception of the marquee, which probably had an impact on Lelé's further designs. As we can see, Niemeyer's extensive use of red on marquees was followed by a tendency to shape the element with sculptural forms, transforming this everyday domestic object into a piece of artwork. Examples of Niemeyer's attitude to marquees (regardless of material) can be found at the Apoteose Square (1983) in Rio de Janeiro, the Araras Theatre (1991), and the Ibirapuera Auditorium (2005), in São Paulo.

The marquee in Lelé lost its character of uniqueness. This means it had a non-exclusive design and did not belong to a specific building. On the contrary, these elements were integral parts of the architect's constructive vocabulary, and in this way, they were applied to manifold projects. Apart from special circumstances – such as the *São José de Ribamar* Chapel in Maranhão (1997), where the context justified the elaboration of a new structural solution – Lelé operated at a more restrained pace, which disencouraged the 'element of surprise', a condition historically associated with Brazilian modern architecture. The common characteristics Lelé applied to his marquees extrapolated professional contours, being assumed as a theme for his life in general.

Fig. 2.125 Oscar Niemeyer's marquees. From top to bottom: Ibirapuera Park's Auditorium in São Paulo (2005). G. Laganà and M. Lontra. *Niemeyer 100* (Milano: Mondadori Electa, 2008), p. 140 | Araras Theater (1991). Jean Petit. *Niemeyer: poète d'architecture* (Lugano: Fidia edizioni d'arte, 1995), p. 165 | Apoteose square, *Sambódromo*, Rio de Janeiro (1983). Jean Petit. *Niemeyer: poète d'architecture* (Lugano: Fidia edizioni d'arte, 1995), p. 331

By taking sheds and marquees as key elements for understanding the technological change within the architect's work, I have attempted to demonstrate how the effort to decrease or soften enforcement barriers at the component level contributed to Lelé's architectural development, making the achievement of suitable shapes easier. But if on the one hand the adoption of steel (from CTRS onwards) had appeared to offer a definite solution, on the other hand, further problems inherent to metallurgy – like folding procedures and oxidation, for instance – reminded the architect that building is a constant challenge. More than ever, a wide range of new operations (cutting, folding, welding, electrostatic painting, etc.) required greater accuracy, speed, and flexibility to manage all the building parts.

Fig. 2.126 São José de Ribamar Chapel (1997). Both marquee and bell tower were produced in Salvador and delivered disassembled to São Luís region (1573 km from Salvador) in the north-east of Brazil. Arquivo João Filgueiras Lima, Salvador

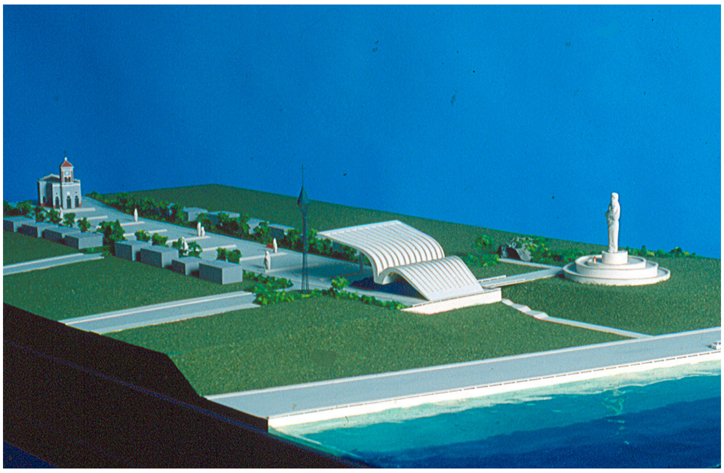


Fig. 2.127 São José de Ribamar Chapel (1997). Scale model showing the urban scale of the new monument, which faces a pre-existing church. Arquivo João Filgueiras Lima, Salvador

Unlike Lelé's previous works, which featured a prearranged infrastructure to produce his components in *argamassa armada*, this new phase of his career relied on third parties to supply components. For the first time, the architect faced the possibility of building an important public work – a 16,000 m^2 hospital complex in Salvador – without having complete control of its entire development process and product roadmap, as Haroldo Pinheiro, head of the architect's team for the Sarah in Salvador at that time, recalls:

> There was no factory for producing the parts of the hospital [of Salvador]. Then a team was set up to manage the construction. We had to carry out public biddings for structure, stainless steel, roofing, air conditioning... A lot of tasks had to be subcontracted. We did not hire a specific building company to conduct the works. With the organization of Lelé, we were able to complete the hospital in 1 year and 2 months.[207]

207 Haroldo Pinheiro. Interview with Adalberto Vilela on May 3, 2016 in Brasília. [Não existia uma fábrica para produzirmos as peças do hospital [de Salvador]. Então foi montada uma equipe para gerenciar a construção. Nós tínhamos que fazer licitações para estrutura, aço inoxidável, cobertura, ar condicionado…. Muita coisa sob empreitada. Não contratamos uma construtora específica para fazer [a obra]. Com a organização do Lelé, conseguimos concluir a obra em 1 ano e 2 meses] (my translation).

In a way, this unusual situation seemed to have contributed to the subsequent development of the building system based on steel structures within Lelé's work, to the extent that it warranted further decisions, like the implementation of a real factory (the Technology Center of the Sarah Chain, CTRS). From that moment on, the imminent challenge would focus on the creation of multiple workshops to assume the global production for the upcoming units of the Sarah hospitals in the country.

This thesis will next move on to Lelé's industrial facilities. What has been presented until now is part of the architect's long trajectory in dealing with different materials – namely concrete, brick, *argamassa armada* and steel – and building techniques. The next section will be focused on Lelé's production processes, which brings us onto the discussion of other topics, rather related to efficiency, productivity, viability, and so forth. This does not mean that materials will no longer play an important role in the narrative. On the contrary, any manufacturing activity is intrinsically connected to the output materials.

The case of steel has been highlighted here, and the emergence of the material in Lelé's career has given rise to a new interpretation. It has been seen as more than a natural consequence of the experimental use of steel observed in previous buildings – such as the RENURB Offices in Salvador (1979), the *Portuguesa* Association in Taguatinga (1984) and the Salvador City Hall (1986). Ultimately, the technological change in Lelé was directly affected, I have argued, by the need for improvements in the components. In this sense, sheds and marquees were not only impactful enough to trigger the industrial production of metallic parts in his architecture, but they also showed the architect's predisposition for other ways of making.

(Building in) "Brazil is not for beginners"

This phrase uttered by the Brazilian composer Tom Jobim[208] still pertains to this day. The complex task of building in a country where the construction industry seemed to be reluctant to adopt prefabrication made things even harder for those who, like Lelé, became involved with the technique in the first place. The fact is that architects who decided to invest in rationalized construction in Brazil at that time – such as Paulo Mendes da Rocha, Oscar Niemeyer, Abrahão Sanovicks, Eduardo de Almeida and João Honório de Mello – had to make the most of the resources available to achieve their goals. Most of the time, they ended up not producing the expected results – in terms of building industrialization – but reaching a feasible standardization of constructive elements.

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208 Antônio Carlos Brasileiro de Almeida Jobim (1927-1994), or simply Tom Jobim, was a Brazilian composer and singer responsible for the creation of the Bossa Nova music style during the 1950-60s in Brazil. Jobim was the author of the famous *Garota de Ipanema* song (Girl of Ipanema), originally recorded in 1962, and incredibly popular in both Brazil and abroad.

In view of this, how can we explain some of the fruitful experiences in the country among the foregoing disarticulated market? The answer is intricate, and ever since, the question remains open. But before trying to respond this question, it is worth asking why prefabrication, as a building technique, decreased in Brazil from 1960 to 1980, at a favorable moment when the National Housing Bank (*Banco Nacional da Habitação*, BNH) was financing both middle-class apartments and social housing projects?[209] What was the meaning behind making precast architecture at these two different moments? In an attempt to provide a wider account of the issue, I would highlight two distinct aspects: the first is related to the country's recent history and the second is relative to its cultural background.

Lelé soon understood that pursuing an independent path from the group of architects exploiting business opportunities within the framework of the BNH was the best choice that could be made. For two reasons: he could be free to invest in his individual constructive research (at that time using precast reinforced concrete in hospital architecture), without necessarily focusing on finding a solution to the housing problem. Secondly, the fact that the Bank appeared under the aegis of the military regime (1964-85), might have prompted the architect to keep a certain distance from the institution, considering that from 1964 to 1968 he came to be persecuted[210] by the dictatorship due to his political orientation and proximity with Niemeyer, a self-declared communist.

Furthermore, the political opening in Brazil in 1985 did not mark an advance in terms of old cultural habits. The republican notion of public and private, often merged in Brazilian culture since colonial times, remained as solid as ever. This is particularly relevant for Lelé, who saw a major transformation in his career when he decided to move from the private to the public sector in 1980. In his endeavor to determine the new course of action, the architect soon came up against the hard knocks of reality: the discontinuity of the public policies of local (and federal) governments as a result of political disputes, which were beneficial to specific politicians or individuals.

The advances Lelé promoted at the level of component design, together with the constant refinement of building systems, contrasted strikingly with the successive closures of his factories throughout the 1980s in Brazil. However, within a context of instability, Lelé learned to work on a short-term basis, optimizing his solutions – from planning to carrying out the transportation of components – to suit the Brazilian political mandate (4 years, from 1988 onwards). Something that may buttress the immediate applicability of building solutions, but which has a negative impact on the progression of long-term experiments with multiple systems and materials.

209 See, Koury, "Arquitetura construtiva: proposições para a produção material da arquitetura contemporânea no Brasil," 227.

210 This situation changed from the 1970s onwards. Lelé had no problems designing and building in Brazil during the period between 1968 and 1985, when democracy was restored to the country.

In this sense, and to conclude, it is comprehensible that practically every detail designed for the *argamassa armada* system of Abadiânia was reapplied during the School Factory project in Rio de Janeiro, without major amendments or a technical review. There was simply not enough time for this level of performance evaluation, in the face of the ongoing administration of the then Governor Leonel Brizola and his Secretary of Culture Darcy Ribeiro. Fortunately, the same cannot be said for the directive in Salvador with Mario Kertész, where he could elaborate a proper system update.

In the face of so many variables and difficulties to implement a continuous cycle in the field of prefabrication in Brazil, Lelé succeeded in establishing a path where interruption and reformulation were two sides of the same coin. Separate yet interconnected, both factors bolstered improvements to systems and components. Without the interludes between one factory and another, Lelé would not have been able to propose minor – although relevant – enhancements to his elements against a background of major shortcomings. From one experience to the next, the architect promoted a critical scrutiny of his work, identifying not only failures at the component level, but also projecting new methods of manufacturing. In a way, this is a good indication that production is an inextricable part of Lelé's designing process.

Part III

Towards a building production process: Lelé's factories in Brazil

Fig. 3.1 Workers assembling the air conditioning duct on the roof of the Salvador City Hall (João Filgueiras Lima, Mariano Casañas, Roberto Vitorino, José Fernando Minho, and Emilia Emiko, 1986). Located in the city's historic center, the metallic structure was assembled in only 12 days. Fundação Gregório de Mattos, Salvador

"Art is not only talent, but above all courage."

Glauber Rocha

8. Industrialized production at the outset: a critical review

When Paulo Bruna[1] suggested in 1976 that industrialized construction in Brazil should adopt the development model based on the equation "industrialization = rationalization + mechanization,"[2] he could never have imagined that his main protagonist would overturn this logic. The formula proposed in the second postwar period in Europe by the French engineer Gérard Blachère[3] does not apply to Lelé and his work. Over thirty years (1979-2009) of intense manufacturing activity in Brazil – which started with the RENURB factory and ended up with the Technology Center of the Sarah Chain (*Centro de Tecnologia da Rede Sarah,* CTRS), both in Salvador – it seems that Lelé inverted some of the fundamental principles of industrial procedure he might have been expected to follow. His implementation of multiple production lines (rather than their efficient reduction) and minimal automation, in an environment of unskilled labor, outlined a scenario which was apparently doomed to imminent failure. And yet, in retrospect, his state-owned factory operations belied the most pessimistic forecasts.

Lelé and his team faced many obstacles during this period in which the industrialization of building processes in Brazil was precluded from responding effectively to local needs (with a wider field of application than traditional construction techniques). The question here is this: under what conditions did the architect overcome these obstacles? Lelé was well aware of the limitations surrounding the possibilities of transforming society through technology. Thus, his compromises and convictions were centered upon exploring new ways to produce the technical object; ways that might prove less expensive and more efficient, given the community-oriented use of the structures concerned.

The manner in which Lelé accomplished this task involved maintaining close ties with the public sector throughout his career, which put him in a singular position when compared with other industrialists in both Brazil and abroad. Nevertheless, this does not mean that the architect did not attempt to bring his concepts of building rationalization to bear on private

1 Paulo Júlio Valentino Bruna is a Brazilian architect whose main fields of study are concentrated around themes such as building prefabrication, industry, history of architecture (Brazil and Latin America), and housing projects. Bruna concluded his PhD in 1973 (University of São Paulo), and published it later in 1976 under the title: "*Arquitetura, industrialização e desenvolvimento*" (Architecture, industrialization and development). In 2010, he published "*Os primeiros arquitetos modernos: habitação social no Brasil 1930-1950*" (The first modern architects: social housing in Brazil 1930-1950).

2 Paulo Bruna, *Arquitetura, industrialização e desenvolvimento* (São Paulo: Editora Perspectiva, 1976), 100. [industrialização= racionalização + mecanização] (my translation).

3 Gérard Blachère (1914-2011) was a French general engineer of roads and bridges (*Ingénieur général des ponts et chaussées,* or civil engineer). He directed the works at the Ministry of Reconstruction and Housing (1957-74) in France after the Second World War and taught (*tecniques industrielles de l'architecture*) at the traditional *Conservatoire national des arts et métiers* (National Conservatory of Arts and Crafts, CNAM).

companies. In the 1960s Lelé came to work for construction firms that aspired to implement industrialization in Brasília. But, as he summed up years later: "the building sector never accepted my proposal."[4] This might have propelled the architect to move from on-site prefabrication to factories (off-site prefabrication) in the hope of filling productivity gaps.

In this sense, the notions of economy and productivity take center stage in the current discussion, and from these a central question arises: how did Lelé come up with a technically sophisticated product resulting from unskilled labor, limited mechanization, and a wide range of variations in the production line? Maybe the answer to this question is related to the architect's own perception of industrialized production. Industrialization for Lelé was a type of production that waived the obligation to employ increasingly mechanized processes. He believed that economy and efficiency could also be achieved by adding hand-operated actions to the fabrication process.

By systematically adapting the *modus operandi* of his factories, Lelé worked on a radical and simple principle: "to change whatever was changeable and to replace what could not be changed."[5] With this method the architect assured a permanent assessment of the deficiencies associated with the ongoing industrial processes. In the end, what renders his architecture sophisticated are the production methods employed for each of the elements involved in his building systems. It now remains to determine the importance of industrial remodeling in the development of Lelé's manufactured architecture.

8.1 Internationalization and the creation of the first factory

Between the early 1960s in Brasília and the end of 1970s in Salvador, prefabrication for Lelé had a precise image: heavy components made of reinforced concrete precast in the building site. As we saw in Part I, Lelé's prefabricated techniques during that period could not overextend the limits of the building site, for various reasons. The professional deadlock observed between the architect and his interlocutors, namely the engineers and the building companies, led to the establishment of on-site prefabrication, starting from the works at the university. Furthermore, Brasília, with its immense free areas and appropriate weather conditions, favored precast construction *in situ*.

Some characteristics of this phase – such as projects incorporating a small number of components and the recurrent use of ground formwork – would have a direct impact on Lelé's first factory (the RENURB Factory in Salvador, 1979-81); and this will be understood here as the moment when the transition from heavy to light prefabrication took place. The challenge

4 João Filgueiras Lima, "João Filgueiras Lima, Lelé [Entrevista a Adriano Carneiro de Mendonça]," in *ENTRE, Entrevistas com Arquitetos por Estudantes de Arquitetura* (Rio de Janeiro: Viana e Mosley, 2012), 125.
5 Ibid.

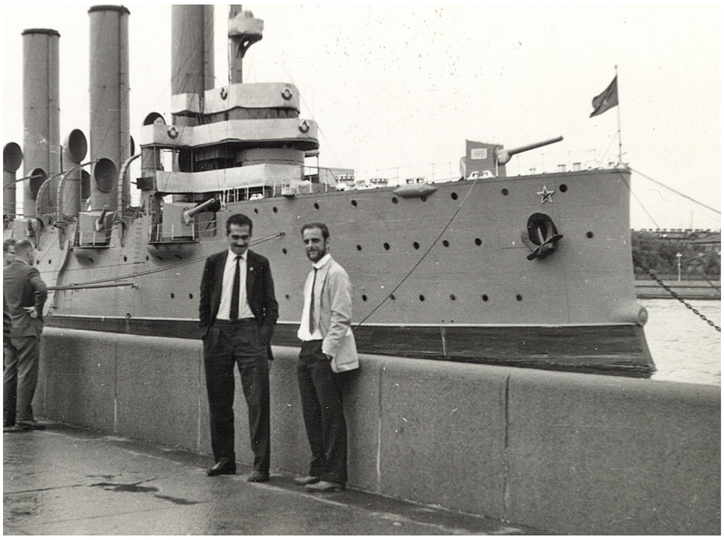


Fig. 3.2 Lelé (left) together with the architect Sabino Barroso in front of the Potemkin Ship in Leningrad, 1963. Arquivo João F. Lima, Salvador

of producing large-scale and low-cost precast elements in a factory, for the first time, required more than a simple adaptation of the techniques employed at the building sites. It was necessary to pave a new way to create the necessary manufacturing conditions outside the construction zones. The references Lelé had in mind were the plants he visited in Brasília (the Rabello Factory, 1967), Prague, and Leningrad, during his trip to Eastern Europe in 1963.

Not satisfied with the outcome of panelized architecture witnessed in Brazil – which he considered "mere importation of European know-how"[6] – the architect envisioned a new way of producing his components, hitherto associated with the convenience and economy of on-site prefabrication. Despite the main disadvantages of moving to a precast plant – namely, the significant loss of time and added expense due to the need to transport components from the factory to the building site (horizontal transportation) – Lelé was convinced about the role of RENURB as an instrument to forge unity in the city landscape.[7]

It was no coincidence that concrete was the material selected to convey the urban unity of Salvador, used massively throughout Kertész's first administration (1979-81) and expressed in works like the new urban furniture conception or the transportation system modifications. The material would assume a clear and harmonious identity within the existing built environment, seen as a contemporary reading of the stonework construction of the colonial past. There is no doubt that the political intention was to put into practice the government's primary goal: to increase the city's main essential services, such as cleaning, maintenance and transportation to "modern urban levels."[8]

The embrace of modernity through the wide use of concrete as a political ideal had been received with great enthusiasm in the second half of the twentieth century in many countries, in a discourse that surpassed the economic factor, as Adrian Forty observes: "the stupendous investment that took place in the sixth and seventh decades of the twentieth century in concrete panel systems was about more than just economic efficiency. It had another purpose too, as a

6 João Filgueiras Lima in: Edgar Graeff et al., *Arquitetura Brasileira Após Brasília. Depoimentos* (Rio de Janeiro: IAB/RJ, 1978), 243. [importação pura e simples de know-how europeu] (my translation).

7 The desire for visual unity in Salvador – to be obtained through the RENURB projects - was expressed by Mário Kertész in his message sent to the City Council in March 1981 [Mensagem enviada à Câmara Municipal pelo Prefeito Mário Kertész – Março/81]. See: Michel Hoog Chaui Vale, "João Filgueiras Lima (Lelé): Arquitetura pública e urbanismo em Salvador (1979-81 e 1986-88)" (Universidade de São Paulo, 2016), 129.

8 See, Ibid., 124.

device to suppress the disorderly and unmodern features of concrete, and to make it into a convincingly "modern" substance."[9]

From the northern to the southern hemisphere, large-panel buildings reached a considerable level of development during the period (inaugurated by the Camus system in France, in 1948, and readapted worldwide). However, its application in Latin America was not emphasized as an effort of postwar reconstruction. Instead, it took on a peculiar character that merged natural disasters and political convenience. In the name of a highly publicized campaign to overcome the devastating effects of cyclones, floods and earthquakes in the region (1963-71), Nikita Khrushchev (and his successor Leonid Brezhnev) took the chance to enhance the political, cultural, and economic ties between Moscow and the governments of Fidel Castro and Salvador Allende.

In this sense, the Soviet Union's donation of factories to Cuba (1965)[10] and Chile (1972)[11] for the prefabrication of concrete panels to fulfill their social housing programs cannot be seen as anything other than an attempt on the part of the Soviet regime to demonstrate its influence in the region during the Cold War period. But curiously, the Chilean government's affinity for large-panel buildings started some years before the implementation of their KPD factory[12] in the small city of Quilpué, in 1972.

On September 6, 1968 the then President Eduardo Frei Montalva (1964-70) visited the largest precast concrete plant of Brasília (the Rabello Factory), proving that technological exchange regarding large panel construction initially began as a South American connection rather than a Soviet transfer. At that time, the building company Rabello S/A was in the process of erecting a large housing complex in the city outskirts, named *Conjunto Residencial da Codebrás* (Codebrás housing complex).[13] With more than 70 buildings, the complex integrated Lucio Costa's plan for the new sector of Brasília: the SHCES (*Setor de Habitações Coletivas*

9 Adrian Forty, "The Writing on the Wall," in *Monolith Controversies* (Ostfildern: Hatje Cantz, 2014), 98. According to Forty, the attempt to classify concrete as either a modern or non-modern material is not particularly appropriate. See: Adrian Forty, *Concrete and Culture: A Material History* (London: Reaktion Books, 2012), 41.

10 In 1963, the hurricane Flora swept across Cuba, devastating the Province of *Oriente* and thousands of residences. The URSS donated a factory to Cuba capable of producing 1,700 totally equipped houses annually with high technology. Installed in Santiago de Cuba, the factory started to operate in 1965. In: Roberto Segre, *Arquitetura e Urbanismo da Revolução Cubana* (São Paulo: Nobel, 1987), 89.

11 On July 8, 1971 a major earthquake struck central-northern Chile, causing death and destruction in the provinces of Coquimbo, Aconcagua, Valparaíso and Santiago. Lasting three minutes, the violent earthquake killed 85 and injured 451 people in Central Chile. In an area of 72,324 kilometers, more than 300,000 houses were damaged, affecting an estimated 2,348,522 people. In: Office of the Foreign Disaster Relief Coordinator, *Case Report Chile-Earthquake July 8, 1971* (Washington, D.C., 1971), 2.

12 The Chilean system known as KPD (КПД) – an abbreviation for what in Russian means "large panel construction" (*krupnopanelnoye domostroyenie*) – was an adaptation of the French Camus System. Known in the Soviet Union as "I-464", the system went to South America retaining a number of improvements to the French model, including the introduction of a linear cast concrete production process. See: Pedro Ignacio Alonso and Hugo Palmarola, Panel (London: Architectural Association, 2014), 184.

13 According to the architect Luiz Henrique Pessina, the Rabello factory was installed in the Industrial Sector of Brasília (SIA) in 1967. The main goal was to support the production of the large number of prefabricated concrete panels necessary to the construction of the Codebrás housing complex in the new capital. The architect and former professor at the University of Brasília supervised the works at Codebrás from July 1967 to February 1969. In Luiz Henrique Pessina. Telephone interview with Adalberto Vilela on September 16, 2016.

Econômicas Sul) or Southern Affordable Collective Housing Sector.

However, it seemed that the viability of an international cooperation in the field between the two countries was related to a different political orientation. The military regime in Brazil, which had been supported by the United States since the coup d'état in 1964, shared with the right-wing Chilean President an interest in developing industrially manufactured buildings, especially to cover the housing deficit and face the population growth.[14]

The point here is that Lelé – who had worked with Rabello during the construction of the university (1962-65) and was hired by the company the very same year as President Frei's visit (1968) to develop the Army Headquarters (*Quartel General do Exército*) designed by Niemeyer in Brasília – could have taken this opportunity to join the official visit to the factory and show his interest in the theme, learn from the technical delegation and support the possible cooperation. But this was not the case.

Distrito Federal

Orgão Oficial do Poder Executivo do Distrito Federal. Decreto N.o 655 de 13 de setembro de 1967.

Brasília. 10 de setembro de 1968 — Ano I N.o 143

FREI CUMPRIMENTA BRASÍLIA

Brasília recebeu o Presidente do Chile, Eduardo Frei. Não são, pois, as fronteiras geográficas as limitações para o entendimento em alto nível. O dinamíssimo Presidente Frei, com a descontração natural aos homens lúcidos, ultrapassou por várias vêzes os rigores do protocolo diplomático, sempre que o pode, para acompanhar o Presidente Costa e Silva.

Na foto, o Prefeito do Distrito Federal, Wadjô Gomide, quando recebia os cumprimentos do Presidente chileno.

PRESIDENTE DO CHILE VISITA MUTIRÃO

Durante trinta e cinco minutos, o Presidente Eduardo Frei, do Chile, visitou as obras do "mutirão" da NOVACAP, (foto) no Setor Residencial de Indústria e Abastecimento. O mandatário Chileno demonstrou ficar impressionado com os serviços, considerando-os uma das soluções para o problema habitacional "também grande em meu país".

Eram 10,15 horas, quando o Presidente Frei iniciou sua visita, passando, inicialmente, pelas obras da Cidade Industrial que a SHIS está erguendo, em convênio com o Banco Nacional de Habitação. Nas proximidades das obras do "mutirão", foi recebido pelo Superintendente da NOVACAP Rogério de Freitas, pelo Secretário de Govêrno, Domingos Malheiros que representava o Prefeito Wadjô Gomide e pelo Superintendente da SHIS, Sr. Sílvio Jaguaribe.

Após os cumprimentos, divisando um grupo de trabalhadores, o sr. Eduardo Frei demorou-se em conversa com os mesmos, indagando de seus Estados de origem, oportunidade em que afirmou: "é incrível! Parece que todo o Brasil se reuniu para construir Brasília". Dizendo-se, depois impressionado com o método dos serviços, visitou uma das unidades, em fase de acabamento, considerando-a ampla e bem feita. A seguir, ao dirigir-se à fábrica de pré-moldados, vendo um grupo de escolares com faixas de "Viva o Chile", O Presidente Eduardo Frei mandou parar o automóvel para conversar com êles e suas professôras. Eram 10,50 horas, quando o Presidente Chileno, findou sua visita, às obras da SHIS, BNH e do "mutirão".

HOMENAGENS

Crianças de Brasília caracterizadas como soldados das fôrças armadas chilenas, desfilaram saudando a espôsa do Presidente Eduardo Frei, durante sua visita ao Jardim de infância da Superquadra 308. A Primeira Dama do Chile se fêz acompanhar por várias autoridades daquele país, sendo recebida pela sra. Maria Helena Gomide, (foto) espôsa do Prefeito do Distrito Federal, sra. Ivan Luz, Profa. Ana Bernardes, Coordenadora de Educação Primário da PDF, e outras personalidades ligadas ao ensino primário da Capital Federal.

BONECAS

Visitando as dependências do Jardim de Infância da SQ. 308, a Sra. Maria Ruiz Frei mostrou-se entusiasmada com o ensino em Brasília e fêz questão de conhecer o interior da casa das bonecas existentes naquela unidade de educação pré-primária.

Ao deixar o Jardim de Infância, a Primeira Dama do Chile recebeu calorosas despedidas por parte dos alunos, professôres e autoridades presentes.

UNIVERSITÁRIO PODE IR A PARIS

Jornalistas da Capital tomaram conhecimento, em almôço na Caixa Econômica Federal de Brasília, oferecido pelo seu presidente, Thales José de Campos, do regulamento para concurso de reportagens sôbre o tema Fôrça Aérea Brasileira, com prêmio de viagem a Paris, destinado a jornalistas profissionais radicados em Brasília e a universitários, dentro do programa comemorativo da Semana da Asa, a ter lugar de 17 a 23 de outubro.

A Caixa Econômica de Brasília oferece duas passagens aéreas aos vencedores dos concursos de jornalistas e universitários, para Paris, com retôrno pelos Estados Unidos da América do Norte, enquanto outros prêmios serão concedidos para outros concursos em que tomarão parte estudantes do curso secundário, primeiro e segundo ciclos. Também estudantes do curso primário participarão das comemorações da Semana da Asa.

Ao almoço compareceram, além do presidente Thales Campos, que frisou a necessidade de a juventude homenagear o brasileiro Alberto Santos Dumont, o major Távora, do gabinete do Comandante da 6a. Zona Aérea, o Capitão Azambuja, da Comissão Organizadora Regional da Semana da Asa, Sr. Arnaldo Ramos, presidente do Sindicato dos Jornalistas Profissionais do DF e jornalistas.

FESTIVAL FOLCLÓRICO

Com inauguração de uma exposição de artesanato e um coquetel oferecido à Imprensa instalam-se no Teatro Nacional, o VI Festival Folclórico de Brasília, sob os auspícios do Departamento de Turismo e Recreação da Prefeitura do Distrito Federal. O festival prosseguiu com aula no auditório da Escola Parque, proferida pelo Professor Theo Brandão, de Alagoas.

Considerada a maior festa do folclore nacional, o festival de Brasília congrega os especialistas da matéria de todo o País, além de conjuntos típicos de quase todos os Estados, a caracterizar os costumes e tradições de suas regiões.

Fig. 3.3 President Frei visited a self-build cooperative (mutirão) in Brasília, where low-income houses were produced close to the capital's industrial sector. Arquivo TCDF. Available at : http://www.tc.df.gov.br/SINJ/Diario/ Accessed on September 19, 2017

Apart from a series of diplomatic commitments in the new capital, such as visiting the place where the future embassy of Chile would be erected,[15] President Frei did not apparently make any further effort to strengthen the links between Brazil and Chile concerning building industrialization. Back in Santiago, he lost the 1970 Chilean presidential election, in favor of the socialist candidate Salvador Allende, who established an effective partnership with

14 This situation was not restricted to Brazil or Chile. Latin America as a whole was suffering from the growth of precarious urban settlements of different forms. For the first time, for instance, in the mid-1960s, informal areas exceeded quantitatively planned areas in Lima, Peru. In order to overwhelm informal urbanization, the Peruvian government and the United Nations Development Program (UNDP) promoted the Previ International Competition in Lima between 1968 and 1975. In an effort to propose low-rise, high-density expandable houses, the most prominent architectural offices worldwide at the time integrated this historic initiative. For further information, see: Sharif S. Kahatt, "Previ-Lima's Time: Positioning Proyecto Experimental de Vivienda in Peru's Modern Project," *Architectural Design* 81, no. 3 (2011): 22–25; Juan Pablo Corvalán, Manuel de Rivero, and Francisco J. Quintana, "L.A. Collective: La Historia Paralela de Latinoamérica Como Laboratorio Reactivo de Occidente," *Summa+*, no. 120 (2012): 113–128; Fernando García-Huidobro, Diego Torres Torriti, and Nicolás Tugas, *¡El tiempo construye! Time builds! The Experimental Housing Project (PREVI), Lima: genesis and outcome* (Barcelona: Gustavo Gili, 2008).

15 See: Manuel Mendes, *O Cerrado de Casaca* (Brasília: Thesaurus, 1995), 209.

Chegada do presidente Eduardo Frei à Fábrica de Painéis modulados no dia 6 de setembro de 1968.

O presidente Eduardo Frei em companhia do Dr. Marco Paulo Rabello, após descerrar a placa comemorativa de sua visita.

Fig. 3.4 Above: Arrival of the Chilean President Eduardo Frei at the Rabello Panel Factory. Brasília, 1968. Below: Eduardo Frei with the engineer Marco Paulo Rabello (the Company's Chairman) after unveiling the commemorative plaque marking his visit. Catalog *Construtora Rabello S.A.* (Brasília: Rabello, 1969). Casa de Lucio Costa, Rio de Janeiro

Construtora Rabello S.A.

Vista aérea do conjunto residencial da Codebrás, no Setor Habitacional Coletivo Econômico Sul, em Brasília.

Fig. 3.5 Aerial view of the Codebrás housing complex in the newly built Southern Affordable Collective Housing Sector (*Setor de Habitações Coletivas Econômicas Sul*, SHCES) in Brasília, 1968. Catalog *Construtora Rabello S.A.* (Brasília: Rabello, 1969). Casa de Lucio Costa, Rio de Janeiro the Soviet Union to run a program of prefabricated housing blocks in the country (KPD). The program was later reconfigured under the neo-liberal politics of Augusto Pinochet's dictatorship (1973-1990) and was discontinued in the 1980s.

But what calls for our attention are the political, social and technical aspects that led Lelé to deviate from panelized architecture, which was then so in vogue across the world in countries like Chile, the Soviet Union, Brazil, Cuba, Germany, Yugoslavia, Denmark, Hungary, the United States, Switzerland, France, Japan, the Netherlands, Canada, Czechoslovakia, Sweden, Italy and the United Kingdom.[16] Nevertheless, his choice to move towards a prefabrication model based on the building's structural frame should not overshadow his former attempts in the realm of large-panel construction for housing in both Brazil (Rabello R9 apartment building, Brasília) and Lybia (Concic-Portuaria apartment building, Tripoli) in the early 1970s.

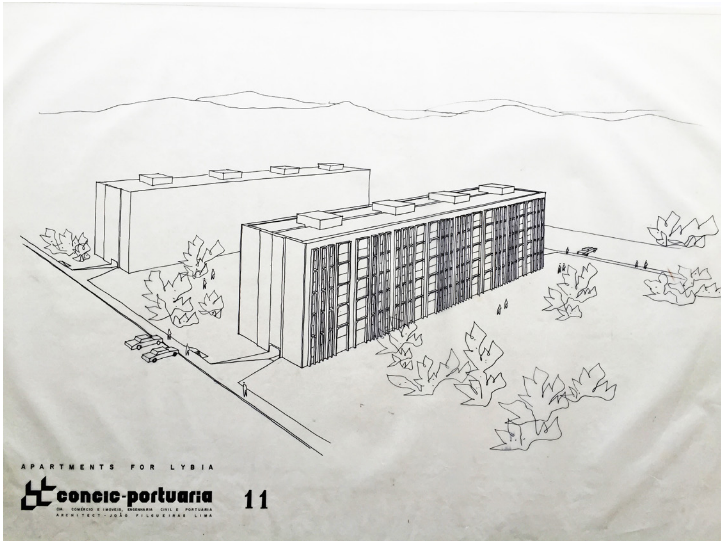


Fig. 3.6 Aerial view of the panelized housing block in Tripoli, Lybia. Design by Lelé, early 1970s. Arquivo João Filgueiras Lima, Salvador

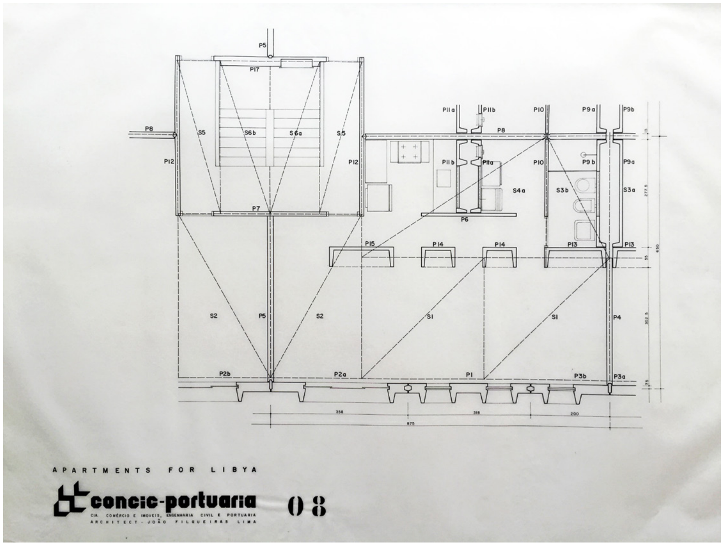


Fig. 3.7 Apartments for Lybia. Design by Lelé, early 1970s. Reinforced-concrete load-bearing panels of different sizes: large-panels for slabs and walls and narrow-panels for the façade element. Arquivo João Filgueiras Lima, Salvador

At that time not only was Lelé involved in heavy prefabrication but he was also studying reinforced concrete load-bearing panels of different sizes for housing solutions. Although Lelé's close relationship with important building companies (such as Rabello and Concic-Portuaria) has already been addressed in Part I, what interests us here is how the architect's involvement with large-panel buildings was dispelled as he carried out the manufactured production of his first components within a precast-concrete plant in Salvador.

The reason for this can be found in the way the housing issue was seen through the prism of basic sanitation. Understood at RENURB as "a concept that encompasses both public health and sanitary engineering,"[17] the works at the *Camurujipe* valley in Salvador forced Lelé to look

16 A comprehensive list of panel systems used in those countries (except for Hungary and Brazil), with the respective period and axonometric model, can be found in: Pedro Ignacio Alonso and Hugo Palmarola, *Monolith Controversies* (Ostfildern: Hatje Cantz, 2014), 182–335.

17 See: n.d., *Salvador: Saneamento Básico* (Salvador: Prefeitura Municipal do Salvador, 1981), 5. [um conceito que

for an alternative solution. In a context where the biggest challenge was to provide urgent and definitive measures for sanitation and circulation (and not reconstruction in response to natural disasters), smaller and lighter components were suitable wherever heavy machinery, such as cranes and trailers, had no access.

Moreover, although RENURB sprang up during the military regime in Brazil, its administration – under Lelés technical control and chaired by Alberto Gordilho Filho[18] – only thrived because of the ambivalent view of Mário Kertész's policy. Nominated Mayor of Salvador by Antônio Carlos Magalhães (a person close to the regime), Kertész made the most of his reputation as a young and innovative public manager to raise funds from sources such as the World Bank (IBRD) in the US, and local ones controlled by the military like the National Housing Bank (BNH), Ministry of Transports, the National Bank for Economic and Social Development (BNDES), and the federally controlled savings bank (CEF). At the same time, his special appreciation of the low-income communities in the outskirts of Salvador – typical of the socialist candidates – would earn him a leading role in the city's administration history.

The nature of building industrialization at both the KPD factory in Quilpué (1972-73), and the RENURB plant in Salvador (1979-81), prompts another relevant question for this chapter: if the political power associated to the precast components manufactured in Chile and Brazil can be portrayed as a symbol of social transformation, how did their production processes assign a technological value to labor? Furthermore, in the Brazilian case, to what extent does this assumption contribute to the analysis of RENURB and Lelé's subsequent factories?

First and foremost, the technological empowerment of the workforce in both Chile and Brazil took place on different levels. While the KPD factory functioned in a fully automated environment, at RENURB manual handling operations were carried out in conjunction with mechanized actions. However, technologically speaking, despite the fact that the Brazilian experience did not match Chile's, it is a big mistake to assume that the RENURB factory in Salvador operated under an experimental basis, without strict production guidelines.

Indeed, there followed a new repositioning of RENURB in the course of Lelé's manufacturing practice. What was before characterized by the limitations of an incipient infrastructure, gradually gave place to a production space that found its quality reference in solid planning. From an analysis of labor and production methods as inseparable parts of the local government's strategy to stimulate a precast building construction in Quilpué and Salvador, it may be worth comparing the experiences between paired countries.

In Chile, the importation of a "ready-to-use" system – with all its mechanisms and procedures predefined – was assimilated by local workers through the expertise of Soviet technicians in charge of their training. There was a clear orientation towards certain scientific

engloba simultaneamente saúde pública e engenharia sanitaria] (my translation).

18 According to RENURB's organization chart in: Vale, "João Filgueiras Lima (Lelé): Arquitetura Pública e Urbanismo em Salvador (1979-81 e 1986-88)," 295.

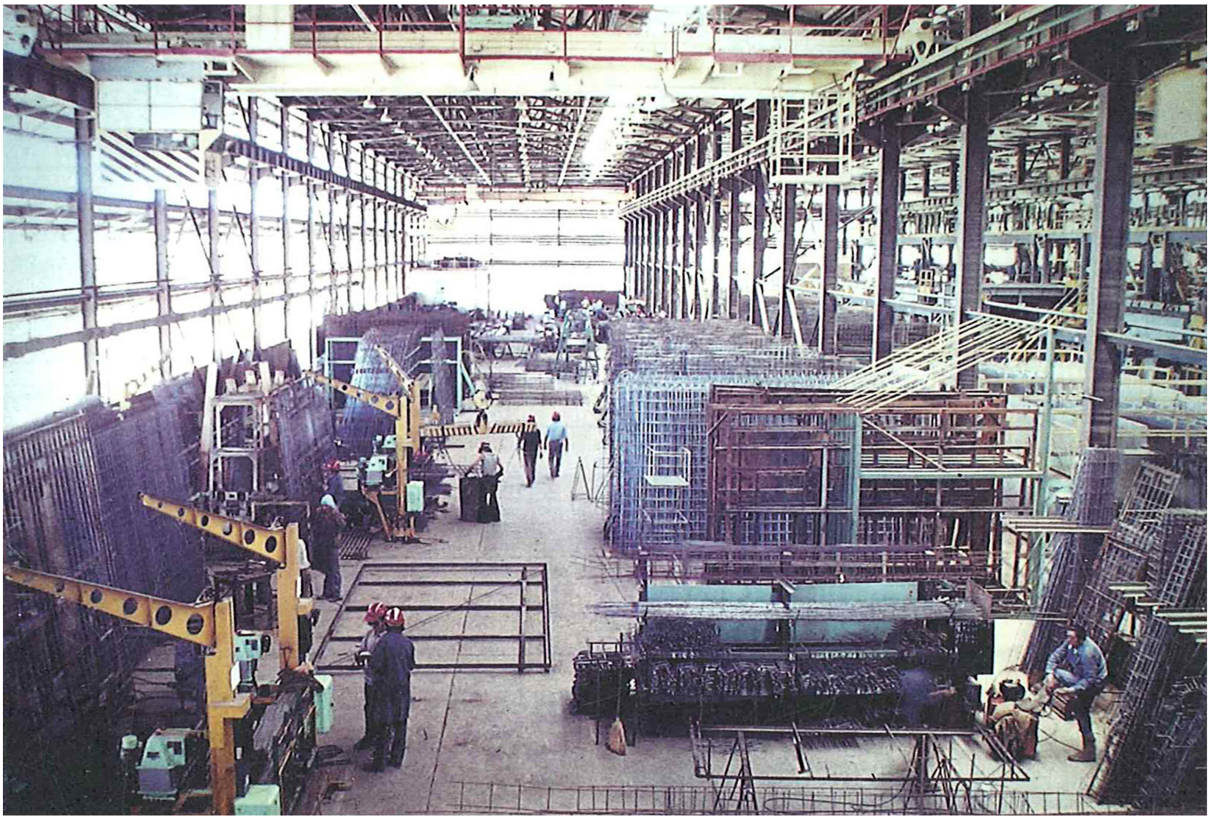


Fig. 3.8 View of the steel reinforcement storage area at the KPD factory in Quilpué, Chile. Picture from Ignacio Egaña Archive. Pedro Ignacio Alonso and Hugo Palmarola, "Panel" (Architectural Association, 2014), p. 202

Fig. 3.9 View of the RENURB's curing area in Salvador, Brazil. On one side of the gantry lies the sequence of *argamassa armada* channel units, on the other stand the concrete bus shelter columns. Arquivo Kristian Schiel, Brasília

management[19] principles, expressed by the excessive control of the workers' tasks and their competence assessment. At the KPD factory, women were encouraged by the Soviets to operate cranes, subversing a practice normally assigned only to men. María Elena Pivet, who became the crane operator's delegate to the KPD trade union, recalled that:

> "It was a really new experience… and it proved to us that despite the fact that before we were just working on domestic chores, we could now do things everybody thought were exclusive to men… I was truly fascinated by the job. We studied for six months at the National Institute for Vocational Education (INACAP) and then another three months at the plant itself. The Russians were quite demanding. They used to test us to see our capabilities, whether we got stressed or not … but unlike others, the crane never made me nervous."[20]

Although both experiences emerged as public initiatives, the level of management associated with specialized training for workers in Chile was not a reality in Brazil. Unlike the highly organized factories Lelé had previously visited – well equipped with concrete central mixing plants and several production lines operated in parallel – the RENURB factory in Salvador, including its layout and labor division, was the result of a collective effort to make the output of two production lines possible, one in reinforced concrete and another in *argamassa armada*.

Situated at the entrance of the city on the edge of the BR-324 highway, the RENURB factory relied on the pre-existing infrastructure of a public asphalt plant in Salvador.[21] With a floor area of 17,000 m^2, the public factory was divided into four main areas: wooden pavilions (administration, warehouse, etc.) covering 550 m^2, a production area (direct and indirect) of 3,150 m^2, a circulation area of 3,600 m^2, and 9,700 m^2 of storage space.[22]

Particular emphasis was placed on the so-called indirect production, comprising the woodwork and metalwork areas. If we consider that the factory's main activity was based on precasting concrete elements of different shapes and sizes, it is perfectly understandable that a pioneering metallurgy sector should have emerged at RENURB, constituting a "very important [step] for the subsequent achievements of reinforced mortar industrialization."[23] Due to the high cost of the metallic formwork, the component's first prototypes were generally

19 For a comprehensive picture of the common ground between scientific management and modernist architecture, see: Mauro F. Guillén, "Scientific Management's Lost Aesthetic: Architecture, Organization, and the Taylorized Beauty of the Mechanical," *Administrative Science Quarterly*, no. 42 (1997): 682–715.

20 María Elena Pivet. Interview with Hugo Palmarola on May 15, 2007 in Quilpué, Chile. In: Alonso and Palmarola, *Panel*, 211.

21 I am indebted to José Fernando Minho for this and many other relevant items of information. A public asphalt plant is a factory that produces asphalt on an industrial scale for the exclusive use of the municipality.

22 Renurb, *Estudos Complementares: Pesquisa Argamassa Armada [Relatório Finep]* (Salvador, 1981), 2. Arquivo Kristian Schiel, Brasília.

23 Giancarlo Latorraca, João Filgueiras Lima, Lelé, ed. Marcelo Carvalho Ferraz (Lisboa, São Paulo: Editorial Blau, Instituto Lina Bo e P.M. Bardi, 2000), 98.

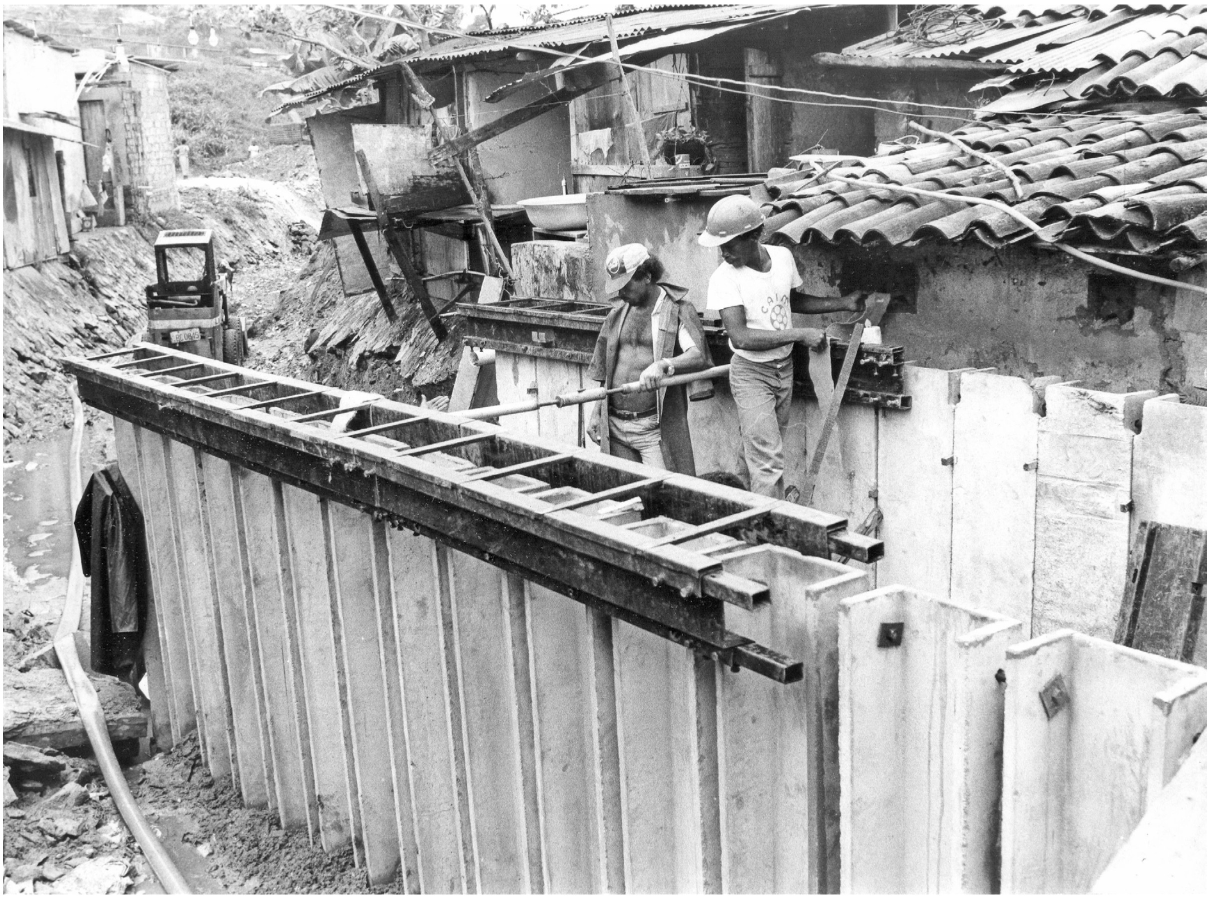


Fig. 3.10 View of the metallic formwork to cast the sanitation channel's top beam. RENURB, 1980. Bom Juá district, Salvador. Arquivo Kristian Schiel, Brasília

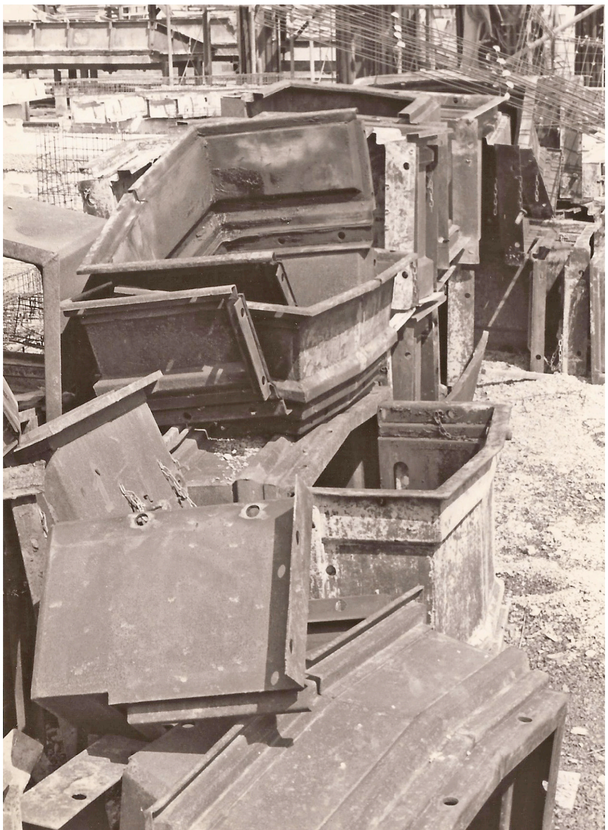


Fig. 3.11 View of the drainage stairways' mettalic molds (*módulo drenante*) at the production patio of RENURB. Salvador, 1981. Arquivo Kristian Schiel, Brasília

made of wood. After a detailed assessment of the molds and the freshly produced elements, the RENURB metal workshop was then in charge of the production of simple steel formwork (such as the cast-in-place top beam of the sanitation channels). Complex formwork, like the drainage stairways, used to be purchased from third-party companies, such as Baprel, Uni-Stein, São Jorge or Gravia.

When Reburb started to operate (1979) as a factory producing bus shelters in view of the TRANSCOL transportation program in Salvador,[24] Lelé's preoccupation with appropriate precasting techniques was organized to satisfy three main aspects: quality control of the elements (finish and endurance), method of production (from casting to storing), and transportation.

As we come to these operational aspects, it is important to evoke the methods which the factories employed. Concrete precasting factories can be divided into two main categories, according to their concreting process: intermittent or continuous casting with stationary molds, or moving molds with stationary concreting.[25] In both cases, the factory organization is arranged according to the production sectors and the equipment positioning, everything planned to foster the workflow. Within these two main categories, the production methods of precast concrete elements may present several variants, such as separate or battery molds for precasting the units; vertical or horizontal casting; water tanks, vapor tunnels (or chambers) or open-air curing, among others.

In view of this wide range of possible arrangements for precasting concrete industrially, it is important to highlight some specificities that characterized the RENURB manufacturing process. Unlike Rabello or the KPD factory – which operated with moving molds and a stationary concrete mixing plant – at RENURB the absence of a mixing plant forced Lelé to adopt a different strategy, and this mainly affected the concrete production and formwork.

The need to produce dense gravel concrete at the same time as lightweight mortar (*argamassa armada*) entailed the use of two distinct mixers. The architect then opted to separate the production lines according to the materials, even if a certain overlapping was observed in the open-air curing areas.

Primarily intended to produce the Salvador bus shelter elements, the reinforced concrete production line at Renurb was supplied by a single 750-liter concrete mixer, responsible for loading stationary molds displaced by a 6-ton sliding gantry with a height of 6.4 m and a 9 m span.[26] The *argamassa armada* production line, in turn, was fed by two mixers – one with a capacity of 350 liters and one with a capacity of 500 liters – responsible for loading a varied number of

24 The implementation of the Transcol transportation program in Salvador was addressed in the second part of this dissertation. For further information, see the section "Urban infrastructure: standpoints on transportation and sanitation."

25 In this work, all the factories were analyzed according to the concrete precasting plants classification proposed by the engineer Gyula Sebestyén in: Gyula Sebestyén, *Large Panel Buildings* (Budapest: Akadémiai Kiadó, 1965), 269–312. See also: Walter Meyer-Bohe, *Prefabricación: Manual de la Construcción con Piezas Prefabricadas* (Barcelona: Blume, 1967), 144–168; José A. Fernández Ordóñez, *Prefabricación: Teoría y Práctica. Tomo 2* (Barcelona: Editores Técnicos Asociados, 1974), 191–201.

26 Renurb, *Estudos Complementares: Pesquisa Argamassa Armada [Relatório Finep]* (Salvador, 1981), 3. Arquivo Kristian Schiel, Brasília.

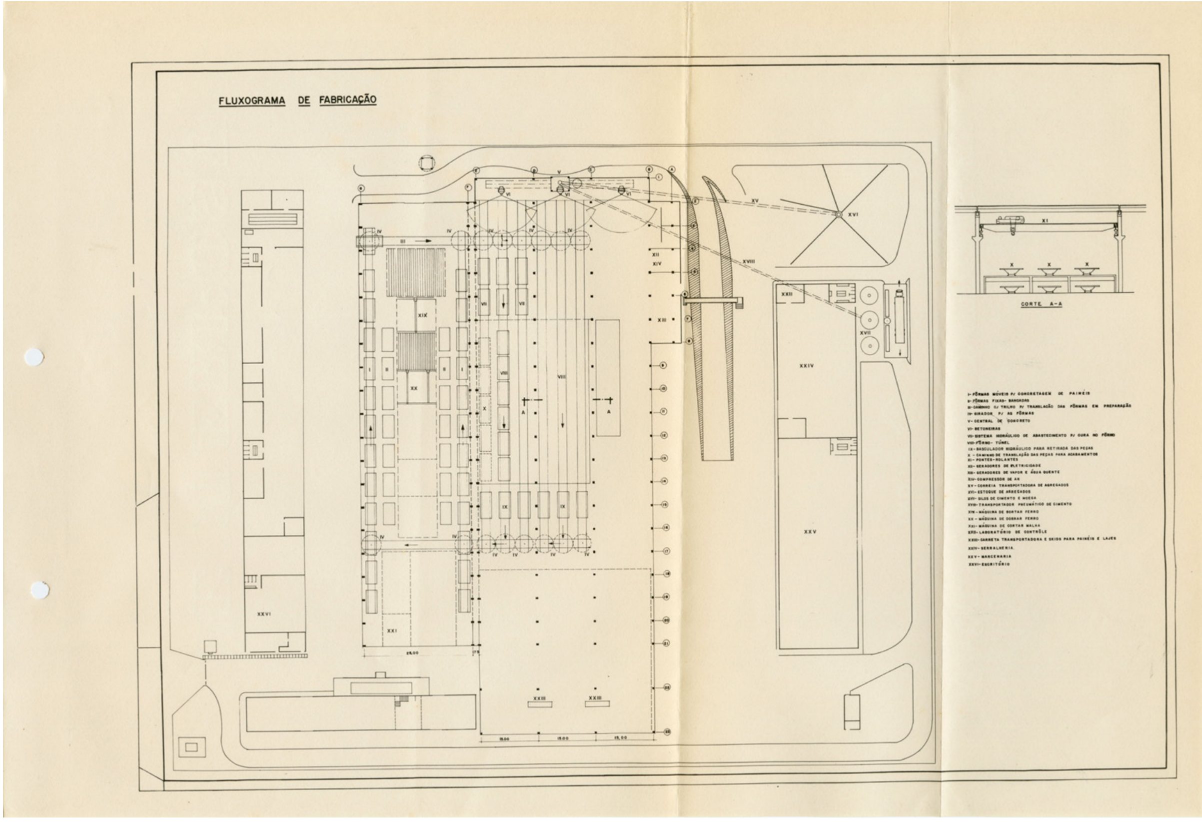


Fig. 3.12 Manufacturing flow diagram for the Rabello factory in Brasília. Catalog *Construtora Rabello S.A.* (Brasília: Rabello, 1969). Casa de Lucio Costa, Rio de Janeiro

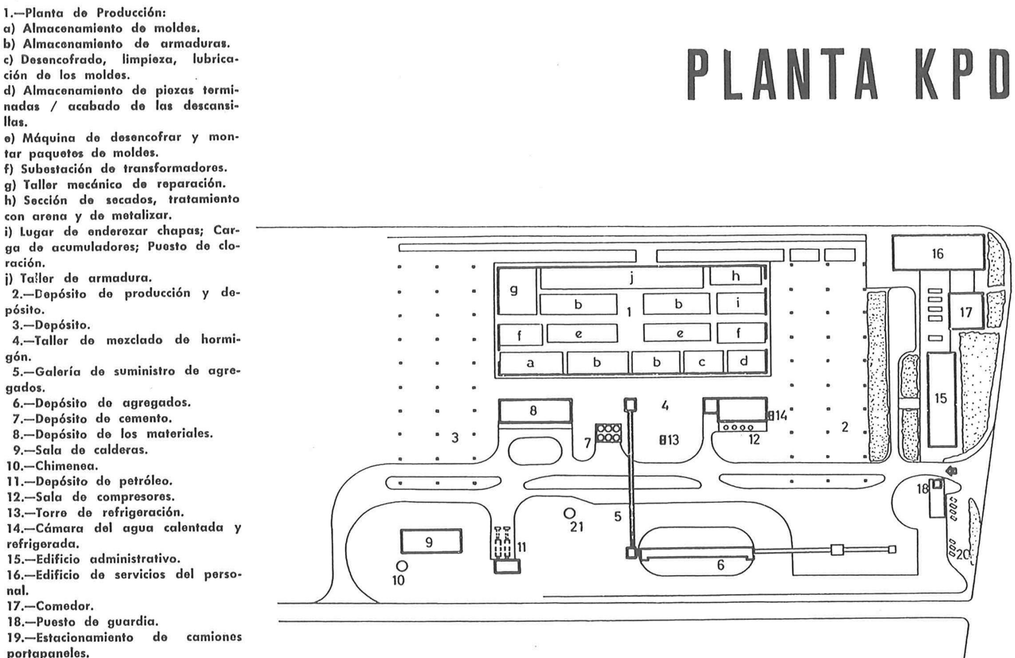


Fig. 3.13 Schematic diagram for the KPD factory in Quilpué, Chile, 1972. Pedro Ignacio Alonso and Hugo Palmarola, "Panel" (Architectural Association, 2014), p. 201

moving molds. The lightweight components were displaced with the help of travelling hoists.

But the unsolved problem was essentially related to the transport of components within the plant. The so-called "small" precast elements (ramps and drainage staircases) made of *argamassa armada* required from Lelé a new manufacturing strategy. The architect needed to find a way to occupy the manpower available on the spot, without forcing the workers to waste unnecessary efforts on their activities and therefore minimizing the production costs.

Given that the tower crane (53 ton/m) already installed on the patio was no longer in use, due to the interrupted production of the bus shelter components (columns, roofs and foundations), Lelé chose a simple method with a low level of technological sophistication: "The basic idea is to try to group the formwork as much as possible into "packages", "batches" or "stacks" so that they minimize the idle capacities of existing equipment (in operation at the bus shelter lines) and equipment yet to be purchased."[27]

The method applied to lightweight components at RENURB seemed to work well, as it triggered a rearrangement of the factory's layout. The area for cleaning and fueling the formwork with steel – previously spread over the manufacturing patio – was then centralized into a readily accessible space contiguous with the metal workshop, within the tower crane's range of action. Therefore, the metallic molds, which were previously transported in small batches, were then grouped and stacked before being conveyed by the crane to the casting area.

For the casting process of the bottom element of the stairways (*módulo drenante das escadas*) a new system composed of three vibrating tables installed at ground level, a mixer plant and a mini crane (jib length 10m) was proposed. The functioning description of this unexecuted plan showed Lelé's willingness to take the risk of moving away from the current manufacturing approach implemented at RENURB to initiate a new production endeavor. By doing so, the architect not only increased the casting speed of elements, but he also began to create mechanisms and equipment specially designed for performing the tasks allotted to them, like the sliding latticed gantry, responsible for placing the formwork in the required precuring tank.[28]

In actual fact, the RENURB factory marked Lelé's incursion into the development of both new and old techniques of industrial fabrication. As we can see from the drawings depicting a synchronized storage operation for the ground element of ramps (*módulo de cobertura de rampa*), the architect managed to efficiently stock, demold and transport the precast units. After 10 hours of precuring, "tablets" of formwork containing the ground element of ramps were lifted horizontally and rotated to a vertical position before reaching the pallets and being stored and finally demolded.

27 João Filgueiras Lima. *Usina: Sistema de Produção [Renurb]* (Salvador, 1981), 5. Arquivo Kristian Schiel, Brasília. [A ideia básica é tentar agrupar ao máximo as fôrmas em "pacotes", "lotes" ou "pilhas" que minimizem as capacidades ociosas dos equipamentos existentes (linhas dos abrigos) e daqueles a serem adquiridos] (my translation).

28 Precuring tanks, or tanks of first cure, were water tanks built at the beginning of the production lines, in which all the loaded formwork remained submerged for 24 hours. After this time, the units generally reached the minimum strength levels for demolding, whereas in the tanks of second cure, the *argamassa armada* elements stayed for more than 4 days.

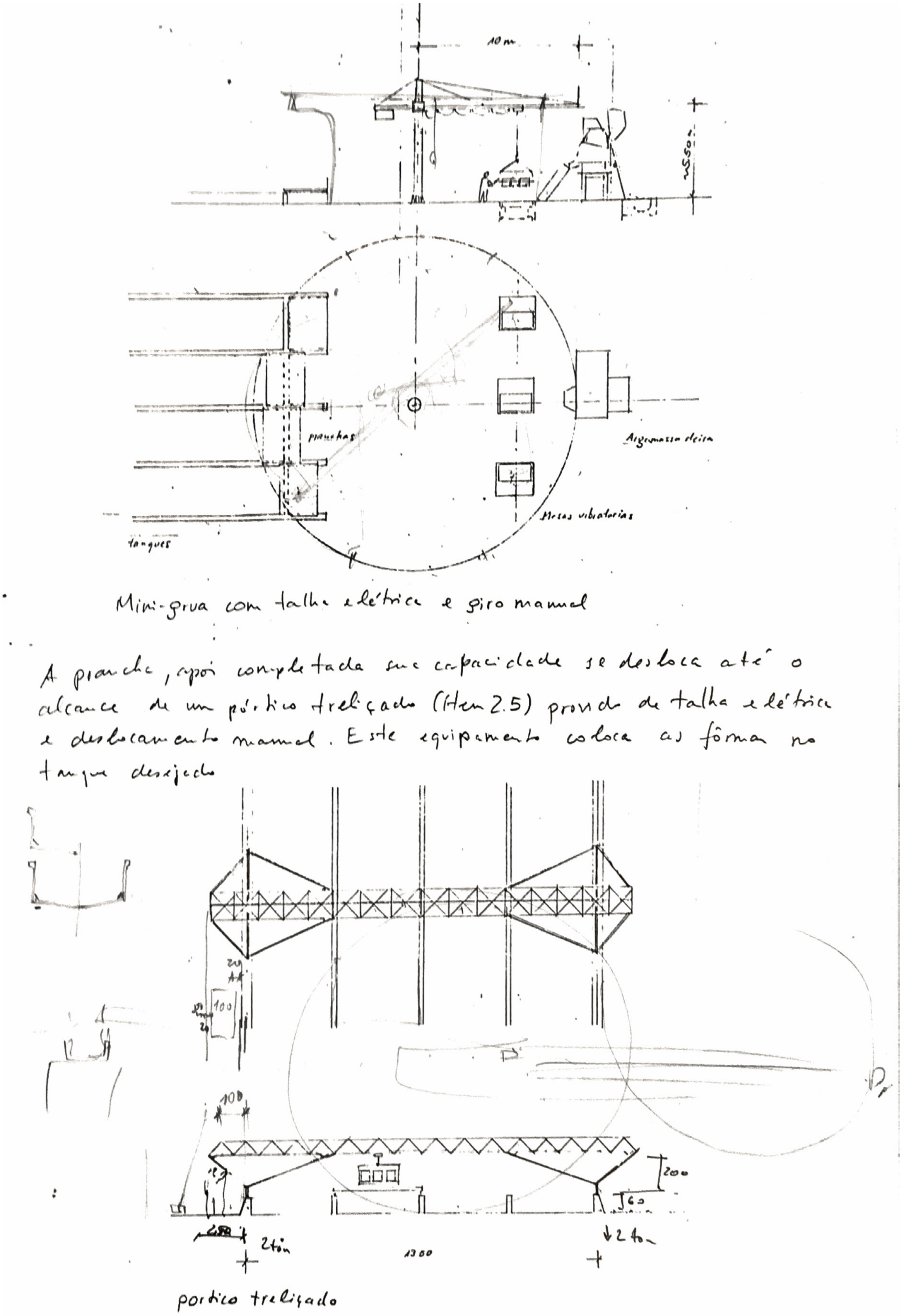


Fig. 3.14 Above: RENURB team's project for a mini crane with electric hoist and manual operation. Below: Sliding latticed gantry positioned on the water curing tanks. *RENURB. Usina: Sistema de Produção* (Salvador, 1981), 9 (unpublished). Arquivo Kristian Schiel, Brasília

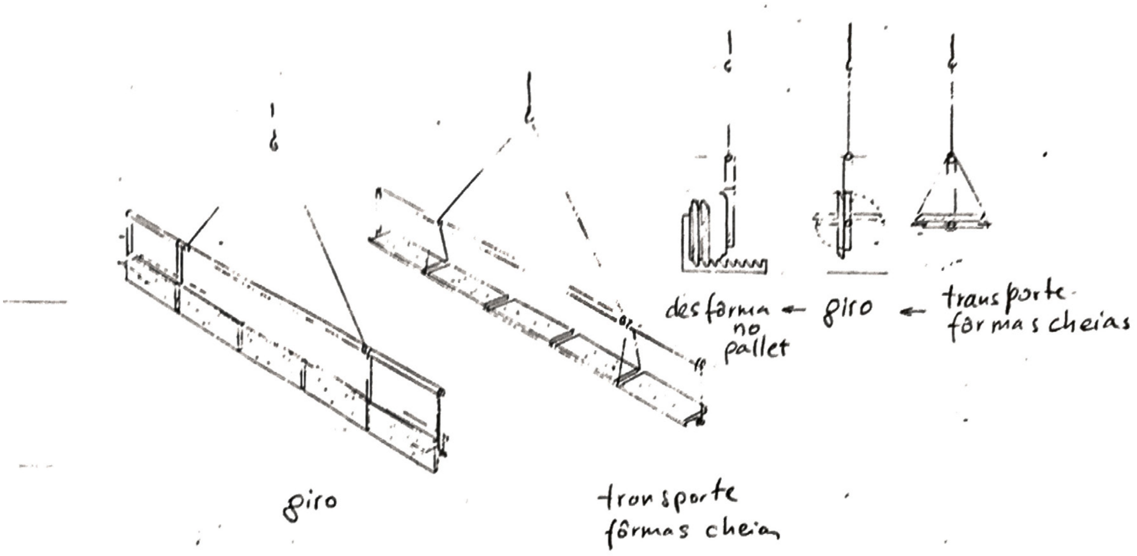


Fig. 3.15 Storage operation for the ground element of ramps. *RENURB. Usina: Sistema de Produção* (Salvador, 1981), 6 (unpublished). Arquivo Kristian Schiel, Brasília

But Lelé also invested a good deal of time in some unsuccessful techniques. It is more than likely that the architect brought precast curing methods to RENURB that he had probably seen at the Rabello Factory in Brasília (1967), like the vapor curing method using wire-framed covers. The concrete members were normally covered by metallic structures with plastic membranes, reducing the amount of water lost to evaporation. Notwithstanding the extensive application of this method at Rabello and the availability of vapor curing equipment with a nominal production capacity of 1,500 kg of water vapor per hour,[29] its experimental use in Salvador did not have a successful outcome.

> RENURB came to hire an engineer who had been working in Brasília with an adapted truck that produced heated steam. He went to Salvador, in his own truck, to carry out a curing test at the factory. We positioned the channel unities side by side and then he injected the steam under the canvas. The result was disappointing for everyone: for the engineer who returned to Brasília without leveraging his business, and for Lelé, who realized that steam curing did not work very well with *argamassa armada*. It was an excellent technique when applied to concrete, but not for *argamassa*. Usually, reinforced mortar pieces obtained good resistance soon after the first 24 hours in conventional curing tanks (with water), a situation that allowed us to handle the components afterwards. Of course, the final compressive strength was obtained over a few more days. But the most important thing was to reach an endurance level that would allow us to demold and transport the parts without cracking, something that the steam cure did not change significantly.[30]

29 Renurb, *Estudos Complementares: Pesquisa Argamassa Armada [Relatório Finep]* (Salvador, 1981), 4. Arquivo Kristian Schiel, Brasília.

30 Kristian Schiel. Telephone interview with Adalberto Vilela on September 30, 2017. [A Renurb chegou a contratar um engenheiro que prestava serviços em Brasília com um caminhão adaptado que gerava vapor aquecido. Ele foi até Salvador,

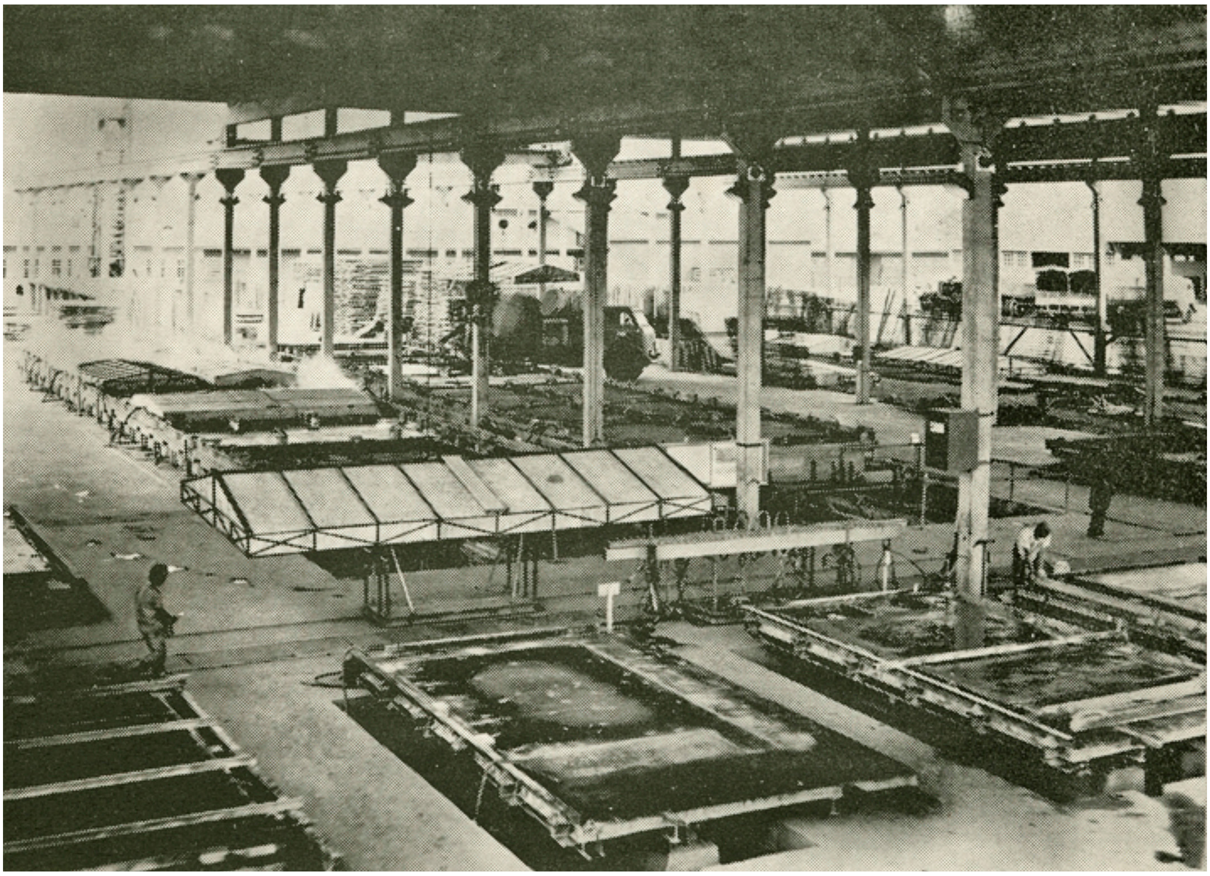


Fig. 3.16 Wired-framed covers at the production area, Rabello factory, Brasília, 1968. Vapor curing was widely used to accelerate the panels' production. Catalog *Construtora Rabello S.A.* (Brasília: Rabello, 1969). Casa de Lucio Costa, Rio de Janeiro

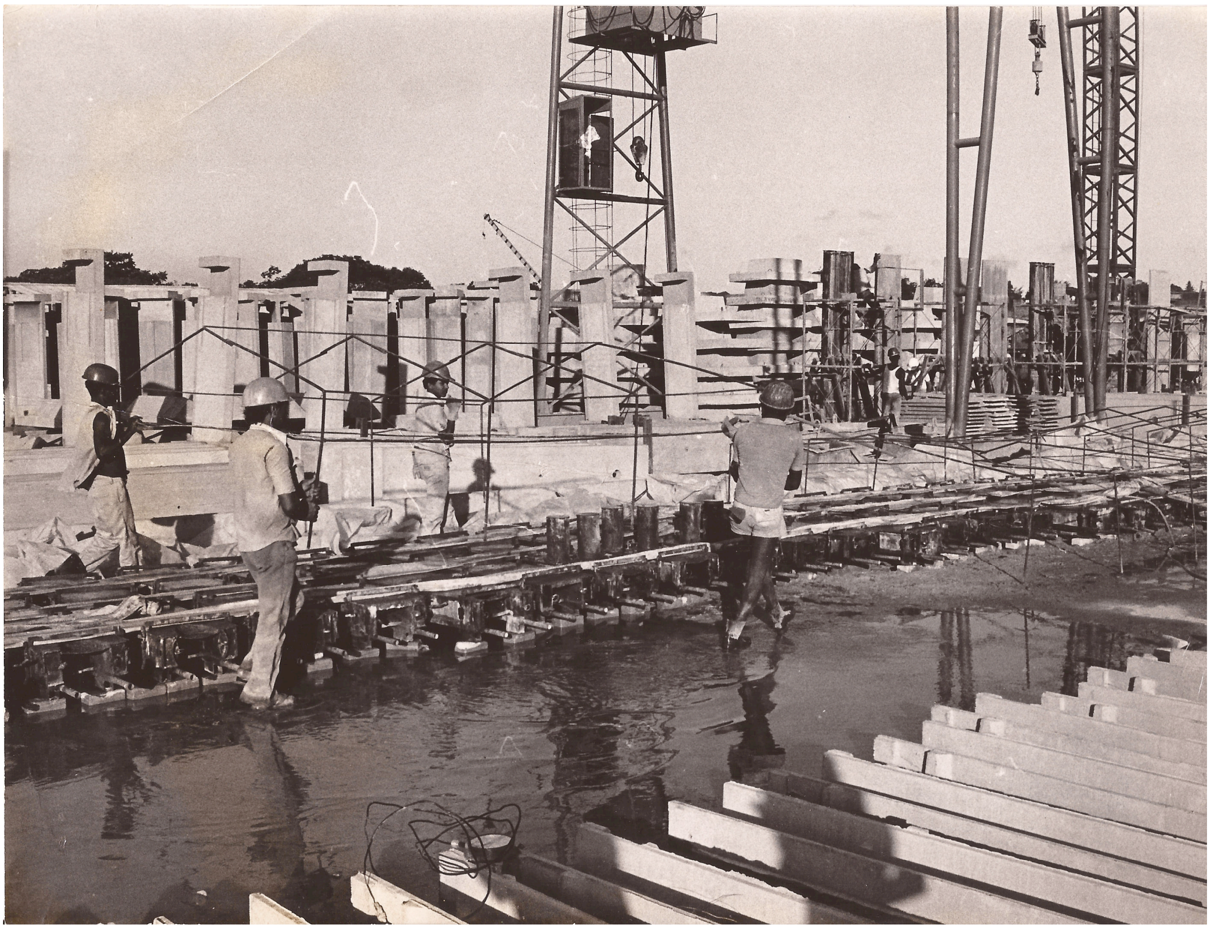
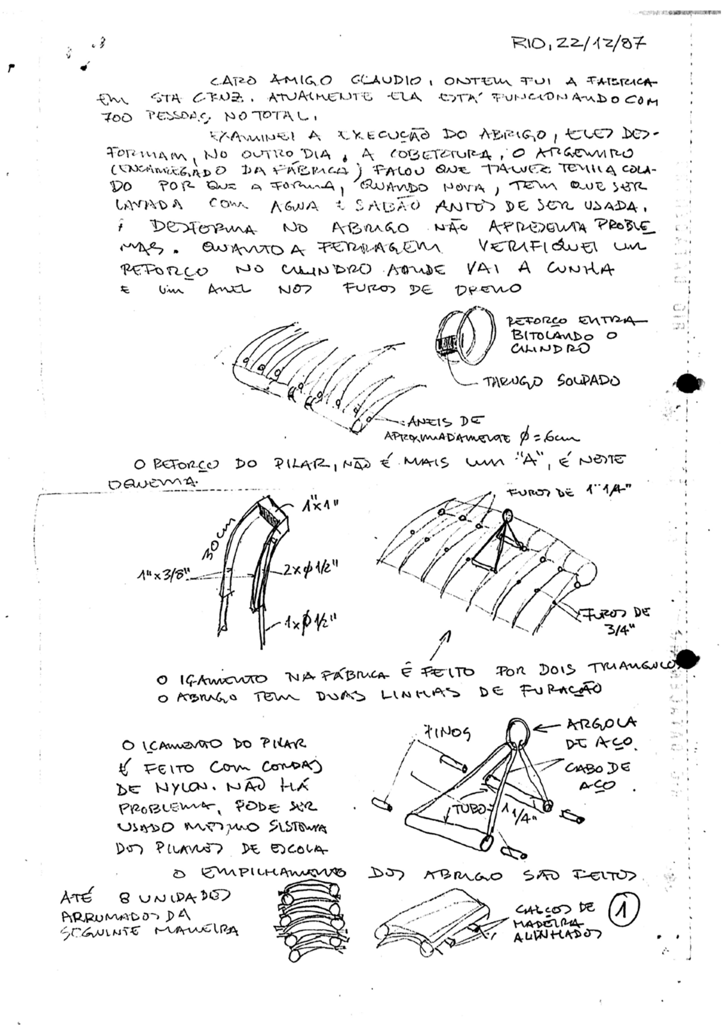


Fig. 3.17 Workers carrying the steel frame to retain vapor during the curing process. The cover is positioned over the sequence of molds. RENURB, 1980. Arquivo Kristian Schiel, Brasília


RIO, 22/12/87

CARO AMIGO CLAUDIO, ONTEM FUI A FÁBRICA EM STA CRUZ. ATUALMENTE ELA ESTÁ FUNCIONANDO COM 700 PESSOAS NO TOTAL.

EXAMINEI A EXECUÇÃO DO ABRIGO, ELES DESFORMAM NO OUTRO DIA. A COBERTURA, O ARGEMIRO (ENCARREGADO DA FÁBRICA) FALOU QUE TALVEZ TENHA COLADO POR QUE A FORMA, QUANDO NOVA, TEM QUE SER LAVADA COM AGUA E SABÃO ANTES DE SER USADA. A DESFORMA NO ABRIGO NÃO APRESENTA PROBLEMAS. QUANTO A FERRAGEM VERIFIQUEI UM REFORÇO NO CILINDRO ONDE VAI A CUNHA E UM ANEL NOS FUROS DE DRENO

REFORÇO ENTRA BITOLANDO O CILINDRO

TARUGO SOLDADO

ANEIS DE APROXIMADAMENTE ϕ = 6cm

O REFORÇO DO PILAR, NÃO É MAIS UM "A", É NESTE ESQUEMA

FUROS DE 1" 1/4"

1"x1"

30 cm

1"x3/8"

2xϕ1/2"

1xϕ1/2"

FUROS DE 3/4"

O IÇAMENTO NA FÁBRICA É FEITO POR DOIS TRIANGULOS
O ABRIGO TEM DUAS LINHAS DE FURAÇÃO

O IÇAMENTO DO PILAR É FEITO COM CORDAS DE NYLON. NÃO HÁ PROBLEMA, PODE SER USADO MESMO SISTEMA DOS PILARES DE ESCOLA

PINOS

ARGOLA DE AÇO.

CABO DE AÇO

TUBO 1 1/4"

O EMPILHAMENTO DOS ABRIGO SÃO FEITOS

ATÉ 8 UNIDADES ARRUMADOS DA SEGUINTE MANEIRA

CALÇOS DE MADEIRA ALINHADOS

1

Fig. 3.18 Letter from the architect (and Novacap employee) Aires Carvalho to Cláudio Gonçalves (Brasília), after his visit to the *argamassa armada* factory in Santa Cruz, state of Rio de Janeiro. December, 1987. Arquivo Aires Carvalho, Brasília

What Lelé and his team empirically observed during the late 1970s and early 1980s was the subject of analysis of a Brazilian scientific study published 14 years later. According to Melo and Libório, "Some cements, as in the case of the Type III, show that, for certain traces, the adoption of temperature peaks of 70°C is unnecessary to reach resistances of fcj> 10 MPa (situation for rapid take out of the forms)."[31] By type III, the authors referred to cements with high initial resistance, which was the category used by Lelé in his factories (*CP-ARI, Cimento Portland de alta resistência inicial*).

It is also curious to observe in the evolution of *argamassa armada* produced by Lelé over the years that this relevant characteristic – the components' demolding in 24 hours – remained practically unaltered after the first experiments at RENURB. In a letter dated 22 December 1987, the architect Aires Carvalho – a Novacap employee in Brasília – commented on his visit to the factory that continued the works Lelé had initiated in Rio de Janeiro. "My dear friend Cláudio, yesterday I visited the factory in Santa Cruz (State of Rio de Janeiro). It is currently running with 700 people in total. I examined the bus shelter execution: they demold the elements the following day."[32]

no próprio caminhão, para fazer um teste de cura na fábrica. Nós posicionamos as peças de canal lado a lado e então ele injetou o vapor por debaixo da lona. O resultado foi decepcionante pra todo mundo. Para o engenheiro que voltou para Brasília sem alavancar seu negócio, e para Lelé, que percebeu que a cura a vapor não funcionava muito bem com a argamassa armada. Ela podia ser uma excelente técnica para a cura do concreto, mas não para argamassa. Geralmente, as peças de argamassa já obtinham uma boa resistência logo após as primeiras 24h em tanques de cura convencional, com água, o que permitia que nós manuseássemos os componentes. Claro que a resistência à compressão final era obtida ao longo de mais alguns dias. Mas o mais importante era esse prazo para poder desformar e transportar sem fissurar, algo que a cura a vapor não alterou significativamente] (my translation).

31 Aluisio Bráz de Melo and Jefferson Benedicto Libardi Libório, "Some Recommendations for the Production of Ferrocement Elements by Means of the Thermal Vapour Cure," in *Fifth International Symposium on Ferrocement*, ed. P.J. Nedwell and R.N. Swamy (Manchester: E & FN Spon, 1994), 311.

32 Aires Carvalho. Letter to Cláudio Gonçalves. Rio de Janeiro, December 22, 1987 (33 pages). Source: Aires Carvalho Archive [Caro amigo Cláudio, ontem fui à fábrica em Santa Cruz. Atualmente ela está funcionando com 700 pessoas no total. Examinei a execução do abrigo: eles desformam no outro dia] (my translation).

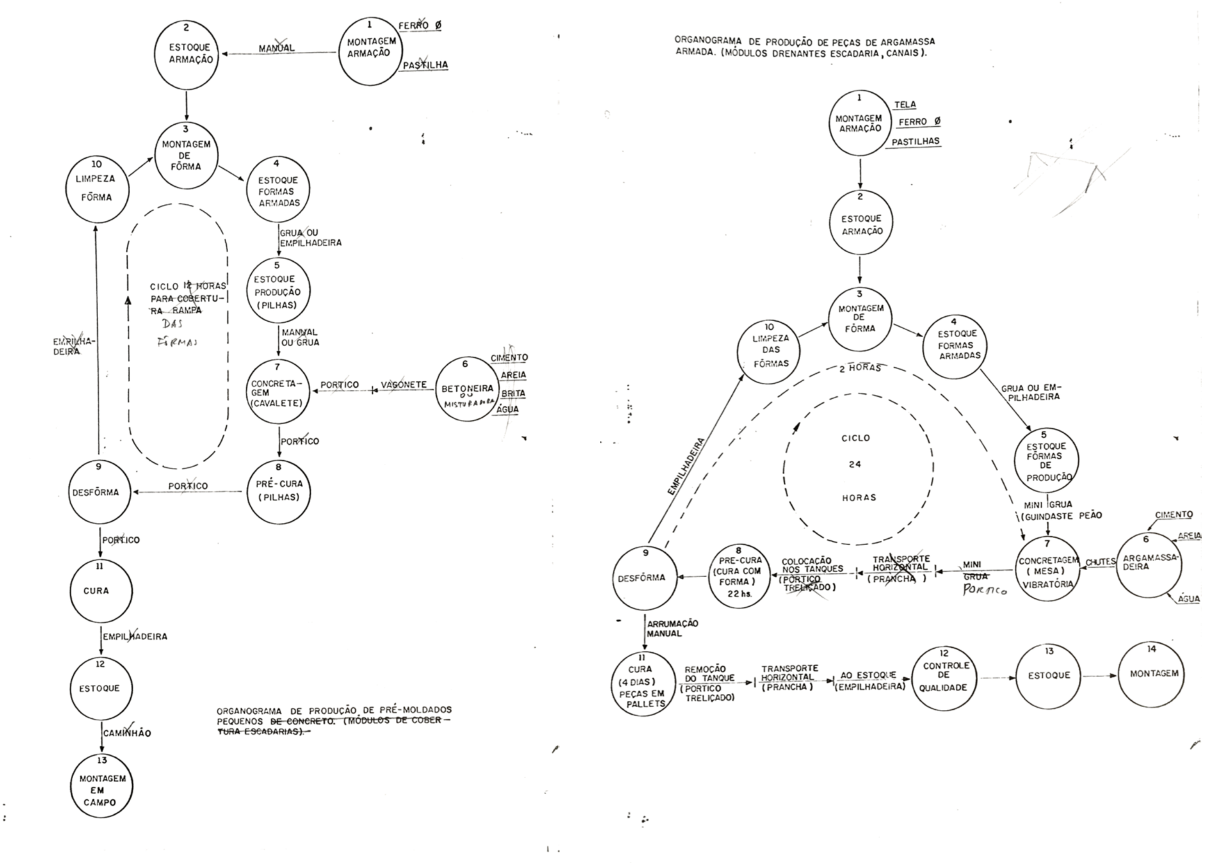


Fig. 3.19 Left: Manufacturing diagram of 12h for small precast elements in concrete. Right: Manufacturing diagram of 24h for *argamassa armada* elements. *RENURB. Usina: Sistema de Produção* (Salvador, 1981), 7-11. Arquivo Kristian Schiel, Brasília

The apparent surprise with which Carvalho reported the accelerated demolding process of precast components at the beginning of his letter brings us to RENURB's production organograms. The graphic schemes developed at Lelé's first factory, depicting the sequence of operations assigned to each production line (concrete and *argamassa armada*), greatly affected the architect's subsequent industrial facilities. It can be seen from the diagrams that both cycles followed a similar pattern of precasting activities – including the (manual) preparation of the molds (steps 1 to 3), casting (steps 6 and 7), curing (steps 8 and 11), demolding (step 9), cleaning (step 10) and stocking (steps 12 and 13) – which was determined by the phases of the metallic formwork themselves.

The main time difference found between cycles (24 and 12 hours) is due to the distinct curing requirements adopted for both *argamassa armada* and reinforced concrete elements. While the former demands a precuring phase of 22 hours – that is, when the loaded formwork remains submerged in water for one day – the latter has a more nimble and efficient procedure, which allows the concrete parts to be demolded after the first 12 hours. In view of these diagrams, it would be incoherent, to say the least, to restrict the RENURB factory to an experimental image, when its organization charts show the contrary.

In fact, principles such as those which characterized the theory of scientific management – efficiency, precision, simplicity, regularity, and functionality – occupied a central place in Lelé's early industrial philosophy. In October 1981, when the production of ramps and drainage stairways reached the mark of 40m/day,[33] the difference observed at the two manufacture lines was not just about the curing processes. Another equally important factor contributed to this discrepancy: the constitution of the mixture.

At that time in Rio de Janeiro, the Santa Cruz factory was using a trace of 1:2.5 (cement: thin aggregate) for the bus shelter elements (column and roof), with a cement consumption of 600 kg/m^3, and a water to cement (w/c) ratio ≤ 0.50.[34] In other words, this was a more fluid mixture that allowed for good workability with the material. Despite the knowledge that compressive strength and water to cement ratio are inversely related values – the more the water to cement ratio increases, the more the compressive strength (MPa) decreases – Lelé opted to work under conditions which assumed the risk of resistance and a more time-consuming cure for his precast units.

Even if these resistance issues are here derived mainly from the application of precast *argamassa armada*, they cannot be dissociated from another aspect of the RENURB factory in Salvador: the lifting devices. In general, upraising operations depend mainly on component weight, but lifting rings anchored in specific parts (or holes) together with their concrete strength may influence the productivity outcomes.[35]

Despite the use of a tower crane and a gantry, the RENURB plant generally counted on basic machinery, some of which was developed at the factory itself. This was the case with the travelling hoists designed to slide along the curing bays for short-term storage. This equipment was developed to lift building components a couple of times during the curing process, from the end of the casting phase until their extraction to be stocked. Two metallic wheels were adapted at both ends of the horizontal cylinder to make the lifting process easier.

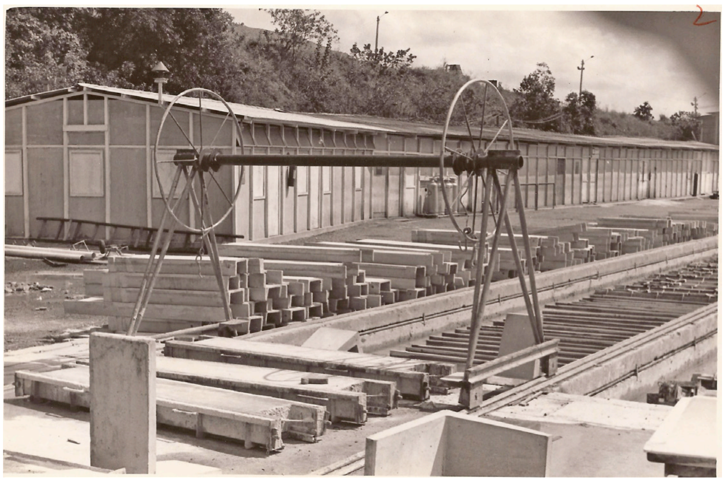


Fig. 3.20 Travelling hoist sliding along the curing tank at RENURB, Salvador, 1980. On the left side, prefabricated channel units await in the formworks for demolding. Arquivo Kristian Schiel, Brasília

As shown in Part II, in some situations heavy machinery participated actively in the sanitation works in the outskirts of Salvador. Whereas the flat ground conditions allowed for this kind of work, munck trucks and excavators were usually used to position

33 Ramps and drainage stairways produced by Renurb (implemented in the districts of Nordeste de Amaralina, Santa Mônica, Alto de Coutos and Calabar) had a different average daily production. The respective values are described in: Renurb, *Relação de Serviços: Dia 05.11.81 [Setor de Usina]* (Salvador, 1981), 2. Arquivo Kristian Schiel, Brasília.

34 Information retrieved from Aires Carvalho's letter. Rio de Janeiro, December 22, 1987, p. 29.

35 Productivity was measured by an analysis of the time taken to conclude a task or individual performance.

the pre-assembled modules of the channel set (two wall elements and one bottom unit, totaling 276 kg). In this regard, lifting connectors such as hooks and load-spreader bars provided the weight distribution to effectively transport the precast elements.

Unlike the sophisticated scissor clamps used in the Soviet Union to erect panel units (with the jaws holding the elements through friction), at RENURB the U-shaped channel module forced Lelé and his team to develop another solution, as cheaply and efficiently as possible. A metallic bar hung at both extremities by steel cables was therefore developed, and the ensemble's weight was uniformily distributed. Its articulation with the central point of the span provided the device with the required flexibility to bend and connect itself to the inner assembling holes of the channel wall elements. The bar reached the horizontal stage during the lifting operation thanks to the equilibrium reached between the force vectors which ran above, below and through the steel cables.

Due to certain limitations of RENURB's metal workshop, cumbersome procedures had to be carried out manually. To ensure the essential metal works at RENURB, a modest steel bending workshop was installed, incorporating a set of manually operated equipment. This included a mesh-straightening machine (calender), responsible for the rectification of the steel meshes (normally delivered on stowed coils), a welding set and a bending machine, to mention the most relevant.

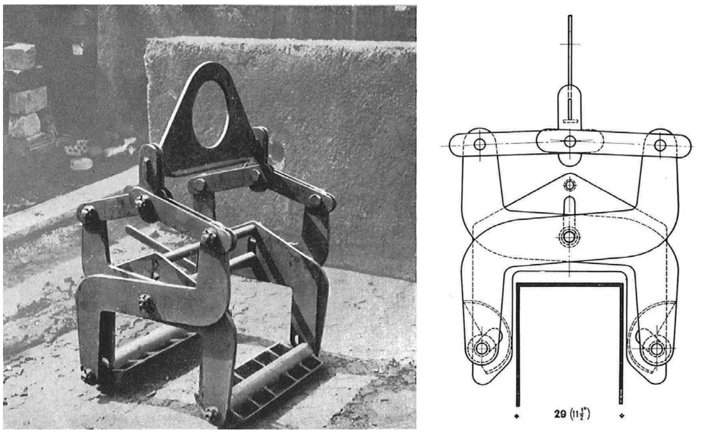


Fig. 3.21 Clamp with eccentric cam-shaped jaws for handling precast elements of intermediate size. Gyula Sebestyén, "Large-Panel Buildings" (Budapest: Akadémiai Kiadó, 1965), p. 330

Fig. 3.22 Lifting device developed at RENURB. A metallic articulated bar hung by steel cables. Salvador, 1980. Arquivo Kristian Schiel, Brasília

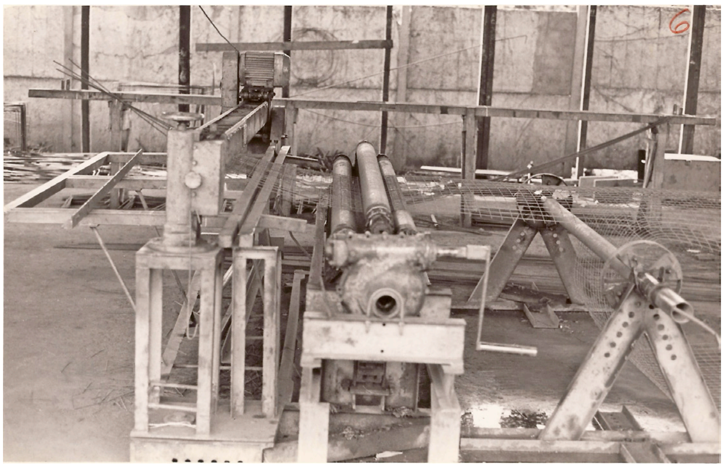


Fig. 3.23 Mesh-straightening machine (calender) at the RENURB'S steel-bending workshop. Salvador, 1980. Arquivo Kristian Schiel, Brasília

Fig. 3.24 Precast sanitation channels' assembly in progress on the outskirts of Salvador (1980). The articulated metallic bar allows the Munck truck to raise one triple module at a time. Arquivo Kristian Schiel, Brasília

On account of ideological reasons or lack of means, Lelé always stressed the importance of manual work in his architecture.

> My proposal to use and develop *argamassa armada* was based on the idea of making concrete prefabrication lighter, therefore allowing a large contingent of workers to be employed in the transportation of the units. I could then eliminate the use of hoists and cranes – these expensive things that replace the workforce – without giving up an industrialized, planned and rationalized system.[36]

Indeed, from the moment when *argamassa armada* started to be industrially produced by Lelé, cranes were no longer needed at the building sites under his coordination. Widely used by the architect at his previous works with precast reinforced concrete, the tower cranes were replaced by munck trucks, as the construction elements became lighter. While lifting devices elsewhere assumed an important role in building prefabrication, it seems that Lelé took a step

36 Francesco Perrotta Bosch et al., *ENTRE, Entrevistas com Arquitetos por Estudantes de Arquitetura* (Rio de Janeiro: Viana e Mosley, 2012), 124. [Minha proposta de usar e desenvolver a argamassa armada foi baseada na ideia de tornar a pré-fabricação em concreto mais leve, e permitir que um grande contigente de mão de obra fosse usado no transporte das peças – dispensando guindaste e grua, essas coisas caras que substituem a mão de obra –, mas sem abrir mão de um sistema industrializado, planejado e racionalizado] (my translation).

backwards when he moved to Abadiânia, after completing his activity in RENURB.

In the small countryside town, both the assemblage and production phases of the precast components assumed a dimension which was clearly focused on human labor. The close collaboration between the architect and local workers was a key factor in the endeavor to build where there was no provision for building prefabrication nor any sign of mechanization; and this endeavor was gathering momentum. Indeed, the lack of adequate infrastructure did not prevent factory expansion within Lelé's work.

8.2 Abadiânia: from *Arquitetura Nova* to the origin of transience

Abadiânia, the turning point of Lelé's prefabricated work, represented both the triumph of the participatory model of precast construction and the failure of a promising attempt to humanize[37] professional relations at the building site. The construction of public primary schools and a bridge in the countryside of Goiás state between 1982 and 1984 were occasions for Lelé to extend his knowledge of *argamassa armada*, acquired during the RENURB works in Salvador. It was also a moment of reflection about new forms of production.

While Salvador provided the architect with the necessary understanding of the nature of lightweight prefabrication and its production mechanisms, Abadiânia called into question the manufacturing process based on labor division. From the *argamassa armada* batching to the increase in precast buildings, there was an effort to promote the collective participation of all parties involved in the work in the small town. Often Lelé found himself undertaking tasks alongside the workers, to the point where – as João Evangelista recalled – "it was hard to distinguish who was who in the building sites."[38]

The foreman of the works in Abadiânia added:

> Every evening Lelé had dinner in my house. We used to arrive at home around midnight completely covered with mud, from head to toe. My wife usually prepared something for us to eat and the next day, at 6 a.m., we were back at work again. Inside and outside the building site, there was no difference between us. Instead of a suit-and-tied architect giving orders, Lelé used to work with the workers the whole time.[39]

37 Lelé's main motivation was to develop architecture with a social impact. For further information on this topic, see the following interview: Susana Olmos and Chango Cordiviola, "L'Human au Cœur de la Fabrique Architecturale / The Human at the heart of the Architectural Factory," *L'Architecture d'Aujourd'hui*, no. 396 (2013): 52-61.

38 João Evangelista dos Santos. Interview with Adalberto Vilela on May 24, 2016 in Abadiânia.

39 Idem. [Toda noite Lelé jantava lá em casa. A gente costumava chegar bem tarde, por volta da meia-noite, cobertos de barro dos pés à cabeça. Minha mulher fazia algo pra gente comer e no dia seguinte, às 6 da manhã, já estávamos de pé, de volta ao trabalho. Dentro e fora do canteiro de obras, não havia diferença entre a gente. Não tinha aquela do arquiteto todo engravatado mandando. Pelo contrário, Lelé se misturava com os operários o tempo todo] (my translation).

Fig. 3.25 Lelé (on the right) and the manual excavation works for the small bridge over the *Curralinho* river in Abadiânia, 1983. Arquivo João Filgueiras Lima, Salvador

Fig. 3.26 Lelé (on the right) oversees the precast procedure of a rib unity of the bridge deck in Abadiânia, 1983. *Argamassa* pouring phase in the metallic formwork. Arquivo João Filgueiras Lima, Salvador

The exchange of experience and knowledge that took place in cases such as Abadiânia was an object of study and interest for a group of architects in Brazil who were dissatisfied with the working relations at building sites in general. Based in São Paulo in the 1970s, the architects Rodrigo Lefèvre, Flávio Império and Sérgio Ferro introduced a production model of construction based on an unshakeable belief in the mutual learning between trained architects and untrained workers. Later known as *Arquitetura Nova*, the group defended a close collaboration with the so-called "unskilled laborers" during the building process for the purposes of both self-development and the creation of a new popular urban culture.

As newly graduated students from the University of São Paulo (1961) and former disciples of Vilanova Artigas,[40] Ferro, Império and Lefèvre started to advocate a new approach to building construction, "reformulating the notion of technique from a social proposal."[41] Adopting the ceramic vault as their most striking element, the *Arquitetura Nova* not only justified the use of minimum resources – operating on the basis of austerity and economy – but also tackled the aesthetic of the *Escola Paulista*[42] frontally. In their houses, "the great roof was no longer a box of concrete, but a vault, a change that was no mere formal option, but a move defined by the properties of simple, cheap and easily replicated technology, ideal for popular housing."[43]

At a moment when liberties were gradually being curtailed – with the advance of the military regime and its economic policy based on mega constructions – the three architects became known for their criticism of modern architecture in the 1960s and 70s in Brazil. The group focused particularly on the mismatch between the developmentalist exaltation boosted by the construction of Brasília and the real accomplishments of the fair-faced concrete architecture in São Paulo. Contrary to the design and aesthetics-based critique expressed by Max Bill[44] and Giulio Carlo Argan,[45] for instance, the *Arquitetura Nova* group condemned the exploitation and alienating labor conditions that prevailed in the name of modernization.

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40 João Batista Vilanova Artigas (1915-1985) was one of the most influential architects in Brazil. A founding figure of the Paulista School in the 1950s in São Paulo, Artigas developed an architecture linked to Brutalism, in which reinforced concrete structures played a central role. Among his most famous works are the FAU Building at the University of São Paulo (1969), the Louveira Residential Complex (1946) and several private houses. For more information, see: Lara Borgonovi e Silva, "Heavy Lightness: The Poetics of Conflict in the Structural Design of João Vilanova Artigas and Carlos Cascaldi" (ETH Zurich, 2016).

41 Ana Paula Koury, *Grupo Arquitetura Nova: Flávio Império, Rodrigo Lefèvre e Sérgio Ferro* (São Paulo: Romano Guerra: EdUSP: FAPESP, 2003), 31. [reformulando a noção de técnica a partir de uma proposta social] (my translation).

42 The term *Escola Paulista* (Paulista School) is used here with a didactic purpose, referring to the works developed in São Paulo from the mid-1950s until the early 1980s by a group of architects who shared a fruitful exchange of ideas and various creative approaches to raw concrete works. By questioning Vilanova Artigas' leading role and prominence in this panorama, Ruth Verde Zein defends the idea of a concomitance of performances among their main actors. For further information, see: Ruth Verde Zein, "A arquitetura da escola paulista brutalista 1953-1973", PhD diss. (Universidade Federal do Rio Grande do Sul, 2005), 43-44.

43 Pedro Fiori Arantes, "Reinventing the Building Site," in *Brazil's Modern Architecture* (London: Phaidon, 2004), 182.

44 Max Bill, "Report on Brazil," *The Architectural Review 116*, no. 694 (1954): 238-39.

45 Giulio Carlo Argan, "Architettura Moderna in Brasile," *Comunità* 7, no. 24 (1954): 48-52.

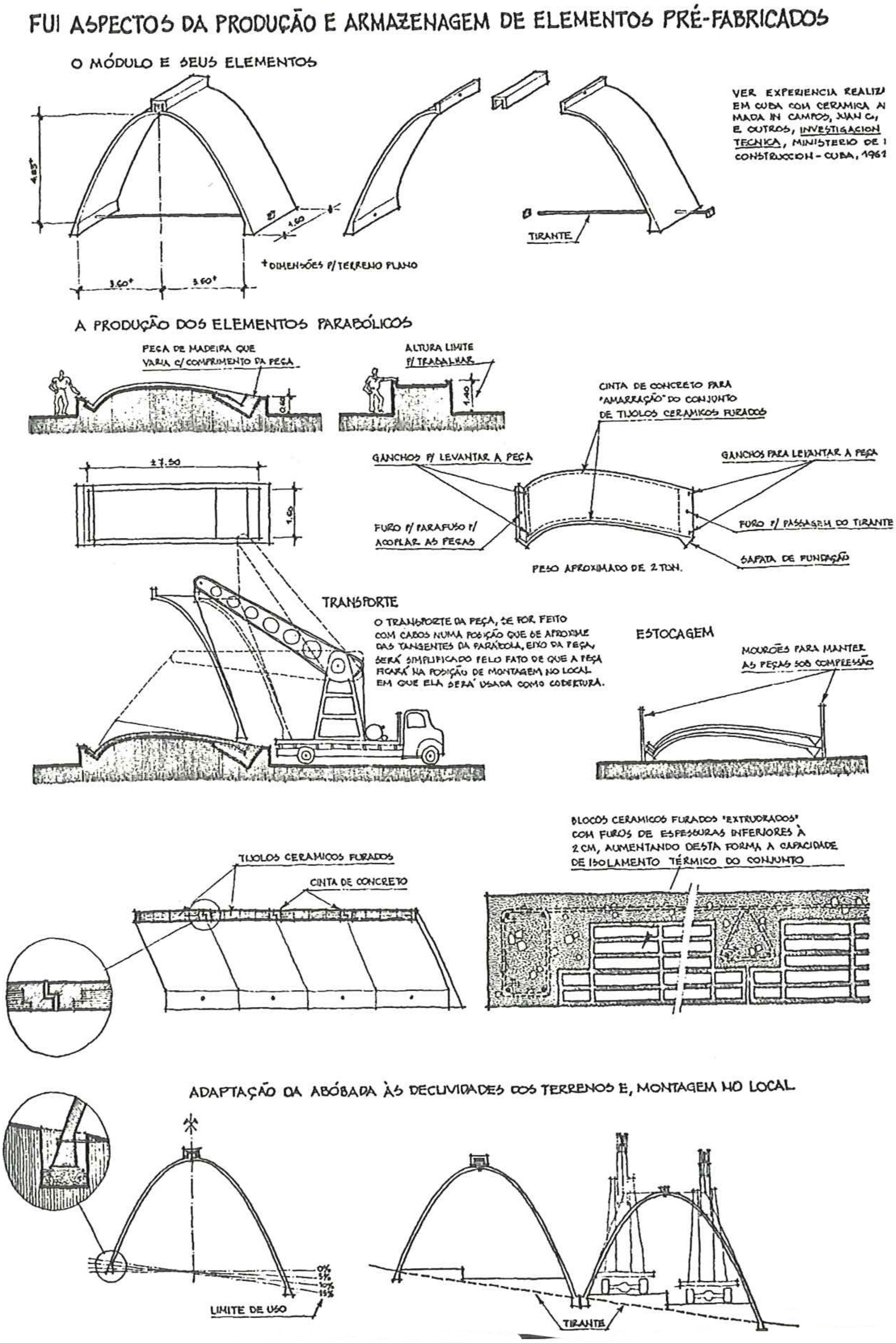

Fig. 3.27 Rodrigo Lefèvre. Aspects of production and storage of prefabricated elements for housing. Master thesis "*Projeto de um acampamento de obra: uma utopia*" (Project of a building site: an utopia), University of São Paulo, 1981. Ana Paula Koury, *Grupo Arquitetura Nova: Flávio Império, Rodrigo Lefèvre e Sérgio Ferro* (São Paulo: EdUSP, 2003), p. 68

In his Master's thesis (1981), Lefèvre summarized the legacy of *Arquitetura Nova* – namely the *mutirões,* or "the self-build housing associations that emerged and were successfully built on the periphery of São Paulo in the 1980s and beyond"[46] – by defending the idea of a new production model based "on another degree of understanding the urban, popular culture, erudite culture, the migrants' problems, construction problems, and the problems life throws up in a transitional moment." [47]

By looking at the production model established by Lelé in Abadiânia, an effort to rearrange the work relations within the building site is visible in a way that recalls the principles of the *mutirões*,[48] here identified through three main aspects common to both experiences. First and foremost, the architect's commitment to the practical implementation of the proposal. According to Lefèvre, "for an architect to participate in a *mutirão* as a new model of production experience, a new professional posture is required: it is not enough to show his solidarity with the proletariat solely on the level of ideology, it is necessary to participate in the plane of production as a producer."[49]

In the second place, construction can be seen as an educational process. Despite the difference in their conceptual origins, this holds true both for the *Arquitetura Nova* and Lelé, who believed that the building site, or the factory, could assume a pedagogical role. Whereas the emergence of the idea in Lelé's work dates back to the University of Brasília and Darcy Ribeiro – as we will see at the end of this dissertation – for *Arquitetura Nova,* "the proposal of a participatory building site as an emancipating educational process is clearly inspired by the theories of the great Brazilian educator Paulo Freire, best known for his internationally acclaimed book Pedagogy of the Opressed."[50]

In addition, and to complete the picture, there is the question of mass-produced architecture. This is the point which at the same time joins and separates Lelé and the *Arquitetura Nova* group. The common ground between their intentions to orient building production towards industrialization relies on the idea of transiency in architecture. In opposition to the notion of long-lasting buildings, as permanent urban landmarks, the ephemeral or transitory characteristic of architecture was what urged Lelé and the *Arquitetura Nova* to pursue their constructive research. As Pedro Arantes puts it, "although clear about the technical and material

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46 Richard Williams, "Towards an Aesthetics of Poverty: Architecture and the Neo-Avant-Garde in 1960s Brazil," in *Neo-Avant-Garde*, ed. David Hopkins (Amsterdam, New York: Rodopi, 2006), 215.

47 Rodrigo Brotero Lefèvre, "Projeto de um acampamento de obra: uma utopia" (Universidade de São Paulo, 1981), 83. [num outro grau de de compreensão do urbano, da cultura do povo, da cultura erudita, dos problemas dos migrantes, dos problemas da construção, dos problemas da vida na época de transição] (my translation).

48 According to Pedro Arantes, the inspiration for this alternative system of production came from another Latin American country: Uruguay. Since 1968, by means of the self-help housing co-operatives called *Ayuda Mutua*, the continuity of public policies for social housing has ensured highly organized building works, and well-managed community housing complexes and facilities. Arantes, "Reinventing the Building Site," 192.

49 Pedro Fiori Arantes, *Arquitetura Nova: Sérgio Ferro, Flávio Império e Rodrigo Fefèvre, de Artigas aos Mutirões* (São Paulo: Editora 34, 2002), 130. [Participar de uma experiência em mutirão dentro de um novo modelo de produção exige do arquiteto uma nova postura: não basta colocar sua solidariedade com o proletariado unicamente no plano da ideologia, é preciso participar no plano da produção, como produtor] (my translation).

50 Arantes, "Reinventing the Building Site," 189

precariousness involved in the *mutirão*, Rodrigo (Lefèvre) imagines that in the future everything might be demolished and rebuilt using another level of technology."[51]

This was exactly what Lelé had in mind when he incorporated large scale production into his schools in Rio, based on the experience in Abadiânia:

> I have always called these *argamassa armada* schools transitory schools, not provisional ones. That's because I imagine that, in around twenty years, they will have already fulfilled their role. They were very cheap, and they solved the crucial problem of setting up schools in the favelas, for example. It is deeply rooted in the architect's thinking that his work will last forever – like the pyramids of the pharaohs – so that new generations will consider him a genius. Instead, the architect should erect a building that aims for a timeframe of ten years. Would you like the urbanization of cities to reproduce the urban model of the favelas, without proper conditions of sanitation or accessibility, treating man as a goat who must climb those stairs 40 m high? This is not a human way of planning a city. The favela is a transitory thing, which stems from the intelligence of poor people who have to occupy spaces that are left in the city. The favela changes like an organism. It does not make sense to build a definitive school in a favela; it should be transitory, like the favela itself.[52]

But it is the variance of opinion between Lelé and the *Arquitetura Nova* that offers us the key to understanding the implementation of the Abadiânia factory and its operation. For Lefèvre, Ferro and Império, the more complex the architectural object (in terms of shape and graphical representation), the more easily the worker becomes discouraged and manipulated. The group's notion that pure volumes, geometrical discipline, and measurement systems push the worker further away from the construction practice derives from Sérgio Ferro's argument that domination in the production process occurs through a sense of alienation at work.[53] In other words, a construction worker that performs certain routine tasks automatically neither has a global idea of the whole enterprise, nor recognizes himself as an essential part in the process. Nevertheless, Lelé conducted his experiments with great accuracy and precision, however complex the architectural object. Rigor was part of his practice, even at Abadiânia, where the

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51 Arantes, *Arquitetura Nova: Sérgio Ferro, Flávio Império e Rodrigo Fefèvre, de Artigas aos Mutirões*, 130. [Tendo clareza, entretanto, da precariedade técnica e material envolvida no mutirão, Rodrigo imagina que no futuro tudo possa ser demolido e reconstruído noutro nível de tecnologia] (my translation).

52 In Lima, "João Filgueiras Lima, Lelé [Entrevista a Adriano Carneiro de Mendonça]," 136. [Sempre chamei essas escolas de argamassa armada de escolas transitórias, e não provisórias. Isso porque imagino que, em torno de vinte anos, elas já tenham cumprido seu papel. Foram baratíssimas, resolveram o problema crucial de implantação de escolas nas favelas, por exemplo. Está muito arraigado no pensamento do arquiteto que sua obra será eterna – como as pirâmides dos faraós –, para que as novas gerações o achem um gênio. Mas o arquiteto tem que fazer uma obra que dure dez anos. Você gostaria que toda a urbanização das cidades reproduzisse o modelo das favelas, sem condições de saneamento, sem acessibilidade, pressupondo que o homem é um cabrito que deve subir aquelas escadarias de quarenta metros de altura? Isso não é uma forma humana de planejar uma cidade. A favela é uma coisa transitória, que decorre da inteligência das pessoas pobres em ocupar espaços que sobraram na cidade. A favela muda, como um organism. Não faz sentido contruir uma escola definitive numa favela; ela tem que ser transitória como é a própria favela] (my translation).

53 Arantes, *Arquitetura Nova: Sérgio Ferro, Flávio Império E Rodrigo Fefèvre, de Artigas Aos Mutirões*, 116. [Volumes, rigor geométrico, sistema de medidas afastam o trabalhador do que faz] (my translation).

precarious conditions imposed a different regime of construction and made workers feel involved and engaged.

Another important aspect of Ferro's theory refers to the architectural drawing as a capitalist form of domination. In 1976, Sérgio Ferro published the book "*O canteiro e o desenho*"[54] (the building site and the design) where he proposed a new buiding site organized by working teams, constructive clarity on all working levels, liberty for the workers to intervene in the building process, and the experience of construction as a pedagogical vehicle. In his writings, there is a clear orientation more in line with handcrafted architecture than manufactured production. The latter was defended by Paulo Bruna in his book released the same year: "*Arquitetura, industrialização e desenvolvimento*"[55] (Architecture, industrialization and development). Bruna advocated the production model based on strict labor division, while Ferro offered the example of a building site defined by mutual apprenticeship through collaboration.

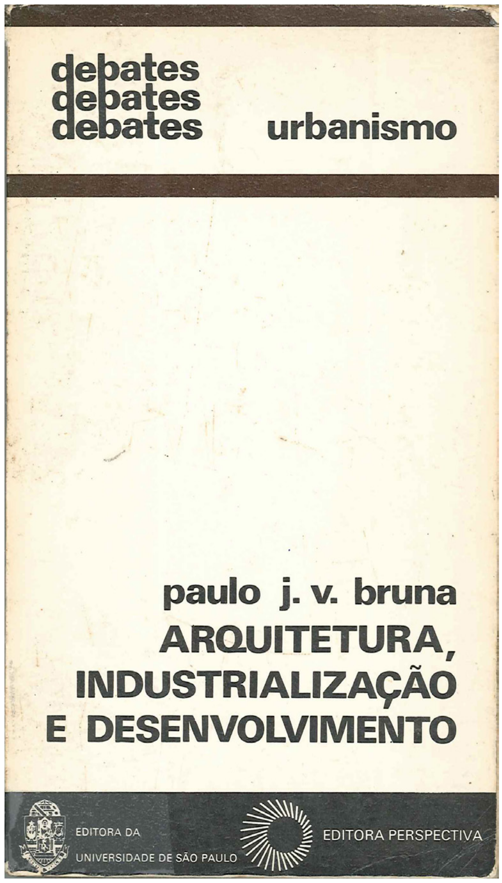


Fig. 3.28 Paulo Bruna. *Arquitetura, industrialização e desenvolvimento*, 1976. 1st ed. Author's archive

In view of these two mutually opposing ideas, what interests us here is that Lelé carried out his work in Abadiânia exactly as envisaged by Ferro and his friends in the 1970s, that is to say, building construction without the support of drawing boards. The manual that appeared as a book[56] in 1984 containing a sequence of didactic drawings made by Lelé to demonstrate the assembly process of the prefabricated schools in *argamassa armada* was not used to assist with their construction. In fact, according to João Evangelista[57] – foreman during the works in Abadiânia – the transitory schools were erected according to the rigid modulation of their structure and the direct instruction of Lelé himself at the building sites.

How, then, does this fact affect our understanding of both the factory and the component's production in Abadiânia? If we imagine that the school prototype in *argamassa armada* was erected without a set of geometric drawings and assembling illustrations, then production – and the factory floor itself – must have assumed a pedagogical organization.

54 Sérgio Ferro, *O Canteiro e o Desenho*, ed. Vicente Wissenbach, 3rd ed. (São Paulo: Prolivros, 2005). The French version was published under the title: *Dessin/Chantier*, (Paris: Éditions de la Villette, 2005).
55 Paulo Bruna, *Arquitetura, industrialização e desenvolvimento* (São Paulo: Editora Perspectiva, 1976).
56 João Filgueiras Lima, *Escola Transitória Modelo Rural* (Brasília: MEC/CEDATE, 1984).
57 João Evangelista dos Santos. Interview with Adalberto Vilela on May 24, 2016 in Abadiânia.

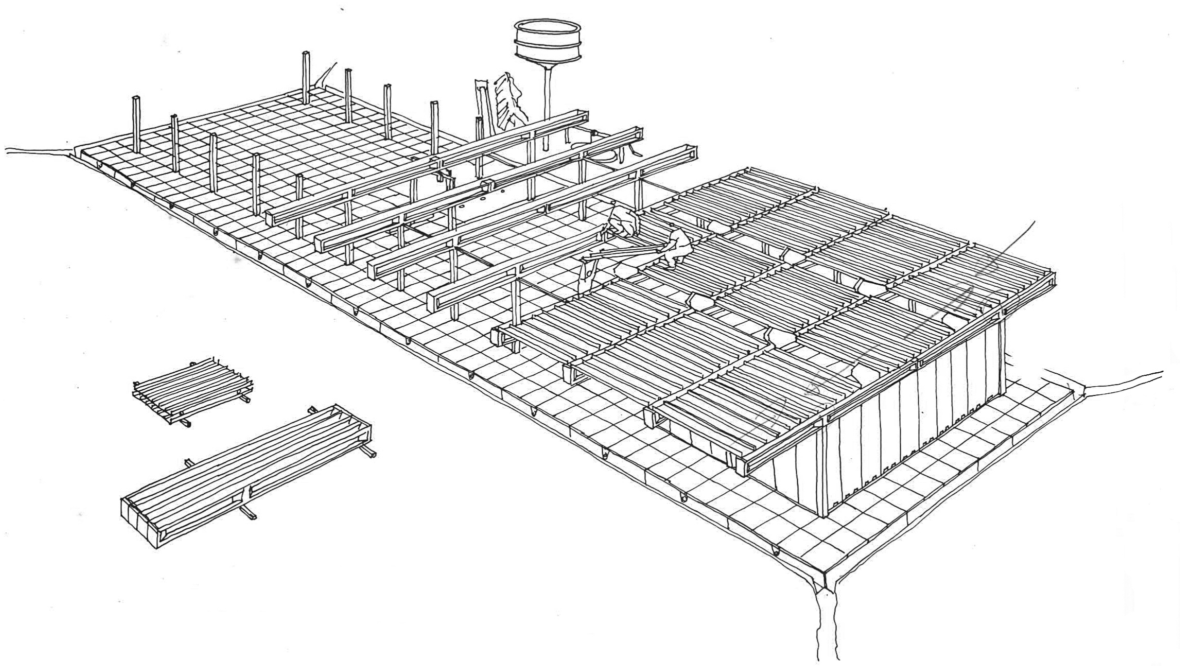
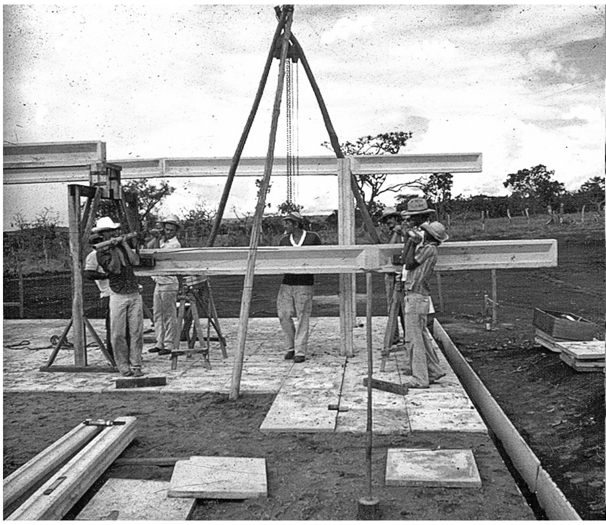


Fig. 3.29 João Filgueiras Lima. Drawing showing the roof construction of the transitory school's prototype in *argamassa armada*. Abadiânia, 1984. João Filgueiras Lima, *Escola Transitória Modelo Rural* (Brasília: MEC/CEDATE, 1984), p. 76



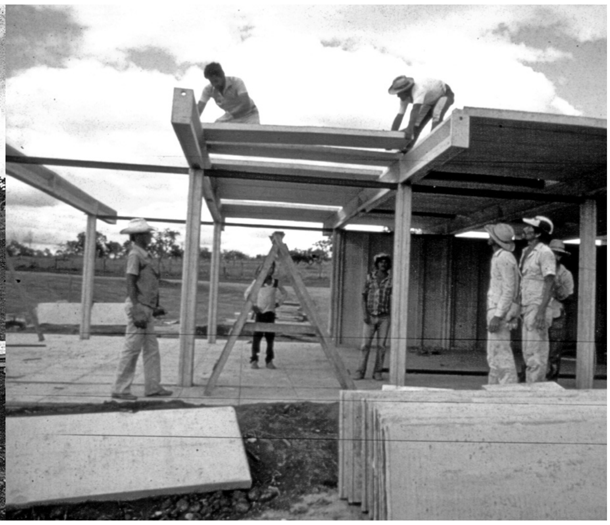


Fig. 3.30 Images of the transitory school construction in Abadiânia, 1983. Left: Lifting operation to raise a roof beam using a rudimentary wooden tripod. Right: Assemblage of roof and sheds. Arquivo João Filgueiras Lima, Salvador

This is exactly what differentiates Abadiânia from the other factories implemented by Lelé: its experimental character (as Lelé stepped into *argamassa armada* flying solo) applied to the architect's predisposition to teach the workers very closely at each construction stage.

Obviously, these particularities were favored by a matter of scale, since the achievements in Abadiânia were reduced to four prefabricated schools – two of which were built with timber (located in the districts of *São Jerônimo* and *Serenata*, currently disassembled), and two in *argamassa armada* (in the districts of *Varginha* and *Barreirinho*) – one covered street fair, and one small bridge.[58] But let us not forget that the modest factory in Abadiânia had very little in common with the drawing board from which it emerged. According to the preliminary study for the plant:

> The suggestion of a plant presented here is only one way to better realize the idea. Its final configuration will depend on the topography, the plot dimensions, etc. In any case, from the layout of the sectors, it conveys the clear intention to create several manufacturing lines (diversification of products) with less concern to optimize production, which characterizes a research factory.[59]

In the end, the factory in Abadiânia was incapable of achieving the levels of production organization (divided into various sectors) and mechanization (with silos, a tower crane and a material laboratory) that Lelé had imagined. Due to budget constraints and local priorities, the plant ended up being installed in two different phases at the same urban site. The factory's first phase was dedicated to producing a new bridge to replace the wooden one destroyed during a recent flood in the region, and the second phase was assigned to building the *argamassa armada* prototype of the primary school.

Using basic materials, Lelé set up the first factory with the money raised by selling a car belonging to the municipality of Abadiânia.[60] The plant was organized around a small L-shaped masonry wall (approximately 60 cm high), with a water curing tank and a concrete mixer on one side, and an improvised wooden bending device (for the steel meshes) on the other. In between these two "sectors", a small shelter made with a timber structure and asbestos roofing protected the area where the concreting phase took place. Stored in the open air and basically in the same area, the whole of the bridge's metallic formwork (pillars, ribs of the bridge deck, and

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58 In: João Evangelista dos Santos. Interview with Adalberto Vilela on May 24, 2016 in Abadiânia. Lelé also built a private residence there for the couple Gil Santini Pinto and Albinéiar Plaza Pinto, both physicians, and a plant nursery for the agronomist João Benko and his wife Divina Benko, which later became the famous Jerivá restaurant. For a complete picture of the realizations in Abadiânia, see footnote no. 91 in Part 2 of this dissertation.

59 João Filgueiras Lima. Ação no Município de Abadiânia - AMA [Proposal of a factory to Abadiânia], descriptive memorial [memória], drawing board undated and unnumbered. Abadiânia, Goiás, 1982. João Filgueiras Lima Archive [A sugestão de usina que ora apresentamos é apenas uma forma de concretizar melhor a ideia. Sua configuração final dependerá da topografia, dimensões do terreno, etc. De qualquer forma, ela deixa claro pela disposição dos setores a nítida intenção de criar várias linhas de confecção (diversificação de produtos) e uma menor preocupação de otimizar a produção, o que caracteriza uma usina de pesquisas] (my translation).

60 Fábio Savastano. Interview with Adalberto Vilela on May 31, 2016 in Brasília.

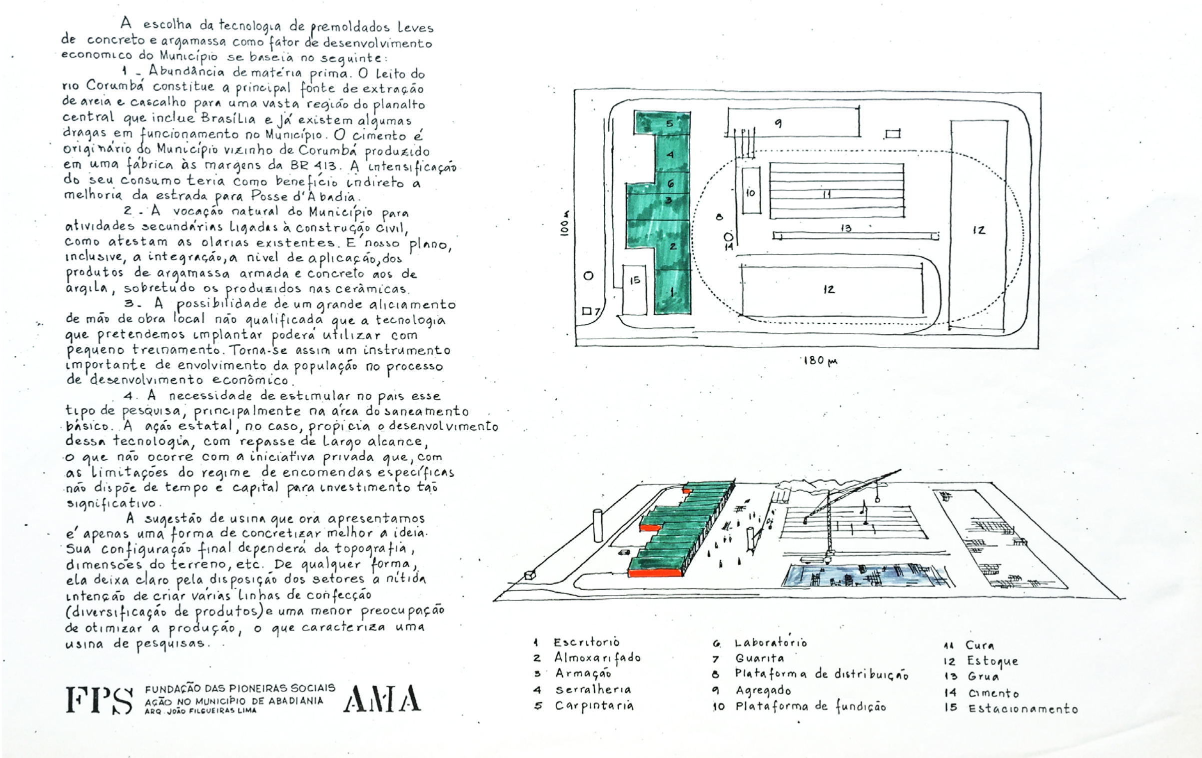

Fig. 3.31 Abadiânia factory's preliminary study including laboratories, carpentry, cure and metal workshops. AMA project. Drawing by Lelé, 1984. Arquivo João Filgueiras Lima, Salvador

Fig. 3.32 First factory in Abadiânia to produce precast elements in *argamassa armada*. Implemented by Lelé in 1983, the factory was created to produce the small bridge's components. Arquivo João Filgueiras Lima, Salvador

guardrail) was designed and manufactured to provide a casting process still attached to the ground.

By far the most sophisticated (and expensive) production equipment found in Abadiânia were the molds, which came from Brasília, where they were manufactured. Designed by Mariano Casañas and produced at the Gravia metallurgical company (*Irmãos Gravia Ltda*), the formwork represented an important step for Lelé towards his main goal: to produce an all-precast *argamassa armada* building. Even though this task would be achieved at the next stage of the Abadiânia factory – with the construction of the transitory school prototype – the bridge played a crucial role as it allowed Lelé to prove the viability of minimum thicknesses for *argamassa armada* elements.[61] It is no coincidence that the standard thickness of the primary school's panel walls was 18 mm, the same width Lelé adopted to precast the ribs of the bridge deck.

After the bridge's inauguration and the comparative experience with the wooden school built in September 1983, Lelé turned himself to the *argamassa armada* prototype of the transitory school. As explained in Part II, the transient character of this building was related to the ephemeral functioning of the rural schools in Brazil, normally bound to the instability of agricultural policy. The mobility assigned to the new school provided a solution, as they could be disassembled and reassembled according to the displacement of the cultivated land.

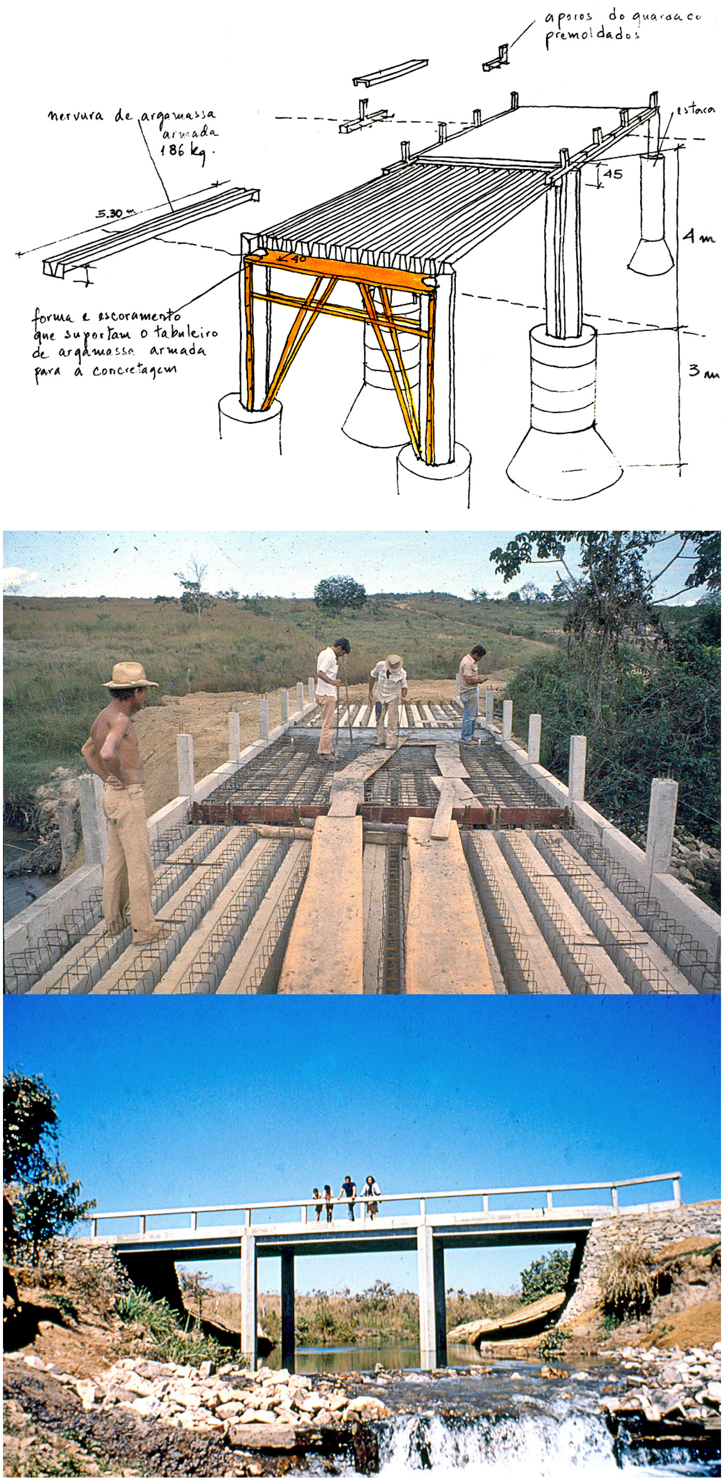

Fig. 3.33 Small bridge (pontilhão) over the Curralinho river in Abadiânia. Lelé, 1983. From top to bottom: initial sketches, the bridge deck's assembly, and the final result. Arquivo João Filgueiras Lima, Salvador

61 Lelé also proved the feasibility of the *argamassa armada* bridge by comparing its cost (USD 3,669.35) with another model made of wood (USD 5,615.50). Although the wooden version was not constructed, unlike the comparison between schools, the architect had a clear intention to give continuity to his light prefabrication research. Drawing board PC (*pontilhão de concreto*), AMA (*ação no município de Abadiânia*), February 20, 1983. Arquivo João Filgueiras Lima.

Fig. 3.34 Second factory in Abadiânia. The plant was installed to produce all the precast elements of the transitory school prototype. Lelé, 1984. Arquivo João Filgueiras Lima, Salvador

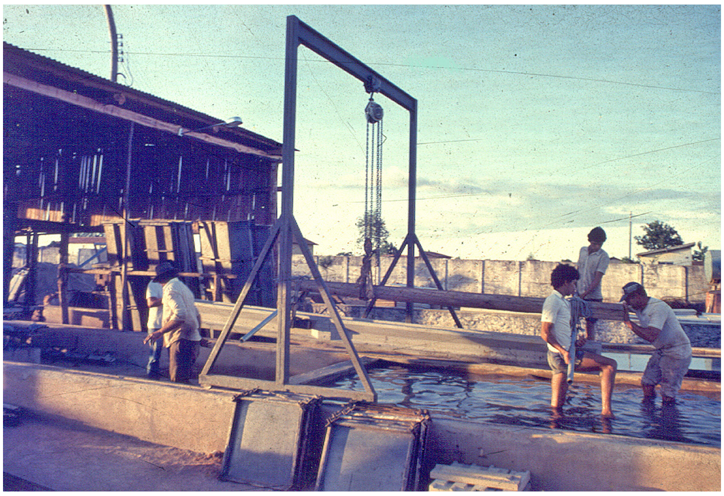

Fig. 3.35 Lifting operation at the second factory. Workers raise a roof beam from the curing tank. Arquivo João Filgueiras Lima, Salvador

Thus, in view of the need to produce a wide range of new precast elements, Lelé built a new factory, keeping the same basic organization. The main modifications to the new plant in Abadiânia concerned the incorporation of a more efficient lifting method (a travelling hoist was installed along the curing tank), the construction of a wider curing area – now with different depths – and, more importantly, the new metallic molds. The refined complexity of the formwork required from both the steel bending and the *argamassa* pouring teams a much higher commitment and much more working time to learn the operations (opening, pouring, closing, vibrating, transporting, curing, demolding, and storing).

In the end, the Abadiânia experience proved that dealing with a new construction technology – with its own measurement system, peculiar geometry and assembling method – need not at all hamper the workers' assimilation of the building process, as Sérgio Ferro had worried. On the contrary, with the support of the Catholic University of Goiás and the figure of Edgar Graeff, Lelé promoted an inclusive building site, while guaranteeing more autonomy for the workers, as originally planned. "The proposed model, using cutting-edge technology, was conceived to be didactically constructed by the countryside communities themselves."[62]

However, if on the one hand Lelé succeeded in proposing a production model based on the coalescent approach of the architect who helps to build and strengthen the relationship between thinking and doing architecture, on the other hand, the same could not be said regarding the expansion of the public schools' network.

> With the results obtained in this pilot experiment, we could affirm that five small precast factories, slightly better equipped than the one in Abadiânia and based in strategic locations across the region of Goiás (with a radius of action less than 200 km), would be enough to update and maintain the state's school network with incomparably fewer financial resources than would have been earmarked for the same purpose using conventional construction techniques.[63]

Despite Lelé's unsuccessful attempt to spread precast factories throughout Goiás state (the five plants never came to be built), what stands out in Abadiânia is the professional renouncement, on the part of the architect who abandoned an on-going industrialization model (initiated in Salvador) to join an experimental building site. In a conscious effort to improve the conditions of the precarious rural schools in the countryside of Central-Western Brazil, Lelé opted to apply technical oriented work to a communitarian way of building. Knowing that technology by itself does not provide the answers to social misadjustments, he realized it was time to set a new pace for production, making it more far-reaching and less restrained.

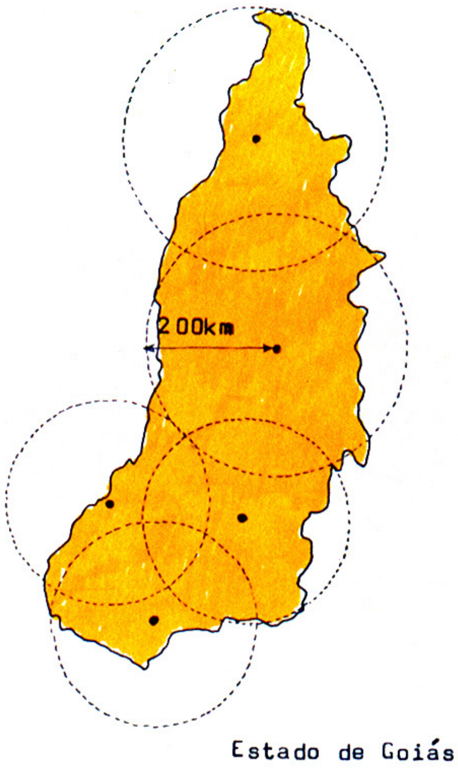

Fig. 3.36 Distribution of the *argamassa armada* factories throughout Goiás state's territory. Lelé, 1984. Arquivo João Filgueiras Lima, Salvador

62 Lima, *Escola Transitória Modelo Rural,* 25. [O modelo proposto, empregando tecnologia "de ponta", foi concebido para, de forma didática, ser construído pelas próprias comunidades dos municípios do interior] (my translation).

63 Ibid., 25-26. [Com os resultados obtidos nessa experiência piloto, poderíamos afirmar que 5 pequenas usinas de prefabricação um pouco mais aparelhadas do que a de Abadiânia, e localizadas em pontos estratégicos do território de Goiás (com raios de ação inferior a 200 km), seriam suficientes para atualizar e manter a rede física de ensino básico do estado com recursos financeiros incomparavelmente menores àqueles que seriam destinados para o mesmo fim utilizando-se técnicas convencionais de construção] (my translation).

9. Mass production: the rise and fall of a building replication model

From 1984 to 1992, Lelé came to implement – either directly or indirectly – five[64] factories in the largest four cities of Brazil (São Paulo, Rio de Janeiro, Brasília and Salvador), producing roughly 640 public schools[65] and countless other forms of civic infrastructure for poorer communities, such as bus shelters, benches and sanitation channels. However, this remarkable achievement, which started as a spurt of production, led to the actual devaluation of its main material: *argamassa armada*. To understand the significance of the shortcoming in Lelé's building replication model and how it helped to reshape the architect's further practice, it is essential to take a close look at both the production processes and the factories themselves.

Beyond the discontinuity of government programs in Brazil – which perhaps had the greatest impact on Lelé's industrial activities, as shown in Part II – other aspects seemed to gain importance or redirect the course of our narrative. Time, cost and the quality of components were among the crucial facets of each factory of this new phase. Nevertheless, the plants' infrastructure (and their layout), together with the availability of materials, inputs, labor force, logistics and other variables, should also be considered. In this context, it would be of interest to begin by mentioning some of the constraints on the development of *argamassa armada* and its main production supplies.

The steel sector in Brazil, which dates back to the first half of the twentieth century, could not adjust quickly enough to the increasing demand of metallic meshes generated by Lelé's factories during the 1980s. The result of this limitation had a direct impact on the design and production of precast elements in *argamassa armada*, especially in the first years of the architect's involvement with the material (1980-84).

> At that time, only welded meshes with a minimum grid of 5 cm x 5 cm and wires with a minimum diameter of 2.76 mm were available. Today, however, there are cheaper meshes with grids of up to 2.5 cm x 5 cm and wires of up to 2 mm. [At RENURB] we used double meshes, which meant that units had a minimum thickness of an inch. Nowadays, in Rio de Janeiro, the parts are only 18 mm thick. The behavior of the *argamassa* is therefore closely linked to the technology available at the time.[66]

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64 The five factories mentioned here are: The School Factory (Rio de Janeiro), the Argamassa Armada Factory (Brasília), FAEC (Salvador), CEDEC (São Paulo) and the CTRS (Salvador). This number does not include the CIAC factories implemented by third party building companies throughout Brazil. According to Mariano Casañas, 13 or 14 factories were installed in the country following Lelé's specifications. Mariano Casañas. Telephone interview with Adalberto Vilela on September 17, 2017.

65 This sum of precast *argamassa armada* schools is an attempt to give a more precise indication of Lelé's production utilizing a building typology to which he devoted great attention. The number was obtained by taking into consideration the official output of the architect's factories as follows: 200 schools in Rio de Janeiro (School Factory), 70 schools in Salvador (FAEC), 359 CIACs all over Brazil, 2 schools in Abadiânia (districts of Varginha and Barreirinho), 7 schools in São Paulo (CEDEC/EMURB), and 1 in the city of Goiás, executed by João Evangelista. A total of 639 schools.

66 João Filgueiras Lima, "A Industrialização da Argamassa Armada no Brasil," in *I Simpósio Nacional de Argamassa Armada* (São Paulo: Escola Politécnica da Universidade de São Paulo, 1986), 122-123 [Nessa ocasião, só eram disponíveis telas soldadas com malha mínima de 5cm x 5cm e fios com diâmetro mínimo de 2,76mm. Hoje, porém, dispõem-se de telas mais

Yet what is even more relevant to industrial concerns here is the evidence that the behavior of the material was still being assessed, which from the point of view of the manufacturing logic may seem quite unorthodox, especially considering that before initiating a large-scale production a well-defined idea of the input and output is normally required. For Lelé, both the primary material (*argamassa armada*) and the industrial product (*precast units*) were susceptible to modifications throughout their production process. With this clear notion of process in mind, the architect established a production method based on empirical investigations, countering the academic conservatism that assigned *argamassa armada* rigid valuation parameters.

The *argamassa armada* technical procedure says that the width of any element made of the material depends basically on five points: the *argamassa* cover thickness, the type and number of steel meshes, the presence of steel wires or bars, the arrangement of the reinforcement, and the dimensional tolerances.[67] Although some of these laboratory-tested variables had been investigated by professionals from the São Carlos School of Engineering from as early as the 1960s, the material only came to be normalized at the end of the 1980s. Despite the architect's unquestionable contribution to the application of *argamassa armada* in Brazil, his abstention from the elaboration of the standard NBR 11173/1990 – "*Argamassa armada*: design and execution" (*Projeto e execução de argamassa armada*) – arises a very precise issue for our chapter, namely the gap between the empirical use of the material and its regulations.

> In the case of *argamassa armada*, I was invited to participate in the creation of the standard. But a standard cannot be established when the process is evolving. Evolution presupposes change. And the norm presupposes staticity. I would be in favor of standardization, if it were done exclusively with evolutionary interest, according to the experimentation of the thing to be normalized. Never as a coercive instrument.[68]

Notwithstanding the architect's contentious notion of evolution applied to the manufacture of *argamassa armada*, his systematized use of the material over 10 years (1980-90) served "as a strong reference"[69] for the standardization committee, especially within the framework of the internal market. According to João Bento de Hanai, emeritus professor from

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econômicas com malhas de até 2,5cm x 5cm e fios de até 2mm. Era utilizada dupla tela, o que fazia com que as espessuras mínimas fossem de uma polegada. Hoje, no Rio de Janeiro, as peças tem apenas 18mm de espessura. O comportamento da argamassa é portanto muito ligado à tecnologia disponível no momento] (my translation)

67 João Bento de Hanai, *Construções de argamassa armada: fundamentos tecnológicos para projeto e execução* (São Paulo: Pini, 1992), 136. [da espessura do cobrimento da armadura, do tipo e do número de telas de aço, da presença de fios, barras ou cordoalhas de armadura discrete, de particularidades do arranjo da armadura, e das tolerâncias de execução admitidas] (my translation).

68 Lima, "João Filgueiras Lima, Lelé [Entrevista a Adriano Carneiro de Mendonça]," 132. [No caso da argamassa armada, me convidaram para participar da criação da norma. Mas não se pode estabelecer uma norma quando o processo está evoluindo. A evolução pressupõe mudança. E a norma pressupõe estaticidade. Eu seria a favor da normatização, caso ela fosse feita exclusivamente com interesse evolutivo, segundo as experimentações da coisa a ser normatizada. Nunca como algo coercitivo] (my translation).

69 João Bento de Hanai. Email interview with Adalberto Vilela on March 26, 2018. [uma forte referência] (my translation).

the São Carlos School of Engineering who chaired the commission which elaborated the standard on *argamassa armada*, the results incorporated in the Brazilian standard did not rely exclusively on laboratory tests.

In addition to the laboratory studies carried out in São Carlos, in the United States (at the University of Michigan, and at the Center for Advanced Cement-Based Materials, in Evanston, Illinois), at the AIT (Asian Institute of Technology, in Bangkok, Thailand), and in countries such as England, Australia, Israel, Japan and Poland, the standard NBR 11173/1990, recalls Hanai, "incorporated important aspects of its content based on codes established by the American Institute of Concrete (ACI), the Russian legislation on armocement structures and the international experience of Pier Luigi Nervi."[70]

If on the one hand the primary purpose of the Brazilian standard on *argamassa armada* had been the officialization of technology in compliance with what good practice recommended, on the other hand it is unlikely that Lelé's "misappropriation" of the material was not taken into consideration. In many cases, for instance, the architect exceeded the maximum permissible value (0.45)[71] of the water to cement ratio of his *argamassa* mixtures and the minimum limit (between 4 and 6 mm) for the *argamassa* cover thickness.[72] Nevertheless, the material quality of his components, which were submitted to aggressive environments (e.g. marine or in contact with the soil) performed favorably.[73]

Thus, the development of Lelé's factories followed the same empirical pattern expressed in the manufacture of his components. This is especially true if we observe how some procedures intended to accelerate production and increase the component quality were gradually introduced into the fabrication line, while old procedures were abandoned with the same swiftness. What we are going to see next is how Lelé's effort to mass-produce *argamassa armada* reached a point of inflection, which heralded a change in the product development.

9.1 A soldier of the Chinese Revolution with a Fordist mind

From 1984 onwards, Lelé started to wear the Chinese tunic, also known as the Mao suit, during presentations and public appearances. This may derive from his trip to China during the same year, whose impact goes far beyond the symbolic uniform. Besides his observations[74]

70 Ibid. [houve importantes aspectos que foram baseados no código do ACI e na norma russa de armocimento e na experiência internacional, especialmente a de Pier Luigi Nervi] (my translation).

71 Associação Brasileira de Normas Técnicas, *Projeto e Execução de Argamassa Armada (ABNT NBR 11173)* (Rio de Janeiro, 1990), 8.

72 According to the ACI 318/95 (American Concrete Institute Standard n. 318) concrete cover as protection of reinforcement against weather and other effects is measured from the concrete surface to the outermost surface of the steel to which the cover requirement applies. American Concrete Institute, *Building Code Requirements for Structural Concrete (ACI 318-95)* (Farmington Hills, Michigan, 1995), 318/318R-67.

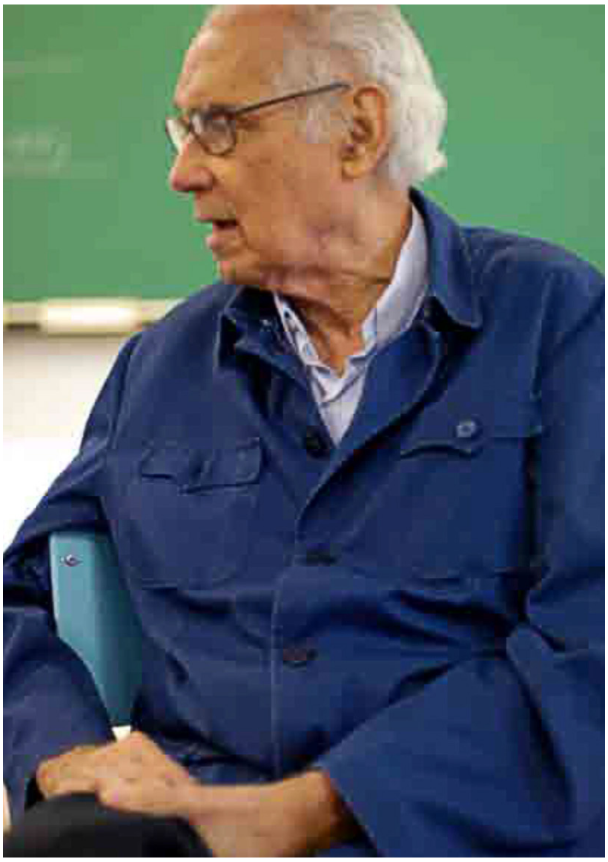
73 Hanai, *Construções de argamassa armada: fundamentos tecnológicos para projeto e execução*, 136–137.

74 João Filgueiras Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a*

concerning the social effects of the Cultural Revolution (1966-76), his attention may also have been drawn to the discipline of the factory workers. Regardless of their limited labor rights, workers had the right to study and work. All the factories were equipped with schools, a library and a kindergarten, as described by Lelé's friend and cartoonist Henfil, who was in the country in 1977.[75]

Lelé himself was definitely not unfamiliar with strict codes of discipline, as he had experienced the severe conditions of duty associated with the construction of Brasília (1957-60) and during the period he studied at the military school (1948-50). But it may have changed the way his next factory operated. The School Factory in Rio de Janeiro, although short-lived (1984-86), was the biggest step ever taken by Lelé in the implementation of a mass production plan in his practice. In terms of units manufactured and assembled, no other factory provided the architect with the scope and magnitude of production as he experienced in Rio. Neglected in the architect's first published monography,[76] the factory underwent very fast development, becoming a milestone in the architect's career. But to understand the effect of this moment on Lelé and his work, one must first understand the misleading questions behind its creation and shutting down.

In July 1984, around ten days before the visit of the then governor of Rio de Janeiro Leonel Brizola[77] to Abadiânia, on August 8, Lelé already had a clear



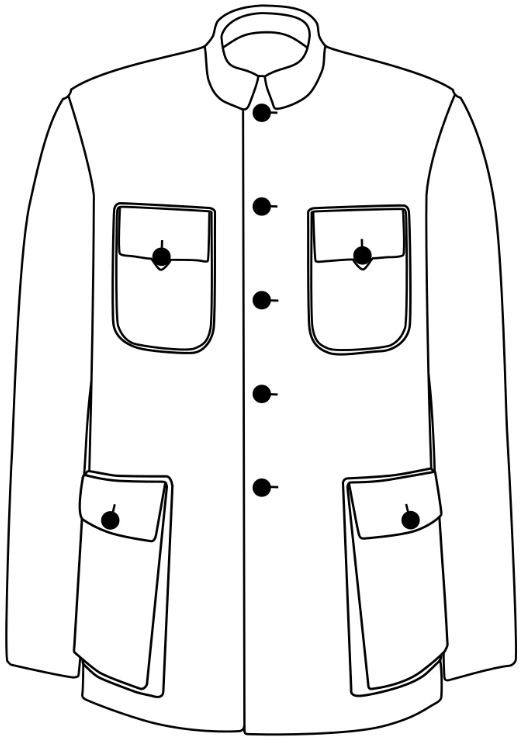


Fig. 3.37 Above: Lelé in his Mao suit during a conference in October 2010. Photograph by André Marques. In: André Marques. "*A Obra do arquiteto João Filgueiras Lima, Lelé: projeto, técnica e racionalização*," master thesis (Universidade Presbiteriana Mackenzie, São Paulo, 2012), p. 31. Below: The Chinese tunic suit. Source: Wikipedia

Cynara Menezes (Rio de Janeiro: Editora Record, 2004), 104.

75 See Henrique de Souza Filho, *Henfil na China: antes da Coca-Cola* (Rio de Janeiro: Record, 1984).

76 Giancarlo Latorraca, *João Filgueiras Lima, Lelé*, ed. Marcelo Carvalho Ferraz (Lisboa, São Paulo: Editorial Blau, Instituto Lina Bo e P.M. Bardi, 2000). However, a comparison was made between this School Factory session and the other plants (RENURB, Abadiânia, and CTRS) described in the book, and several images were dedicated to it, along with a brief extract from a letter exchanged between Lelé and Darcy Ribeiro.

77 The duration of the School Factory (from November 1984 to December 1986) corresponded with Leonel Brizola and Darcy Ribeiro's tenure in office in Rio de Janeiro (from March 1983 to March 1987).

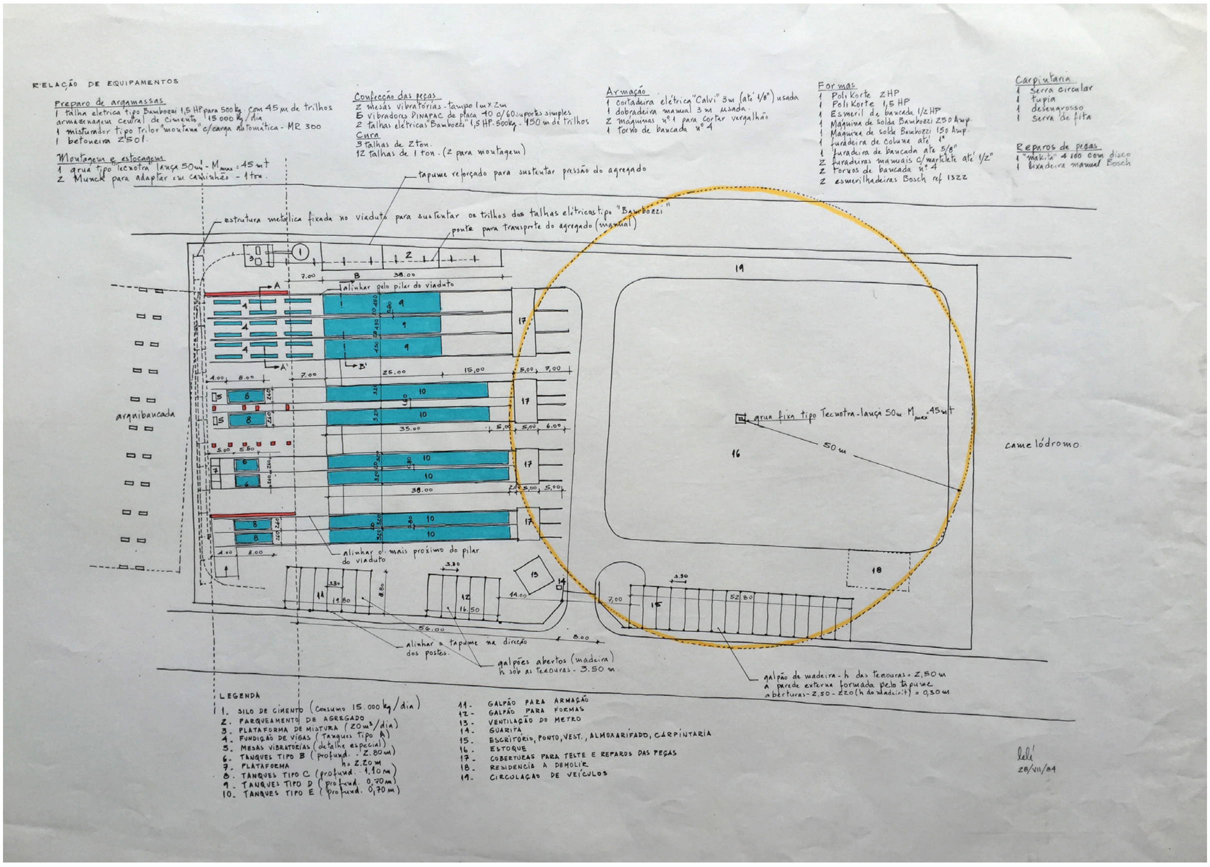


Fig. 3.38 The Rio de Janeiro School Factory's master plan with comprehensive list of materials and equipment. Drawing board dated July 28, 1984. Arquivo João Filgueiras Lima, Salvador

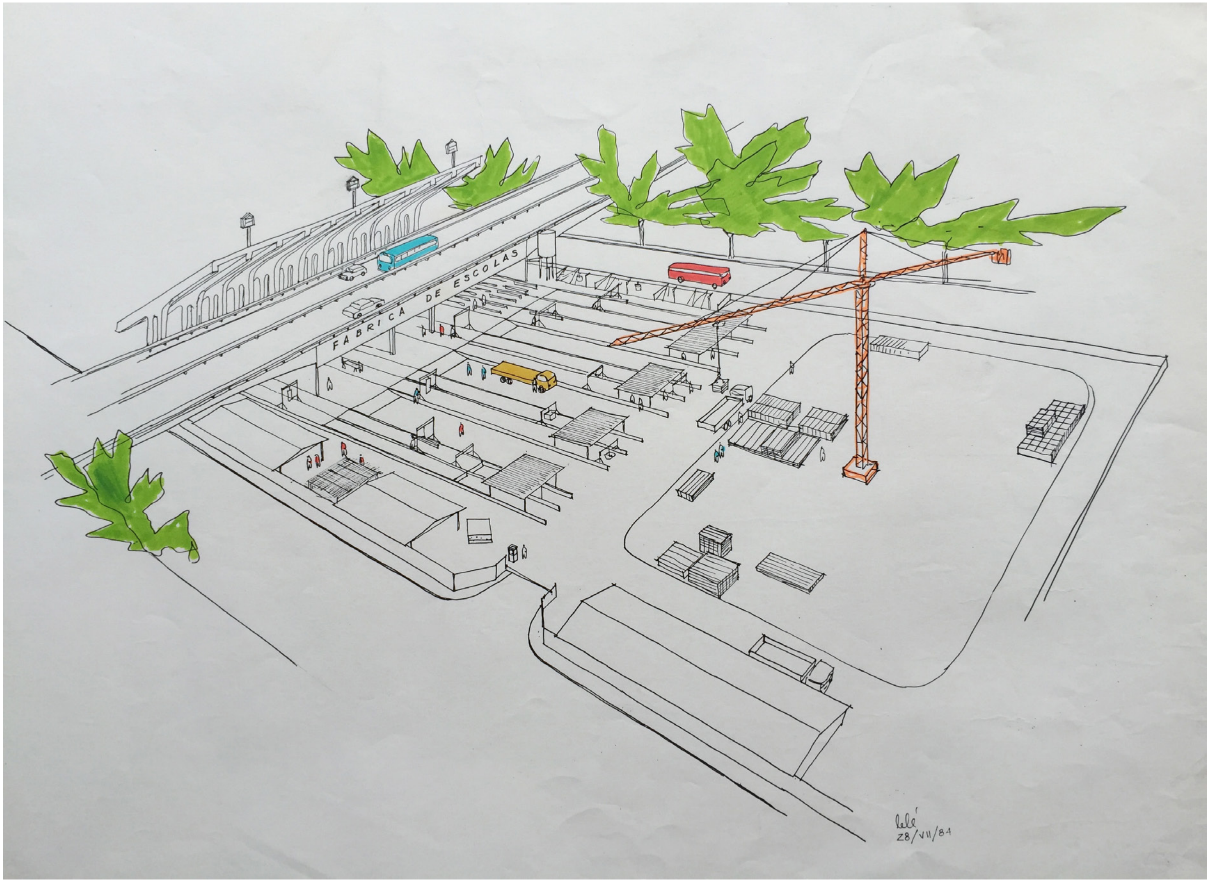


Fig. 3.39 Aerial view of the School Factory's first proposal with the casting area located under the *São Sebastião* viaduct. Drawing board dated July 28, 1984. Arquivo João Filgueiras Lima, Salvador

picture – at least in terms of production space – of what the outcome of the School Factory would be. A precise project for the new plant included a detailed list of equipment divided by sectors – such as *argamassa* mixture, formwork, curing, assembling, and stocking – all of which was necessary for commencing the production. It also presented a layout that, despite not having been implemented as indicated, gives us a hint about the organization of the manufacturing lines and their connection with the imagined sectors. What Lelé did not know was that his precast technique would assume unprecedented proportions from then onwards.

Fig. 3.40 Children's House (*Casa da Criança*). Lelé, 1984. Arquivo João Filgueiras Lima, Salvador

Fig. 3.41 Isolated school at the former *Jardim Guadalajara* (*Complexo do Alemão)*, Rio de Janeiro, 1985. Arquivo João Filgueiras Lima, Salvador

Inaugurated on November 28, 1984, the industrial complex in Rio was mainly designed to produce primary schools and childcare centers that would complement an on-going educational program, which we will discuss further. The idea was to use the expertise acquired with the *argamassa armada* prototypes developed in Abadiânia and reproduce them on a large scale in Rio de Janeiro. In some ways it worked out, as evidenced by the figures.

With approximately 3,000 employees at the outset of production – 1,800 of whom worked in the manufacturing line and around 1,200 in the on-site assembly activities – the School Factory built 180,000 m^2 of precast works in a little more than two years of activity (until December 1986). In the first 18 months, a large amount of public equipment was produced in Rio de Janeiro, encompassing 140 schools (with 8-14 classrooms each), 50 *Casas da Criança* (Children's Houses), and 11 health centers, as well as 1,200 bus shelters, 2 auditoriums, and 2,200 m of sanitation channels.[78]

More than 200 schools were built in total, amid isolated schools and Children's Houses. The difference between them was a matter of size and type of intervention. While isolated schools were destined for flat land using the model experimented in Abadiânia – with a terrace

78 Fábrica de Escolas de Argamassa Armada. Proposta para o Governo de Minas Gerais. João Filgueiras Lima, Lelé. Março, 1987, p. 24. Arquivo Kristian Schiel, Brasília.

on the same level as the classrooms and long cantilevers on the roof beams to enable peripheral circulation – the Children's Houses were designed to be assembled in Rio's hilly favelas.

In a letter to Darcy Ribeiro, Lelé clarified the modifications he had made to the *argamassa armada* school system after Abadiânia: "As you suggested, the main beams of the new model have been strengthened to allow the roof level to be used as a terrace."[79] Moreover, he added that despite the school's simple design, the change in the roof configuration and the complexity of the building's assembly (access, drainage, uneven topography, etc.) determined the creation of new components, such as a set of guardrails, a precast sun-canopy, and the incorporation of previously designed parts, such as drainage stairs and retaining wall units.

To understand the factory's operation, we must first examine how its strategic location favored the workforce and consider the impact of its physical expansion on production. The School Factory was located between *Presidente Vargas* avenue and *Benedito Hipólito* street, in a middle-to-lower-class neighborhood called *Cidade Nova*. Its proximity with the *Central do Brasil* – the most important train station of Rio de Janeiro – and its connections ensured that workers coming from both the North and West zones of the city could disembark close to their working area, which was viewed favorably overall.

Unlike Lelé's original plan (see Figs. 3.38 and 3.39), the first factory was installed on the other side of the *São Sebastião* viaduct, close to the *Praça Onze* (Square Eleven). The reason for this initial modification is probably related to the reduced area allocated for the casting sector, originally meant to occupy the space under the viaduct. A wider casting area was fundamental for Lelé to meet the political promise of producing two schools per day – a total of 300 (150 Children's Houses and 150 isolated schools) – from 1985 onwards. In order for this to happen, the architect assumed a daily production of 600 m^2 of *argamassa armada*, which left little space in the factory for research and new applications of the material.

Lelé's personal (and political) commitment to the schools was such that it practically absorbed all the production lines. A close look at the factory's functioning reveals how the work stations and sectors were shaped for producing the schools' components. Basically, the School Factory in Rio consisted of four light industrial buildings, organized in parallel with open-air functions in between them. Buildings dedicated to administration, casting, repair, and metallurgy were separated by three patios: the first with steel meshes, cement and sand stock; the second with the curing tanks; and the third with the crane and deposit area.

The embryonic metal workshop of Salvador (RENURB, 1980) gave place to a complete and independent metallurgic sector in Rio, which produced everything from the components' formwork to the electrical ducts and luminaires for the schools. From the School Factory onwards, Lelé no longer depended on imported molds from Brasília, since they started to be manufactured locally by Mariano Casañas and his team, under Lelé's supervision. It did not at first appear possible to promote a higher level of mechanization without compromising the

79 João Filgueiras Lima. Letter to Darcy Ribeiro. July 1984. In: Latorraca, *João Filgueiras Lima, Lelé*, 148.

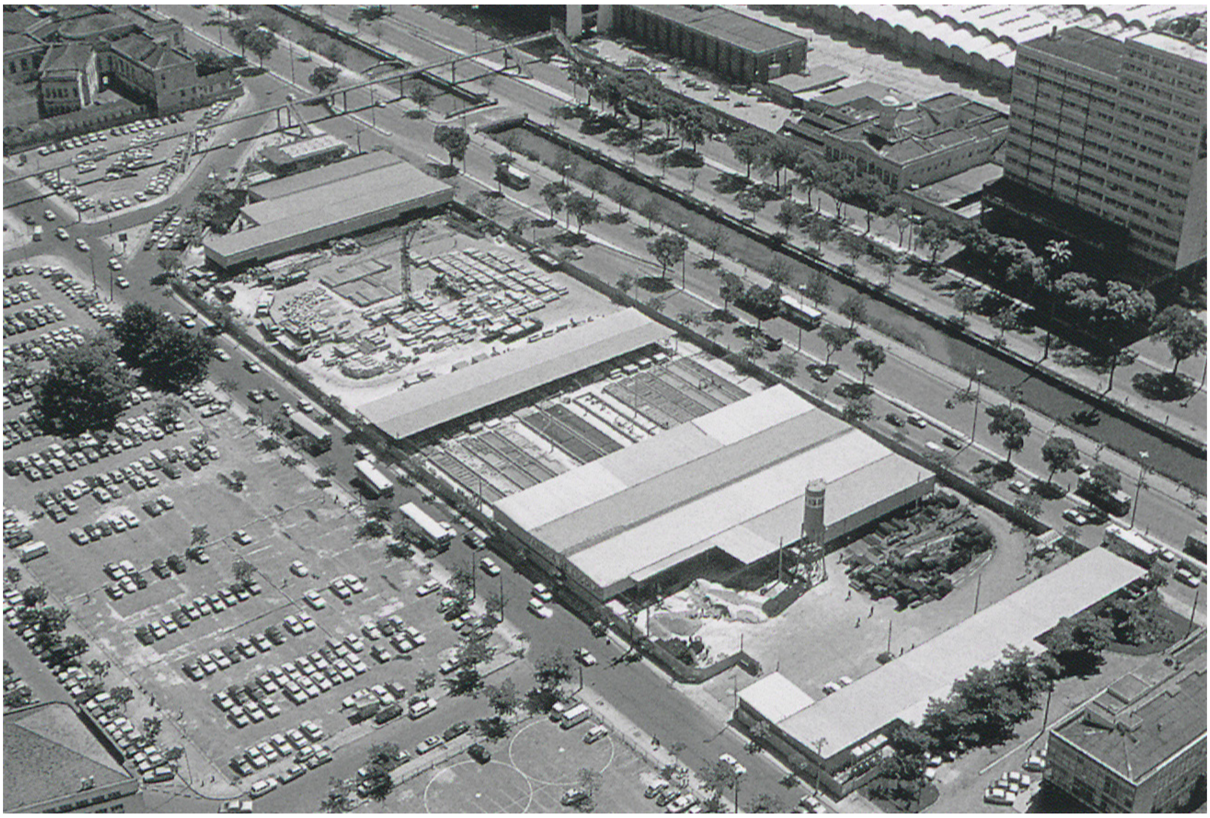


Fig. 3.42 The School Factory before the expansion of its facilities in the city center. Rio de Janeiro, 1984. Hugo Segawa. "Lelé: tecnologia com sentido social" In *A Arquitetura de Lelé: Fábrica E Invenção*, edited by M. Risselada and G. Latorraca. São Paulo: Imprensa Oficial SP, MCB, 2010, p. 64

factory's social commitment to the hiring of unskilled labor.

Let us not forget that the technology employed by Lelé allowed the School Factory[80] to hire more than 3,000 employees of all educational levels, and that 40% of the plant's operating expenses were destined for the payment of staff. From the roughly 3,000 people allocated to the production line, 80% were composed of workers with few or no qualifications, and 20% consisted of architects, engineers and skilled workers specialized in services like carpentry, metalwork, and electrical and hydraulic installations. The other 1,200 field workers dedicated to the buildings' assembly were hired directly from the poor communities where the works were being carried out.

Back to the question of mechanization, the performance of the *argamassa armada* casting sector had already given signals of automation in Rio. Electric hoists attached to the ceiling distributed the *argamassa* mixture transversally to the casting lines. Once the mixture was poured into the steel molds, they proceeded to be compacted at the vibrating tables – designed for each component – for several seconds, reducing air bubbles and voids inside the

80 The School Factory belonged to the state of Rio de Janeiro, but labor was hired out by third-party building companies. As a result of public bids, two companies were selected to provide services for Lelé and his team at the School Factory in Rio: Sanebrás Engenharia Ltda., responsible for erecting the factory itself, and H. Guedes Engenharia Ltda., in charge of the staff administration and the monthly production. At the end of each month, Lelé's team, therefore, saw to the measurement of the building works and payment of the companies. With information provided by: Zeca Franco. Interview with Adalberto Vilela on April 8, 2016 in Rio de Janeiro.

formwork. Despite this small level of mechanization at the casting area, a sliding gantry with manual hoists continued to be used for lifting and lowering precast components at the curing bays for many years.

It is widely known that Lelé only reached a higher automation level of production with his latest and long-lasting factory (1992-2009), the Technology Center of the Sarah Chain (*Centro de Tecnologia da Rede Sarah,* CTRS). However, without a sequence of prior attempts to reduce the manufacturing time involved with manual inputs – which started in Rio (1984) – no further development would have been possible in terms of both production acceleration and machinery. Therefore, the need to lower the average time for completing routine tasks was already an indication that Lelé had definitely incorporated the industrialist spirit into his practice with a clear idea in mind:

> What happens in the School Factory in Rio de Janeiro is that the production is much larger than the physical space itself. This is because the high number of employees, especially without qualifications, was purposely exaggerated to absorb a lot of labor. In this way, there is little automation, although the key is to achieve a very sophisticated product.[81]

The architect's pursuit of this sophisticated product, in reference to the *argamassa armada* elements, cost him dearly both technically and politically. Without the appropriate time to stop and think about the production and performance of the precast schools, Lelé found himself bogged down in work. According to Zeca Franco, architect and head of the assembly sector, "Lelé arrived at the factory at 6:30 in the morning and worked 14 hours a day, from Monday to Sunday. The daily meetings always took place at 7:00 p.m., after the staff returned from the field work."[82]

The situation only worsened when the government of Rio de Janeiro decided to duplicate the factory in September 1985, increasing its production from 400 to 600 m^2 per day, and hiring even more employees, totaling almost 4,000 people in 1986. At that time, at the request of the respective Governors, the factory was already being exported to other Brazilian states, such as the Federal District, Rio Grande do Sul, and São Paulo. When the so-called "greatest educational work in the country"[83] started to be attacked in the media by political opponents,

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81 Lima, "A Industrialização da Argamassa Armada no Brasil," 124. [O que acontece na fábrica do Rio de Janeiro é que a produção está muito maior do que o próprio espaço físico propicia, dado o elevado número de funcionários, que foi propositalmente exagerado, com o intuito de absorver bastante mão-de-obra, principalmente sem qualificação. Tem-se, dessa maneira, pouca automação, embora a tônica seja conseguir um produto bastante sofisticado] (my translation).

82 Zeca Franco. Interview with Adalberto Vilela on April 8, 2016 in Rio de Janeiro. [Lelé chegava na fábrica às 6:30 da manhã e trabalhava 14 horas por dia, de segunda a domingo. As reuniões diárias aconteciam sempre às 19 horas, depois que o pessoal voltava do campo] (my translation).

83 Darcy Ribeiro, "A demagogia de Jorge Leite *et caterva*," *Jornal Do Brasil* (Rio de Janeiro, October 31, 1985), 3. A letter in response to Deputy Jorge Leite's denunciation of João Otávio Brizola (son of the Governor), Darcy Ribeiro (vice Governor), the engineer José Carlos Süssekind, and João Filgueiras Lima for their alleged involvement in irregularities concerning the CIEP's public tender and payments.

Fig. 3.43 The School Factory after the expansion of its facilities in the city center. Rio de Janeiro, 1985. Giancarlo Latorraca. *João Filgueiras Lima, Lelé*. Edited by Marcelo Carvalho Ferraz. Lisboa, São Paulo: Editorial Blau, Instituto Lina Bo e P.M. Bardi, 2000, p. 148

Fig. 3.44 Lelé (left) and Darcy Ribeiro at the School Factory. Rio de Janeiro, 1985. Arquivo João Filgueiras Lima, Salvador

Darcy Ribeiro defended the factory's expansion based on the justification that this would be "the only form of production that guarantees the construction of schools in 20 days at a price that only reaches half of the usual cost, with immensely superior architectural and functional quality."[84]

The problem was that Lelé already knew that the quality to which Darcy Ribeiro referred to in his letter depended heavily on modifications implemented at the schools' component level. Sheds, internal partitions and beams, for instance, had already shown that their industrial production required adjustments. The production speed, amount, and especially design of these components led to small failures during the casting phase that undermined in their structural integrity in the short run. Most of these failures, such as the reinforcement exposure, were caused by the small thicknesses adopted by Lelé for his *argamassa armada* units – varying from 11 to 25 mm – which required severe quality control.

The complex process involving the pouring of *argamassa* into narrow metallic formwork – filled with welded meshes and steel bars – was exacerbated by the small openings at the top where the *argamassa* mixture was supposed to enter and the long way it had to travel until reaching the mold's bottom. This situation became even worse when it came to prefabricated components cast in a vertical position, like the panel walls. Standing 2.3 m high and with a width of only 18 mm, the schools' internal partitions were at risk of non-homogeneous casting or deficiencies in the *argamassa* cover thickness.

For Lelé, mass production was closely bound up with the design of components and systems. He was aware that any modifications proposed at the component level would impact the production chain – even if this required a new set of formwork for optimizing the casting time. Therefore, the architect reshaped small details in some elements expecting to solve problems he had already identified. This attitude became particularly perceptible with the gutter-beams and their physical modifications over the years.

During this phase, thanks to three consecutive versions of the element (see Fig. 3.45), Lelé improved the school's beam section (V1, V2, and V3), which resulted in better casting, demolding, and assembling procedures. Yet, it was a true challenge for the archietect to pour the *argamassa armada* mixture from the upper part of components, such as the gutter-beam. This element was cast in a horizontal position with narrow edges that varied in width from 2 cm in Abadiânia (and Rio de Janeiro) to 5 cm in Brasília (CIAC School). In her analysis, Cristina Trigo[85] pointed out that the limited mass of the V1 beam's upper part was insufficient to meet the compression stress to which the element was subjected in the middle of the span. Moreover, the narrow space could not accommodate – with enough thickness of *argamassa* cover – the reinforcement in the region of the supports and cantilevers, where the same upper part was then

84 Ibid., [a única forma de produção que garante a construção de escolas em 20 dias a um preço que apenas alcança a metade do custo habitual, com qualidade arquitetônica e functional imensamente superior] (my translation).

85 Cristina Câncio Trigo, "Pré-Fabricados em Argamassa Armada: Material, Técnica e Desenho de Componentes Desenvolvidos por Lelé" (Universidade de São Paulo, 2009), 123.

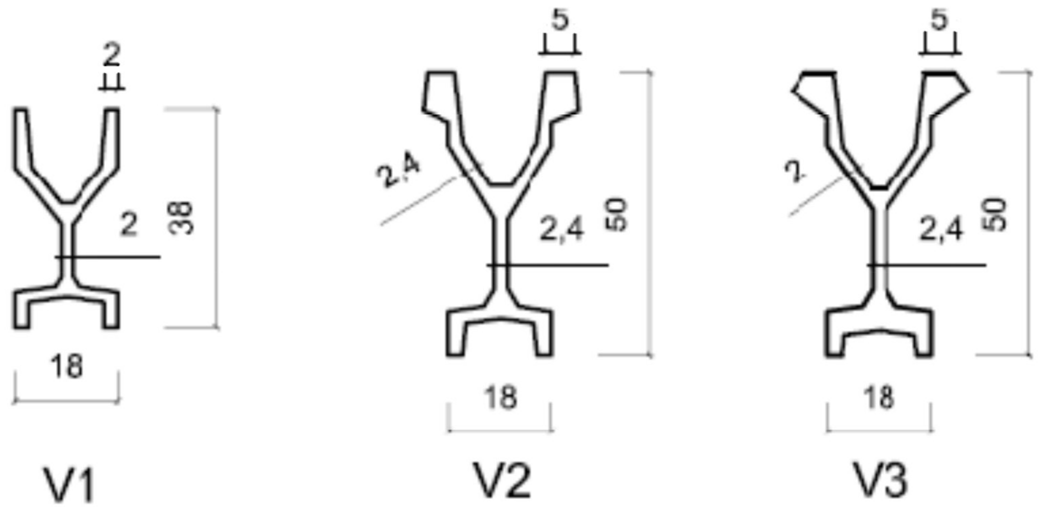

Fig. 3.45 Different versions of the gutter-beam over the years. The element appeared in 1982 in Abadiânia (V1) and had its design altered several times before its application at the CIAC schools (V3), in 1991. Cristina Câncio Trigo, master thesis (Universidade de São Paulo, 2009), 123

subjected to tensile stress.

In an interview with Trigo in 2008, Lelé admitted that when the beam received the other roof elements of the school, "its delicate support [of the beam's upper part], very fragile, sometimes broke."[86] Even if the required modifications could not be implemented when the School Factory in Rio was still in operation, what matters here is the architect's mental process towards the technological adjustments of his own systems. For as unseemly as it may sound, massively replicating a product clearly doomed to reformulation helped him to understand and identify the drawbacks. As Zeca Franco recalls:

> There was a subliminal process that Lelé left aside, but which existed. So much so that when he implemented systems in Salvador that derived from Rio, he in fact confirmed that the solutions had already been settled in his head. That intense production in Rio only reinforces the thesis of Richard Sennett, making is thinking, that is to say, the hand was informing the head of all that he would do next in Salvador. When you are working on the 1: 1 scale, making things, you are nurturing this intellectual process. Even if there is no formal attitude towards producing new technological fronts. But the project is there, in gestation.[87]

86 Ibid. [Esse apoio muito delicado, muito precário, às vezes quebrava] (my translation).

87 Zeca Franco. Telephone interview with Adalberto Vilela on November 10, 2017. [Há um processo subliminar que Lelé deixou de lado, mas que existiu. Tanto é assim que quando ele implementou em Salvador sistemas que derivam do Rio, no fundo ele confirma que as soluções já estavam resolvidas na sua cabeça. Aquela produção intensa no Rio apenas reforçam a tese de Richard Sennett, fazer é pensar, ou seja, a mão estava informando a cabeça tudo que ele iria fazer em Salvador em seguida. Quando você está trabalhando na escala 1:1, realizando as coisas, você está alimentando esse processo intelectual. Mesmo que não haja formalmente uma atitude de produção de novas frentes tecnológicas. Mas o projeto está ali, em gestação] (my translation).

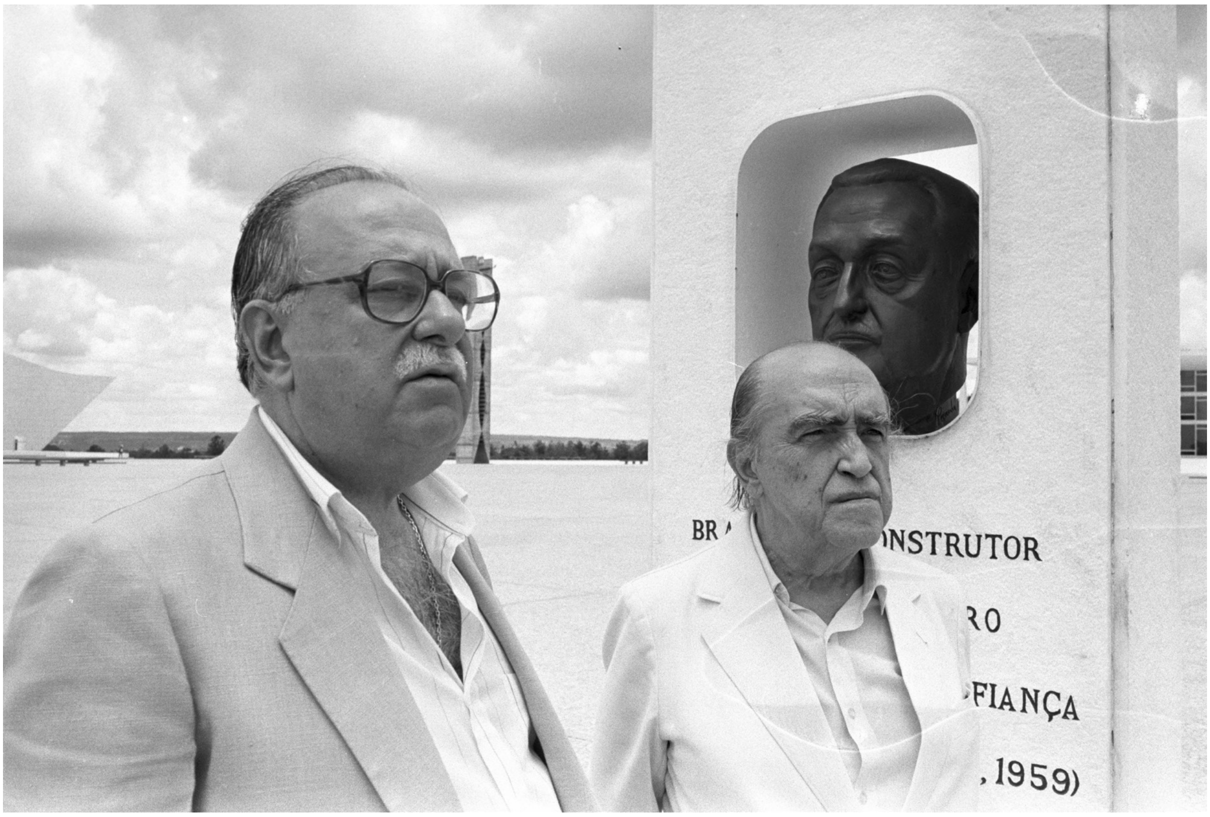

Fig. 3.46 The Governor José Aparecido de Oliveira (left) and Oscar Niemeyer in Brasília. Undated. Arquivo Público do Distrito Federal, Brasília

But the modifications Lelé intended to make in order to improve the quality of his mass-produced components would not be applied immediately. More than one year before moving back to Salvador, where these modifications effectively took place, Lelé installed his next factory in Brasília in parallel with the works in Rio. Inaugurated in October 1985 by the then Governor of the Federal District José Aparecido de Oliveira (1985-88), the *Argamassa Armada* Factory already appeared outdated. Oliveira's government program was based on the resumption of projects elaborated by the original team of architects of Brasília, and the creation of new solutions for the city. Thus, figures such as Oscar Niemeyer, Lucio Costa, Burle Marx and Lelé were invited to rethink the new capital.

The fact that Lelé reproduced the same procedures and conditions in Brasília that he had found in Rio de Janeiro, suggests that he perceived the new industrial opportunity in the capital as a mere continuation of the on-going works of the School Factory. Despite the difference between the manufacturing capacities in both cases – with production more accentuated in Rio – one factor distinguishes these two experiences: the master plan. The inversion proposed by Lelé for the metal sector – moving it from the back of the factory, placed behind the storage area in Rio, to the very front, close to the main entrance, in Brasília – was apparently for a good reason. The architect realized that positioning the metallurgy area close to the casting pavilion would prevent long displacements of the formwork within the plant.

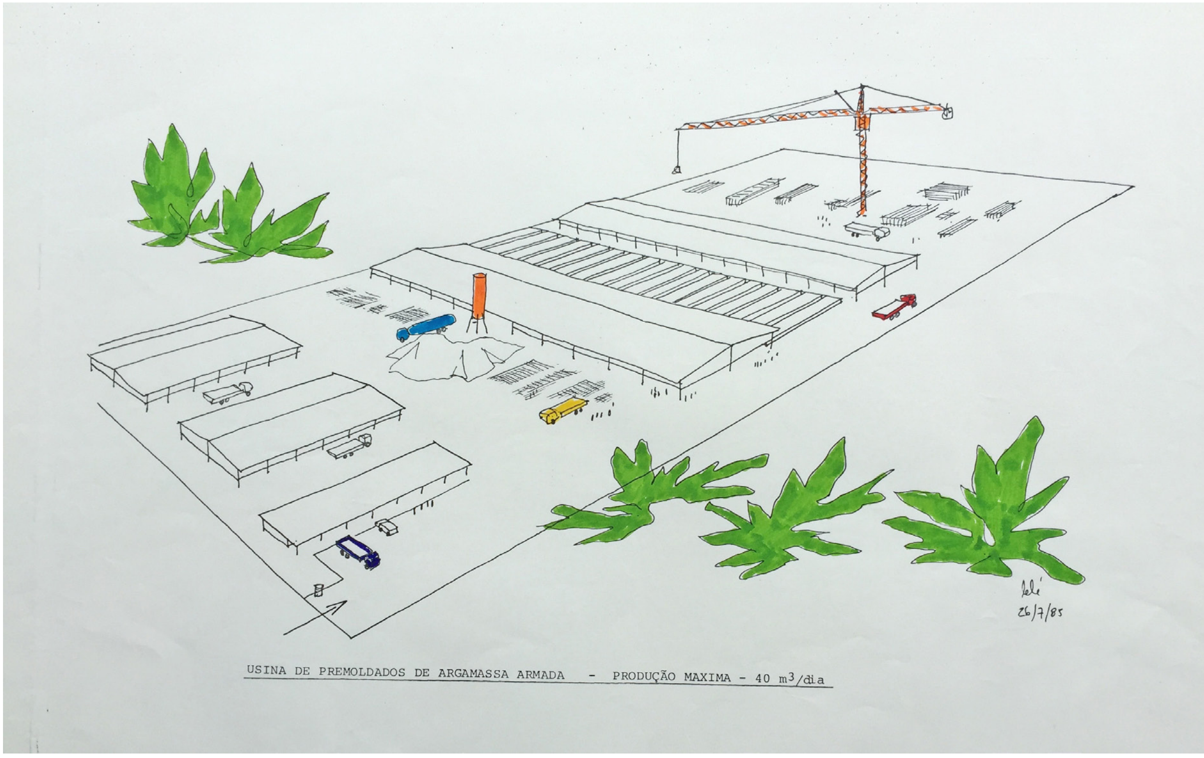

Fig. 3.47 Aerial view of the *Argamassa Armada* Factory in Brasília with the metal workshop located close to the plant's main entrance. Sketch by Lelé, July 1985. Arquivo João Filgueiras Lima, Salvador

In general, the closer the formwork cycle stays to the casting area – which includes a wide range of actions, such as manufacturing, retreating, cleaning and repairing – the lesser the strain (on the formwork). This strategy was not successful but it was also exported across Federal District boundaries to other factories managed by Lelé in other Brazilian states. It is important to highlight that, unlike the School Factory in Rio which was "duplicated" in 1985 – increasing in land area from approximately 16,000 m² in 1984 to 30,000 m² in 1985 – the *Argamassa Armada* factory in Brasília underwent more aggressive expansion over a longer time span, increasing from 56,000 m² in 1985 to 68,000 m² in 1991.[88]

The explanation for this relies on the long-term survival of the Brasília factory (1985-1994),[89] in comparison to the others. Located in the industrial district of Ceilândia,

Fig. 3.48 Official pamphlet of the *Argamassa Armada* Factory in Brasília with the slogan "the concrete solution for versatile designs." Arquivo Aires Carvalho, Brasília

88 Estela M. O. Lima et al., *A Implantação dos CAICs no Distrito Federal e Entorno* (Brasília, 1992), 5. Arquivo Aires Carvalho, Brasília.

89 According to Aires Carvalho, the *Argamassa Armada* factory in Brasília ceased its activities only at the beginning of 2007, during the Governor José Roberto Arruda's tenure in office (2007-2010). 1994 was the year when the production of the CIAC schools was shut down. In: Aires Carvalho, interview with Adalberto Vilela on May 25, 2016 in Brasília.

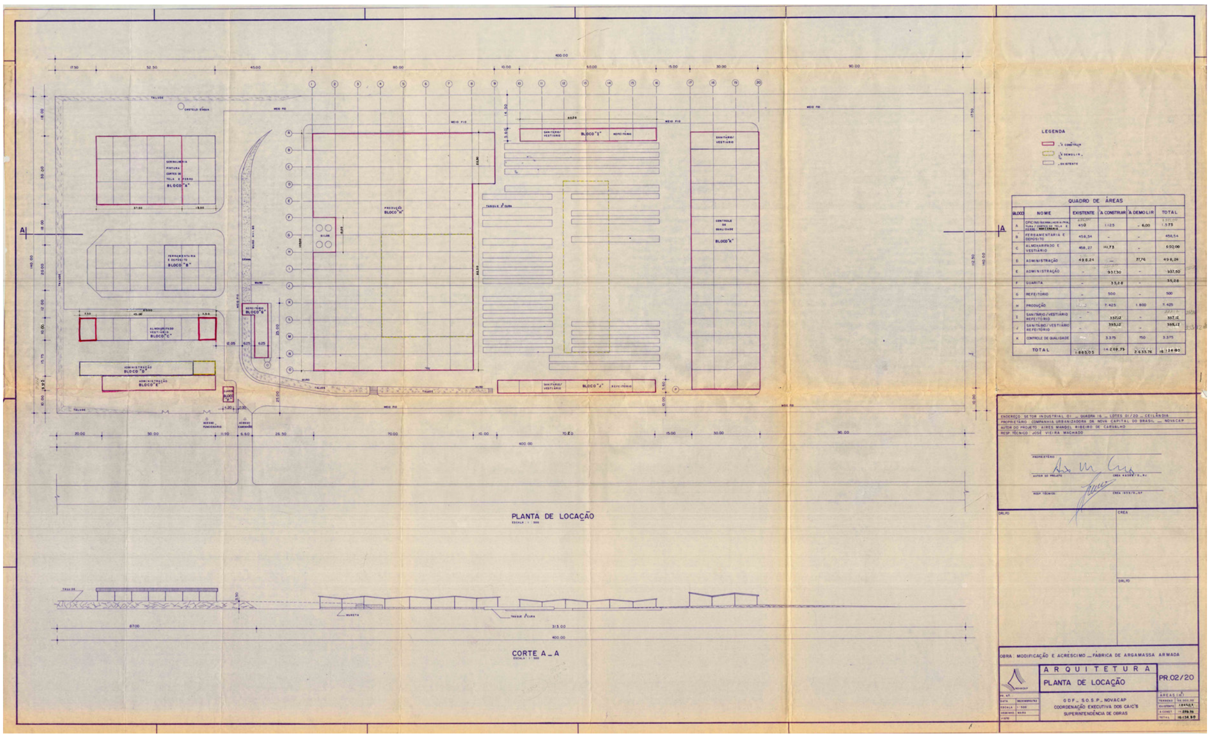

Fig. 3.49 Expansion plan of the *Argamassa Armada* Factory in Brasília, Ceilândia satellite city. All the areas marked in red indicate the new buildings to be erected. Drawing board no. PR.02/20. Novacap Works Superintendency, 1992. Arquivo Aires Carvalho, Brasília

Fig. 3.50 Aerial view of the *Argamassa Armada* Factory in Brasília (Ceilândia satellitte city) displaying the expansion of the facilities. Arquivo Aires Carvalho, Brasília

34 km outside *Plano Piloto*, the *Argamassa Armada* industrial plant had its output dramatically affected by the inclusion of the CIAC schools on the production line in 1991. At first, with a production capacity limited to 12 m^3/day, the factory produced 24 schools, 8 health centers, 3 kindergartens, 6 police stations, and 9 administrative buildings spread across the Federal District.[90] After 1991, however, the daily production jumped to 65 m^3, which allowed the factory to produce 3.5 CIACs per month, 19 of which were erected in the metropolitan area of Brasília by 1992.[91]

When compared to the School Factory in Rio, whose production reached 600 m^2 of *argamassa armada* per day, as mentioned previously, the factory in Brasília may not represent a considerable leap forward in the quantitative expression of prefabrication outcome. Even considering its wide investment in infrastructure – such as the batching plants, mixers of 375 liters/min, 4 cement silos of 100 t each and 355 tons of metallic molds[92] – the *Argamassa Armada* industrial plant did not work as expected, mostly due to management issues.

Together with the factory in São Paulo (CEDEC), which we have yet to discuss, and other minor experiences,[93] the factory in Brasília was one of the few prefabrication plants implemented by Lelé that operated without the direct coordination of the architect. This led to a series of technical divergences regarding both the final product and the factory's functioning and can be interpreted in at least two ways: by insisting on the role of Lelé in the direct management of the facilities, and by questioning the autonomy of the factory in production management, regardless of the architect's interference.

To fully grasp these points, we must first understand the circumstances of the creation and management of the *Argamassa Armada* factory in Brasília. When the Governor José Aparecido proposed installing an industrial plant to produce precast *argamassa armada* components in the Federal District in 1985, he left the factory's administration to Novacap[94]. As a public company that belongs to Brasília's government, Novacap has always maintained close links with the Secretariat of Public Works, at that time chaired by the architect Carlos Magalhães.[95] Niemeyer's right-hand man in Brasília, Magalhães did not get on well with Lelé.

Besides, Novacap's slow-paced mechanisms for commercial contracts (input purchasing, for instance) irritated Lelé to such an extent that the architect decided to quit the works in Brasília and go back to Rio. But he left behind a part of his team, entrusted to collaborate with

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90 Kristian Schiel, *Considerações sobre o fechamento da Fábrica de Argamassa* (Brasília, 1990). Arquivo Kristian Schiel, Brasília.

91 Lima et al., *A Implantação dos CAICs no Distrito Federal e Entorno*, 5. Arquivo Aires Carvalho, Brasília

92 Ibid.

93 In this work, I will not address the factories installed by Lelé in Campinas (early 1990s) and in Ribeirão Preto (Fabes, *Fábrica de Equipamentos Sociais*, 2002-04), due to their minor contributions to the topic.

94 Instituted by Law n. 2874 of September 19, 1956, the Urbanizing Company of the New Capital of Brazil (*Companhia Urbanizadora da Nova Capital do Brasil*, Novacap) was responsible for transferring the capital from Rio de Janeiro to Brasília and building it on the country's Central Plateau.

95 Carlos Magalhães da Silveira (1933) is a Brazilian architect who collaborated with Oscar Niemeyer on many projects in Brazil and abroad. Magalhães studied architecture in Rio de Janeiro and moved to Brasília in 1959, soon after his graduation. A skilled builder and well-connected professional, he oversaw the construction of the Cathedral of Brasília.

Novacap in the factory's management. As Haroldo Pinheiro, member of Lelé's team and one of the plant's coordinators, recalls: "That was our mistake: linking the factory to Novacap. They [Novacap] showed us [Lelé's team] a great deal of mistrust, and vice versa. We also had our uncertainties about the Novacap team."[96]

By the end of the experience in Ceilândia, in 1994, production was no longer in line with the respective industrial infrastructure. The interruption of the CIACs national program drove the *Argamassa Armada* factory to operate far beyond its output capacity, thereby leading to a long period of low yield. But supposing that the political interference had not affected the factory in Brasília at all, under which conditions would the existing structure have been effective in producing better results? Was Lelé's presence crucial in order to avoid future imbalances in production? Perhaps the answers to these questions are associated with those instruments the architect envisaged to minimize technical drawbacks.

Lelé knew that strict monitoring of the component quality would bring him a certain level of freedom in management to allow for new types of operation. The architect created a material analysis laboratory within the factory, imagining that if the properties of *argamassa armada* were tightly controlled, most of the problems related to casting, demolding and repairing would decrease. In a sense, he was right. A good *argamassa* mixture naturally provides better conditions for proceeding to those production phases. However, one final aspect remains which Lelé did not consider and which makes an enormous difference in view of his outbound strategy: the presence of a leader.

Despite his notorious failures as administrator, Lelé had an innate talent for managing and understanding people. Yet in the daily grind of architectural practice, his behavior oscillated between firebrand, ringleader and soldier,[97] such was his commitment. Like the experience in China, Lelé also implemented an educational program in Brazil for workers at his plants. But the learning challenge remained on a management level. The architect then realized that by gradually transferring his knowledge and skills this would help to prevent his absence from being perceived as a burden or cost to the ongoing prefabricated works. For this reason, from the very first factories, Lelé started training a small number of architect collaborators to employ a broad range of construction skills. "Whoever worked with Lelé knows the [architectural] system completely. He never taught us a building speciality. He forced us to work at every stage of building, saying, you are not an expert, but a global connoisseur. This he did with a privileged group of people, maybe about 10 or 12 who have these overall capabilities,"[98] affirmed Fábio

96 Haroldo Pinheiro. Interview with Adalberto Vilela on May 3, 2016 in Brasília. [Esse foi o nosso erro: vincular a fábrica à Novacap. Havia muita desconfiança deles (Novacap) para conosco (equipe do Lelé) e vice-versa. Nós também tínhamos nossas incertezas quanto à equipe da Novacap] (my translation).

97 'Soldier' was a term used by Zeca Franco to define Lelé's relentless dedication during the works at the School Factory in Rio. Zeca Franco. Telephone interview with Adalberto Vilela on November 10, 2017.

98 Fávio Savastano. Interview with Adalberto Vilela on May 31, 2016 in Brasília. [Quem trabalhou com Lelé conhece o sistema por completo. Ele nunca ensinou pra gente uma especialidade. Ele obrigava a gente a fazer tudo. Você não é um especialista, mas um conhecedor global. Isso ele fez com um grupo privilegiado de pessoas, talvez uns 10 ou 12 que possuem essas capacidades globais] (my translation).

Savastano, Lelé's former collaborator.

But his return to Rio de Janeiro in 1986 did not end well for Lelé, nor his factory. All hope of continuing the School Factory disappeared after the political defeat of Darcy Ribeiro and his candidature for state governor. In the second half of the same year, the factory was transferred from the state to the municipal government (Saturnino Braga), and its new location in Santa Cruz, 64 km away from the center of Rio, marked the beginning of the decline in its manufacturing activities. Given this scenario, Lelé returned to Salvador to begin what would be the most fertile and creative period of his manufacturing production, the City Factory.

9.2 Mitigating the constraints of innovation

Following Mário Kertész's withdrawal from the Salvador mayor's office in November 1981, the uncertain future of the RENURB factory began to surface. Designed to produce urban equipment for sanitation and transportation works, the factory's number of staff increased considerably over the next few years and production decreased, contributing significantly to its closure. With Kertész's return to the City Hall in 1986, this time elected,[99] Lelé became reintegrated into the mayor's team and his political project. Together, they realized that it was easier to create a new factory than try to recover RENURB. Thus, the FAEC (*Fábrica de Equipamentos Comunitários*) – or City Factory – emerged, as envisioned by its founder, the anthropologist Roberto Pinho. With new features regarding production, the City Factory introduced a new intent: to produce lightweight prefabricated buildings.

The shift from a technologically restrictive and centralizing posture at RENURB towards more agile, decisive and prolific initiatives at FAEC indicated a new manufacturing phase in Lelé in which the architect sought to move beyond the limits of *argamassa armada*. The mere reproduction, on a large scale, of the precast primary schools and sanitation channels – to mention the most explored programs – was no longer enough. In the new factory, Lelé was free to invent new typologies and create solutions to familiar issues.

Examples of the "inventive accreditation" process favored at FAEC can be found in the two-story primary schools (1986) and the Ceilândia hospital's project (1987). The adaptation of the previous school system required not only the creation of new components – like slabs, beams and pillars – but the unfolding of joints and connectors that allowed for the building's vertical expansion. The cross-shaped metallic tube, for instance, was intended to fulfill two primary functions: to ensure the rigidity and general stability of the school to withstand horizontal forces, and, at the same time, to conduct the rainwater through the column.

99 Despite his political break with Antônio Carlos Magalhães, who had appointed him to office in 1979, Mário Kertész was elected as Mayor of Salvador with 61.6% of the votes in 1985, proving a high degree of popularity. See Vale, "João Filgueiras Lima (Lelé): Arquitetura Pública e Urbanismo em Salvador (1979-81 e 1986-88)," 215.

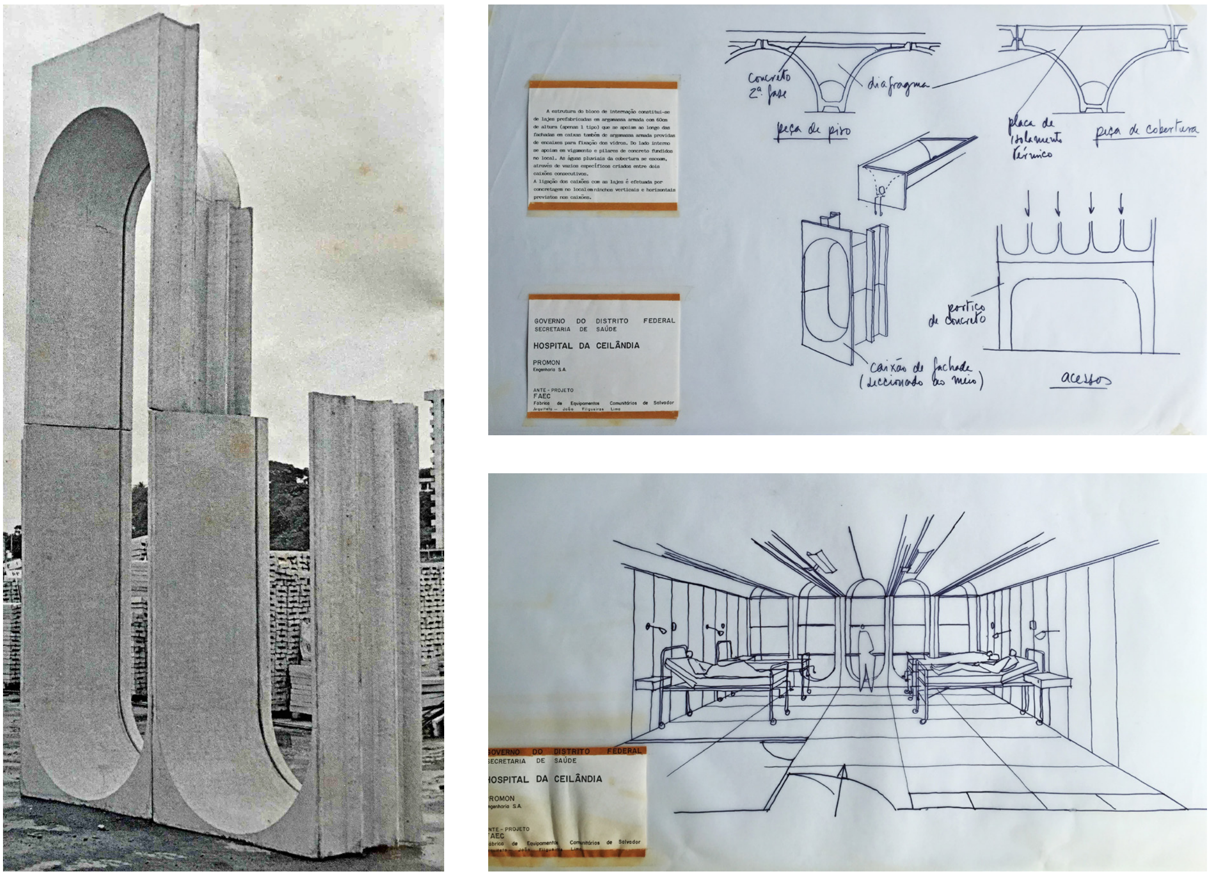

Fig. 3.51 Ceilândia hospital (unexecuted) designed to be produced by FAEC in Salvador and assembled in Brasília. Lelé, 1987. Left: Façade element prototype. In: Lívia Pedreira. "Estética Da Repetição." Arquitetura e Urbanismo 4, no. 20 (1988): 38. Right: Sketches by Lelé showing constructive details and internal spaces of the hospital. Arquivo João Filgueiras Lima, Salvador

In this phase Lelé advanced his research, crossing the boundaries of traditional precast components. In an effort to add more flexibility to the hospital project, the architect introduced hybrid features to the façade element, making it adjustable to fit the building's various indoor heights. Although the hospital did not end up being built, the element's real-size prototype in *argamassa armada* was constructed at FAEC, making tangible the architect's goal of advancing in the study of precast movable parts.

The FAEC period was ripe for far-reaching modifications to the existing precast buildings Lelé was still linked to, namely, the integral construction model in *argamassa armada*. Notwithstanding the highest autonomy verified at FAEC's metal sector – which started to produce steel building structures in Salvador and no longer just the formwork, as in Rio de Janeiro – Lelé ventured out to explore other materials and constructive systems. His research on canvas roofs supported by prestressed steel cables anchored to metallic masts converged with the design of two unexecuted buildings for the coastal area of Salvador in 1986. Together, both the *Parque do Aeroclube* (with a central span of 131.75 m) and the intervention at the *Largo da Mariquita* showed Lelé's willingness to go far in the direction of prefabricated buildings with large spans.

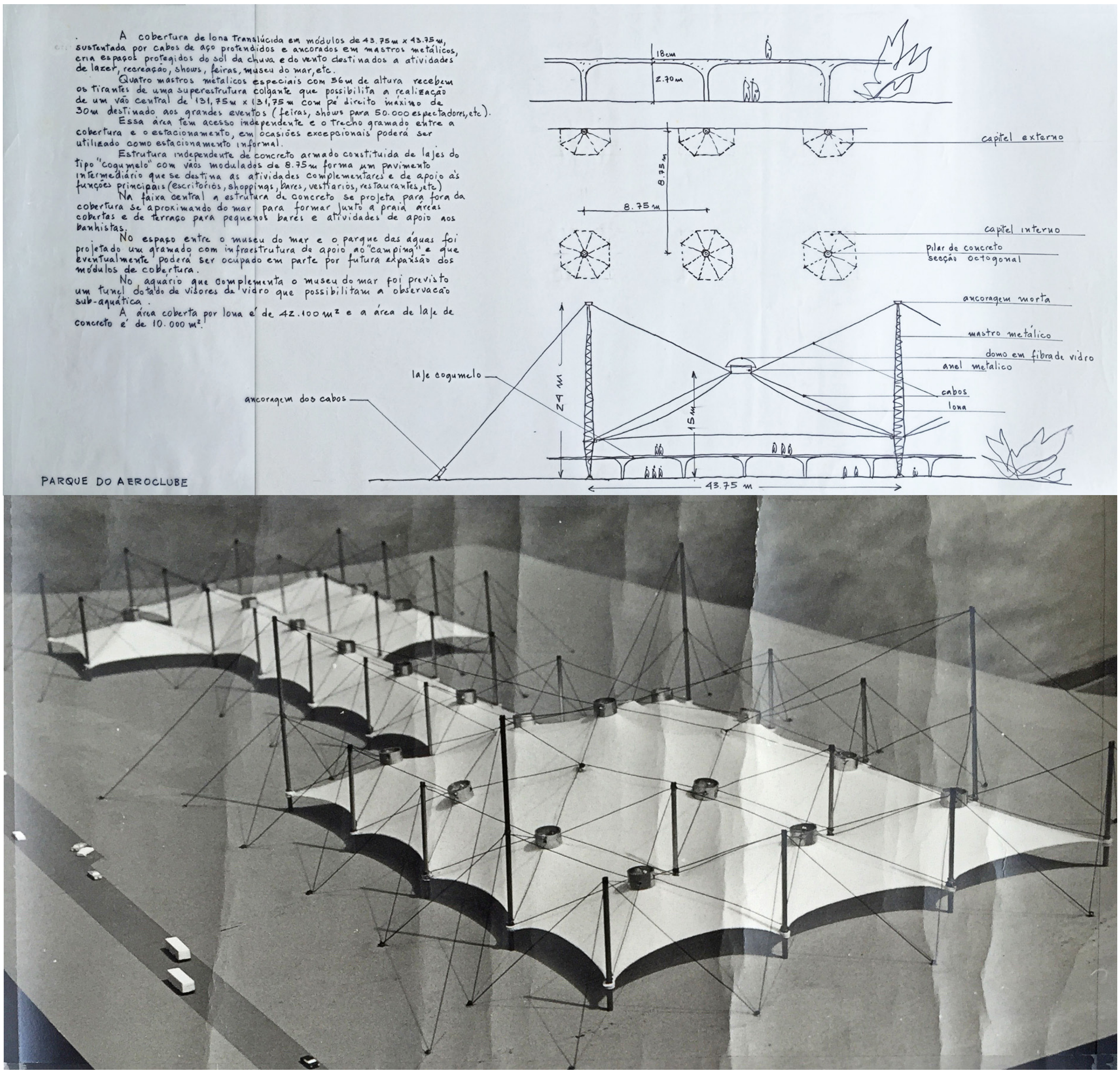

Fig. 3.52 Parque do Aeroclube in Salvador (unexecuted). Lelé, 1986. Above: descriptive memorial and cross section of the central span module. Below: phograph of the scale model. Arquivo João Filgueiras Lima, Salvador

However, faced with obstacles to making progress with so many new types of product and process, the FAEC plant focused on meeting the most urgent infrastructure demands of the city. Therefore, production did not follow the same dynamics of innovation that the new projects had proposed, being restricted to previous standards where labor surpluses, open-air curing tanks, a large stock area and basic mechanization maintained the status quo . With roughly 35 long open-air curing bays,[100] the factory ended up reinforcing a weather-dependent model of the curing process whereby the *argamassa armada* parts remained submerged in shallow water tanks heated by the sun. This model, which originated at Lelé's first factory (Renurb, 1979-81), would only be amended by new procedures at the Technology Center of the Sarah Chain (*Centro de Tecnologia da Rede Sarah*, CTRS) from 1992 onwards.

100 According to Tomáz Bacelar, head of the *argamassa armada* workshop at the CTRS, the FAEC curing tanks were 60 m long and 2.60 m wide. In: Tomáz Bacelar. Telephone interview with Adalberto Vilela on January 29, 2018.

Fig. 3.53 The City Factory (FAEC) in Salvador. Above: aerial view of the plant's facilities in the district *Caminho das Árvores*. Below: Faec's production area showing the curing tanks and some precast elements, such as the gutter-beam and the star-shaped foundation. Arquivo Fundação Gregório de Mattos, Salvador

Curing remained a crucial aspect across the entire lifespan of Lelé's factories. Many successful or failed experiments were conducted throughout the FAEC's three years of operation. "One of the problems posed in the production of large-scale parts was the cure, due to the problems of retraction caused by the high cement content of the mortar mix. Several experiments were carried out, including moistened sand, and the best result was the immersion curing in water. Such a system is still used today."[101]

Despite its short duration (1986-88), the FAEC factory was deemed "the richest and most fruitful"[102] experience among all Lelé's factories. The reason for this, according to the architect, was twofold: the tangible benefits brought to the population of Salvador – with projects like the footbridges (Fig. 3.54), the urbanization of public squares, the construction of schools, kindergartens, the City Hall and the intervention in the historic center (Lina Bo Bardi and Lelé, 1987-88) – and the technological research that laid the foundations for subsequent factories.

The enhancements of the *argamassa armada* industrial procedures observed in the state-owned plants set up in Brasília (1990-94, construction of the CIAC schools), São Paulo (1990-93, CEDEC Development Center) and Salvador (1992-2009, CTRS Technology Center) were largely driven by FAEC's concerns and priorities regarding formwork and casting issues. The relevance these topics acquired within Lelé's manufacturing activity became visible after his return to Bahia.

Whereas the CIAC schools have already been discussed from both political and technological points of view, the Technology Center of the Sarah Chain will be analyzed in the next and final section of this chapter. But what interests us here is to highlight the production issues which arose in the intersection between FAEC and another factory called CEDEC, the Center for the Development of Urban and Community Equipment (*Centro de Desenvolvimento de Equipamentos Urbanos e Comunitários*). Installed in São Paulo during the leftist mayorship of Luiza Erundina[103] (1989-92), the CEDEC represented a deep revision of the manufacturing methods implemented by Lelé at FAEC in Salvador.

By placing both experiences under the same analytic lens, I shall attempt to show how the innovations introduced and tested by the CEDEC team affected the way Lelé regarded and produced *argamassa armada* from then on. Even if this exchange was carried out as a sort of back and forth movement between empirical use and scientific development, the contribution

101 Lima, "A Industrialização da Argamassa Armada no Brasil," 122. [Logo de saída, um dos problemas colocados na produção de peças em grande escala foi a cura, devido aos problemas de retração de uma argamassa muito rica. Foram feitas várias experiências, inclusive com areia umedecida, e a de melhor resultado foi a cura submersa em água. Tal sistema é utilizado até hoje] (my translation).

102 Latorraca, *João Filgueiras Lima, Lelé*, 154.

103 The Brazilian politician Luiza Erundina de Sousa was born in 1934 in a small city of the state of Paraíba. Her election to serve as São Paulo's mayor from 1989 to 1992 was considered one of the most important achievements of the Brazilian Workers Party (PT). Her government was composed by a group of internationally known leftist intellectuals, who took care of the main Secretariats. These included: the economist Paul Singer (Planning), the educators and philosophers Paulo Freire and Mário Sérgio Cortella (Education), the writer and philosopher Marilena Chauí (Culture), etc.

Fig. 3.54 Construction stages of a footbridge produced by FAEC in Salvador and assembled in Brasília, 1988. Arquivo Aires Carvalho, Brasília

of the experiments conducted in São Paulo to the optimization of the CTRS' *argamassa armada* workshop in Salvador is unquestionable.

Before entering the discussion of these innovations, it might be useful to consider the distinct nature that characterized the two factories. While the FAEC inherited the "mass-production" conception from the School Factory in Rio, the CEDEC factory worked at a more gradual pace of production. The idea was to start with simple urban furniture, such as trash bins, benches, and sanitation channels, and gradually move to more complex equipment, like the schools and kindergartens. It is important to mention that Lelé was not an actual member of the CEDEC team, working mostly in the background as an eventual consultant.

However, this did not prevent the architect from exercising influence on the center's coordination board. Unable to join the CEDEC project because of the CIAC national program under development in 1990, Lelé suggested in a meeting with Erundina that the architect Mayumi Watanabe Souza Lima should chair and organize the new center. Mayumi, who had worked with Lelé at the beginning of the 1960s at the University of Brasília (CEPLAN) and whose master thesis[104] had been supervised by Lelé (1963-65), seemed the most appropriate name in São Paulo.

The problem was that despite Mayumi's early interest in prefabrication, she had by now distanced herself from the constructive aspects of production, becoming more affiliated with themes combining architecture and education. This does not imply, however, that Mayumi did not get involved in matters related to technical and working conditions. On the contrary, not only did she support the integration between the local staff and part of Lelé's team[105] based at the factory, but she also, and most importantly, "mustered sufficient political support to overcome the difficulties associated with the factory development."[106]

The first great challenge for Mayumi as head of the CEDEC's coordination was the short period allowed for setting up the factory and putting it into operation. With a small team[107] working temporarily at the iconic Martinelli building,[108] the CEDEC office had only a few months to organize and carry out the research on materials and industrialized building systems. In April 1989, the São Paulo Municipal Urbanization Company (*Empresa Municipal de Urbanização*, EMURB) – of which the CEDEC factory would become an integral part –

104 Mayumi Watanabe Souza Lima, "Aspectos Da Habitação Urbana: Projeto de Habitação Coletiva Para a Unidade de Vizinhança São Miguel" (Universidade de Brasília, 1965).

105 The first member of Lelé's group to take part in the CEDEC team was the architect Kristian Schiel. He was followed by Fábio Savastano – assigned to lead the assembly sector – and later Waldir Silveira, Roberto Vitorino and Mariano Casañas. In: Paulo Eduardo Fonseca de Campos. Telephone interview with Adalberto Vilela on December 21, 2017.

106 Paulo Eduardo Fonseca de Campos. Telephone interview with Adalberto Vilela on December 8, 2017. [dar o apoio político necessário ao desenvolvimento da fábrica frente às inúmeras dificuldades] (my translation).

107 According to Paulo Eduardo Fonseca de Campos, the CEDEC factory initiated its activities with Mayumi Watanabe Souza Lima, Kristian Schiel and himself. In: Paulo Eduardo Fonseca de Campos. Telephone interview with Adalberto Vilela on December 21, 2017.

108 Standing 30 storeys high, the Martinelli Building was the first skyscraper in Brazil and the tallest building in Latin America when it was inaugurated (1929). Designed by the Italian-Brazilian entrepreneur Giuseppe Martinelli, the building housed many companies from the São Paulo public administration, such as EMURB, COHAB and many others.

Fig. 3.55 CEDEC's inauguration in 1990 in São Paulo. At the center the Mayor Luiza Erundina, together with the workers and Mayumi Watanabe (in red), head of the factory. Arquivo Paulo Eduardo Fonseca de Campos, São Paulo

published a booklet entitled "Alternative *Argamassa Armada*" (*Opção Argamassa Armada*).[109] In the study, the public company ratified the choice of the material and its possibilities for construction by depicting examples mainly from Lelé's previous factories, particularly the FAEC in Salvador. In the face of a favorable political situation,[110] the material was presented as a "unique opportunity"[111] to engage in a joint action between the largest and richest cities of the São Paulo Metropolitan Area.

Fig. 3.56 Booklet produced by EMURB (1989) that gave rise to CEDEC's manufacture model based on *argamassa armada*. Arquivo Kristian Schiel, Brasília

By approving *argamassa armada*, the City Government saw "an important ally in the current administration for the stance it was taking in relation to its projects and investments: the starting point is the user and the point of arrival is the quality

109 Marilda Fróes, *Opção Argamassa Armada* (São Paulo: EMURB, 1989).

110 At that time, cities such as São Bernardo, Santo André, Diadema, Santos, Campinas and Piracicaba were all under the administration of the Workers Party (*Partido dos Trabalhadores*, PT), like São Paulo.

111 Ibid., 10.

improvement of the built environment that is offered."[112] Unlike Mário Kértesz, Leonel Brizola, José Aparecido or Fernando Collor – who also used *argamassa armada* politically in their mandates – Luiza Erundina seemed to have emphasized more the importance of "quality" than the benefits of "large-scale production." Not by coincidence, this orientation was perfectly aligned with Mayumi's discourse and practice.

For the architect and former head of the Secretariat of Public Works (EDIF) in São Paulo, "a kindergarten, for example, will no longer be a low-cost construction to be inaugurated, it will be the architecture of a place intended for children and therefore necessarily cheerful, bright, with areas designed for the specific needs of children in their development."[113] Perhaps this overemphasis on quality may have affected the outcome of CEDEC, a center which finally produced so little. Inaugurated on June 26, 1990 in a lower to upper middle-class neighborhood called *Canindé*, the CEDEC factory erected only seven prefabricated schools in São Paulo, among other urban equipment and sanitation channels, over two-and-a-half years of operation.[114]

It is curious to observe that such a low level of production somehow reflected the excessive burden imposed by EMURB when the company listed the guidelines to be adopted industrially in the technology of *argamassa armada*. One of the points of EMURB's study envisaged the "feasibility of reproducing the modular system of FAEC with possible adaptations."[115] Here, we start to understand that these adaptations went beyond the production method, also affecting the plant's physical space and its administrative board.

For example, while the FAEC in Salvador operated with greater autonomy on the management side, the CEDEC emerged as a center completely tied to the rigid bureaucratic structure of EMURB. It was not uncommon at CEDEC for the executive body to be confrontational in its propositions. On many occasions, as Paulo Eduardo Fonseca Campos recalls, Mayumi had to defend her plans and her young team of architects from the diverging ideas of the CEDEC's finance director. With internal demands far exceeding what could be considered a reasonable level, "the financial administration and the controllership ended up creating obstacles to improving the way things worked."[116]

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112 n.d., "Fábrica de Equipamentos Urbanos," *Cimento & Concreto*, no. 114 (1990): 7. [Um importante aliado na postura que a atual adminsitração pretende manter em relação a seus projetos e investimentos: o ponto de partida é o usuário e o ponto de chegada a melhoria da qualidade do ambiente que é oferecido] (my translation).

113 Ibid. [uma creche, por exemplo, não será mais uma construção de baixo custo a ser inaugurada, ela será a arquitetura de um lugar destinado às crianças e, portanto, necessariamente alegre, claro, com áreas projetadas para as necessidades específicas das crianças em seu desenvolvimento] (my translation).

114 A comprehensive list of CEDEC's realizations during the period from June 1990 until December 1992 can be found at: Cássia Schroeder Buitoni, "Mayumi Watanabe Souza Lima: A Construção do Espaço para a Educação" (Universidade de São Paulo, 2009), 99.

115 Fróes, *Opção Argamassa Armada*, 11. [viabilidade de reprodução do sistema modular da FAEC com eventuais adaptações] (my translation).

116 Paulo Eduardo Fonseca de Campos. Telephone interview with Adalberto Vilela on December 21, 2017. [A gestão financeira e a controladoria acabaram criando entraves para que as coisas andassem melhor] (my translation).

Furthermore, the dimensioning of CEDEC plant assumed a very conservative approach to manufacturing performance. Compared to the FAEC production lines – with roughly 35 curing tanks – the CEDEC factory retained only three to four curing bays, including the factory layout after the building extension (*Fábrica 2*). The second layout proposition was presented with only four production lines, showing from the beginning the plant's distinct orientation, whose maximum production reached 50 m^3 per month.

Last but not least, there were the adaptations to the production method. This is indeed the point that seems to confirm that some experiments promoted by the CEDEC team to optimize the manufacture of precast elements in *argamassa armada* would be incorporated by Lelé. We know that the architect corroborated the implementation of CEDEC, to a lesser or greater extent. According to Cássia Buitoni in an interview with the architect Vera Pastorello, "Lelé provided not only the factory's installation project, but also the entire list (with quantities and specifications) of equipment and materials necessary for its operation. This allowed the bidding processes to occur simultaneously with the construction of the factory itself, without delaying the beginning of production."[117]

However, Lelé's production in Salvador began to be questioned in São Paulo, especially regarding the layout proposed for the prefabricated schools. Therefore, a series of amendments to the layout of the primary schools was made with the justification that differences between weather conditions, culture and even security impeded the construction of open schools like the ones erected by the architect in Salvador, Brasília and Rio de Janeiro. Furthermore, as Ruy Bentes recalls, "these changes greatly facilitated the erection of buildings on urban lands with unconventional forms."[118]

In addition, questions such as quality control and operational cost were also taken into consideration. At a certain point, the CEDEC team started to redraw the blueprints of the precast components sent by Lelé from Salvador using the latest features and technologies of graphic computation to analyze their constructive logic. After some months of study, they came up with the following hypothesis: the only way to accelerate or even double the production of components in a factory with limited space, such as the CEDEC, was to invest in a thermal vapor cure.[119] Consequently, the curing time previously set to between 9 and 12 hours using the immersion of elements in water tanks could be reduced to roughly 4 hours with vapor chambers.

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117 Buitoni, "Mayumi Watanabe Souza Lima: A Construção Do Espaço Para a Educação," 75. [Lelé forneceu não apenas o projeto de instalação da fábrica, mas também toda a listagem (com quantidade e especificações) de equipamentos e materiais necessários ao seu funcionamento, o que possibilitou que os processos de licitação ocorressem concomitantemente à construção da fábrica, sem atrasos para o início da produção] (my translation).

118 Ruy Franco Bentes, "Considerações sobre Projeto e Produção de Componentes Pré-Fabricados de Argamassa Armada" (Universidade de São Paulo, 1992), 33.

119 The thermal cure with vapor is a means to accelerate the low reaction between a pozzolana and the free calcium hydroxide of $Ca(OH)_2$ liberated during the hydration of the cement. Temperatures above 88°C, however, are necessary to accelerate the reactions sufficiently, so that satisfactory levels of resistance in newer concretes are attained. In: Melo and Libório, "Some Recommendations for the Production of Ferrocement Elements by Means of the Thermal Vapour Cure," 301.

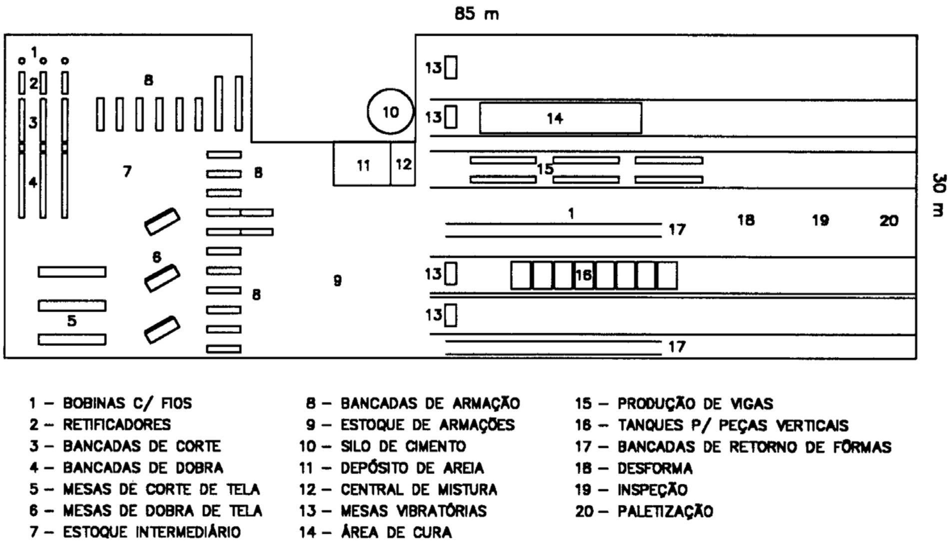

Fig. 3.57 CEDEC factory, second layout after the facilities' extension. The production lines are concentrated on the right side of the plant. Ruy Franco Bentes. "*Considerações sobre projeto e produção de componentes pré-fabricados de argamassa armada*." Universidade de São Paulo, 1992, p. 53

Fig. 3.58 CEDEC factory in São Paulo. Production area. Curing tanks with water before their adaptation to vapour chambers. Arquivo Paulo Eduardo Fonseca de Campos, São Paulo

In this way, they would be able to solve three critical problems: firstly, the production could be increased without investing money in the purchase of new metallic formwork (generally the most expensive part of precast *argamassa armada* factories); second, the reduced space of the factory floor would not be an issue, since the multiplication of curing tanks was no longer needed; and thirdly, production during the winter would not be affected. With low temperatures at night ranging from 5 to 6°C at that time of year in São Paulo in the beginning of the 1990s, "it was not unusual to demold the precast components the next day, in the morning, and sometimes they would break,"[120] remembers Paulo Eduardo Fonseca Campos.

Despite Lelé's skeptical attitude towards the thermal cure with vapor – which he had already tested at RENURB in Salvador ten years before – the CEDEC team transformed all the water tanks used for curing the precast elements by immersion into a sequence of individual vapor chambers. It is important to remark that this decision was taken after the consent of the EMURB's executive board, convinced by the technical support provided by the São Carlos School of Engineering (EESC).

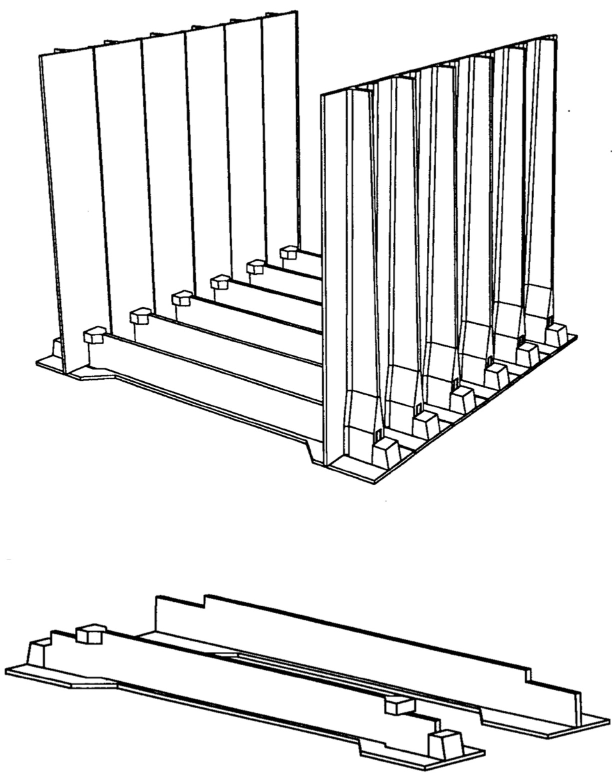

Fig. 3.59 Sanitation channel's adaptation by the CEDEC team. Above: assembled set. Below: bottom element showing the increase of contact area with the vertical element in the CEDEC's version (left). Ruy Franco Bentes. Master thesis. Universidade de São Paulo, 1992, p. 25

Among other findings, the engineers verified that "the adoption of resistance (fcj> 10 MPa) for rapid removal from the mold makes possible the re-use of formwork of up to 4 times a day, reflecting significantly on the cost of installations in precast reinforced mortar factories, making the economic investments and quality guarantees of the mortar more favourable when compared to the usual processes."[121]

Other adaptations to Lelé's production method gained momentum at CEDEC thanks to the collaboration with the *Grupo de São Carlos*. Besides the exclusive adoption of the thermal vapor cure, the factory in São Paulo started to modify the design of the sanitation channels, "deconfiguring the situation of the cantilever in order to relieve the strain at the point where the precast parts were connected."[122] A reduction at the

120 Paulo Eduardo Fonseca de Campos. Telephone interview with Adalberto Vilela on December 21, 2017 [Não era raro desformar as peças no dia seguinte pela manhã e elas se quebrarem] (my translation).

121 Melo and Libório, "Some Recommendations for the Production of Ferrocement Elements by Means of the Thermal Vapour Cure," 311.

122 Bentes, "Considerações sobre Projeto e Produção de Componentes Pré-Fabricados de Argamassa Armada," 27. [desconfigurando a situação de balanço até então existente, com o intuito de aliviar os esforços na região de encaixe entre os

schools' component level was also observed, which therefore led to fewer production lines in the factory.

The implementation of simple stationary molds instead of Lelé's double and movable formwork considerably reduced the production costs at CEDEC. The idea was to create casting tracks where three of the most numerous elements of the building system – the wall, floor and roof panels – could be produced in fixed lines. Unlike Lelé's method, these elements were cured not by immersion, but by water aspersion. In this case, controlled irrigation was ensured by agricultural sprinklers overnight, which used up a modest yet continuous supply of water.

Although this solution required less financial investment, a certain loss was observed in the final finish of the precast components. This is because, without Lelé's double metallic molds, the parts retained a good and homogeneous finish only on one side (the one turned to the mold). The other side, turned to the uncovered top, was normally rectified using a stainless smoothing trowel.

Another divergence between the CEDEC and FAEC factories in the ways they dealt with the issue of quality control can be observed when we analyze the implementation of the CEDEC's quality program. According to the engineer Ruy Bentes, "most of the problems with *argamassa armada* precast elements are caused by irregularities in the steel framework."[123] Given that the most common defects found in precast concrete elements – such as cracks, exposed reinforcement, and honeycombs – could be avoided or minimized by ensuring the proper placement of the reinforcement in the molds, the factories would not have needed the repair workshop, which was so common at Lelé's plants.

As this was by nature manual work, and it was almost impossible to add any level of automation – therefore making quality control even harder – the solution found by the CEDEC team was to identify each employee responsible for each type of reinforcement (beams, wall panels, columns, roof panels, and so forth) with adhesive labels. Thus, "every rebar worker, knowing that his mistakes or his lack of attention would be identified, would do his best to produce in accordance with the technical specifications."[124]

Even with the number of refused steel framework, or fitting errors, reduced to almost zero, the psychological control based on the traceability of products adopted at CEDEC clearly contradicted the precepts of freedom and political self-awareness instigated by Mayumi in the workers' behavior. Proof of this could be found in the journal of political development posted weekly on the factory notice board. Edited by Mayumi and the pedagogue Marta Grosbaum, the *da-dzi-bau* revived the Japanese tradition of street communication. The journal was "an example of how Mayumi thought the professional performance of the workers should be, a

pré-moldados] (my translation).

123 Ibid., 144. [A maior parte dos problemas ocorridos com peças de argamassa armada tem origem em irregularidades na armação] (my translation).

124 Ibid., 99. [cada armador, sabendo que os seus erros ou sua falta de atenção seriam identificados, faria o melhor possível para produzir dentro das especificações] (my translation).

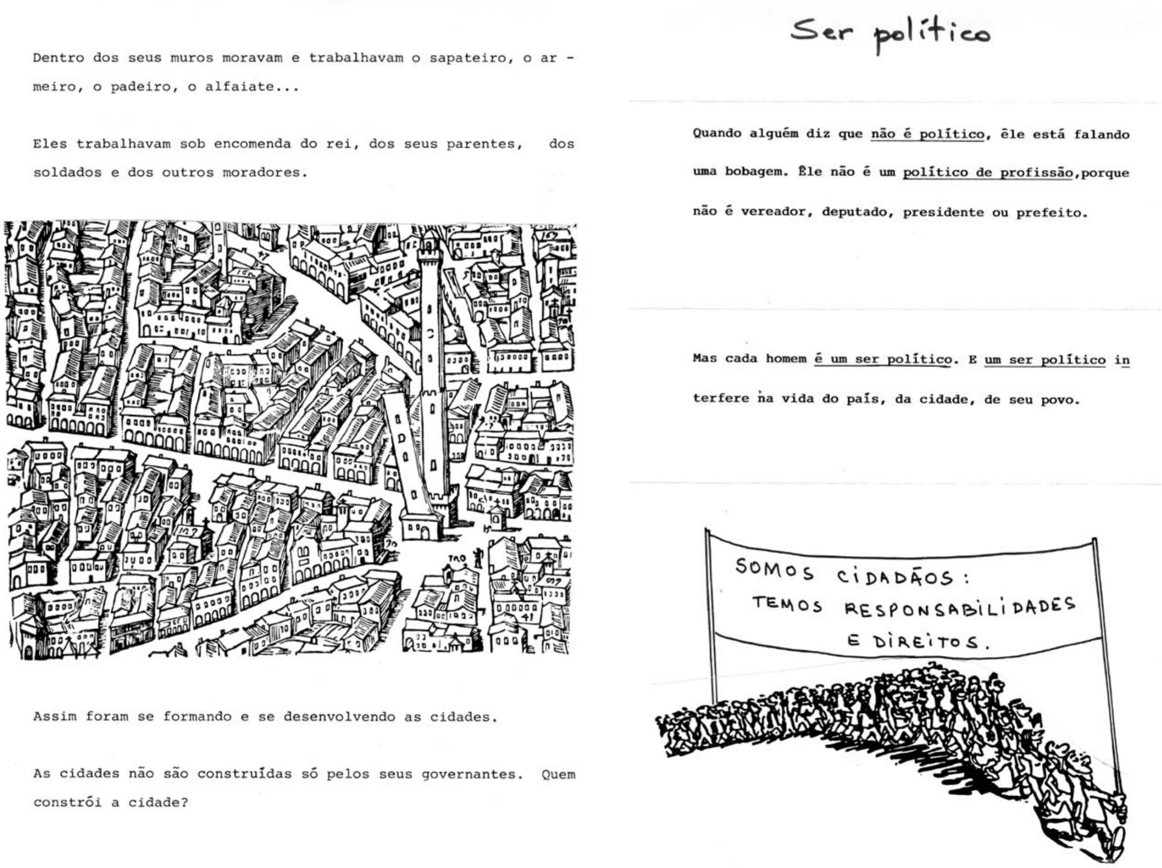

Fig. 3.60 Da-dzi-bau weekly publication posted onto CEDEC's bulletin board. Edited by Mayumi Watanabe and the pedagogue Marta Grosbaum. Cássia Schroeder Buitoni. "*Mayumi Watanabe Souza Lima: A Construção do Espaço para a Educação*." Universidade de São Paulo, 2009, p. 95

collaboration in the formation of conscious citizens capable of participating in the construction of the new democratic society."[125]

But the *da-dzi-bau* – whose main goal was to tell in chapters a critical history of society, from the advent of work division to the local problems of urbanization (including the process of industrialization) – was not disconnected from a larger framework. Its approach, in keeping with Buitoni, "goes from the general (history of mankind) to the particular (the CEDEC's operation)."[126] In this sense, it may be pertinent to add Mayumi's concerns for the historical and cultural development of the students (not only children, but also adolescents), namely the future occupants of the prefabricated schools in São Paulo.

For each new school, usually inaugurated in the peripheral districts of the city, the CEDEC team provided the community with explanatory leaflets explaining both the origin of the neighborhood's name and the school's visual communication project[127]. However, what

125 Buitoni, "Mayumi Watanabe Souza Lima: A Construção Do Espaço Para a Educação," 94. [um exemplo de como Mayumi achava que deveria ser a atuação profissional dos técnicos, colaborando para a formação de cidadãos conscientes e capazes de participar da construção da nova sociedade democrática] (my translation).

126 Ibid. [parte do geral (a história do homem) para o local (a atuação do Cedec)] (my translation).

127 The CEDEC schools' communication project was carried out by Francisco Homem de Mello, who created a different logo for each school, according to the names of the districts in which they were built.

Estudantes do Jardim Sinhá:

Você que é jovem, mas não é mais criança; você que está na escola e é curioso; você que ultimamente viu muita coisa nova e recebeu informações, geralmente pela televisão; você já sabe que no Brasil dos anos 60 existiu gente que morreu lutando contra a ditadura; soube também, muito recentemente, que um presidente eleito foi afastado por corrupção.

Mas você ouviu falar pouco de um aspecto importante dessas informações: o de que a existência de um fato está ligada à existência de outro.

Ou seja: não existiriam os que lutaram nos anos rebeldes se não tivessem existido os que implantaram e defenderam a ditadura. Não existe o corrupto – aquele que se deixa corromper – se não existir o corruptor – aquele que corrompe.

Assim você vai entender porque a sua escola, que fica no bairro **Jardim Sinhá**, tem no frontão a figura dos capoeiristas negros, e na caixa d'água a figura de um leque. Nós quisemos lembrar a você que as **sinhás** de antigamente não poderiam existir sem que houvessem **escravos** para lhes servir, e vice-versa.

Então, você que está descobrindo o mundo real, vai perceber que para existir explorados tem que existir exploradores. E se existe explorador, é porque os explorados aceitam essa situação.

Você vê que tudo isso faz parte da história do Brasil que você conhece. Mas a história sempre muda, e você pode ajudar a escrever uma nova história. Para participar da construção de uma nova história, o conhecimento é uma arma muito importante. Por isso você estuda, e quanto mais você estudar, melhor você vai usar a sua arma – ou seja, o seu conhecimento.

Então, cuide bem desta escola que você recebeu e está ajudando a existir, porque todos nós que participamos do seu projeto e de sua construção o fizemos com muita paixão, sabendo que ela ia servir para você e para os que nela trabalham.

Um abraço.

Equipe da EMURB
Empresa Municipal de Urbanização

São Paulo, outubro de 1992

Fig. 3.61 Leaflet of the *Jardim Sinhá* primary school (CEDEC factory, 1992), showing the *capoeiristas* and the *sinhá's* folding fan. Cássia Schroeder Buitoni. "*Mayumi Watanabe Souza Lima: A Construção do Espaço para a Educação*", master thesis (Universidade de São Paulo, 2009), p. 95

draws our attention here is how this initiative surpassed the mere level of giving information, going beyond in the sense of the student's social development. This becomes clear if we take, for instance, the case of the school erected at *Jardim Sinhá*, in the district of *Sapopemba* (the Eastern Zone of São Paulo), and observe the political content in the message printed in the respective pamphlet.

> Therefore, you will understand why your school, which is in the *Jardim Sinhá* neighborhood, displays the figure of the black *capoeiristas* on the front façade and the figure of a folding fan on the water tower. We wanted to remind you that the *sinhás* of the past could not have existed without the presence of slaves to serve them, and vice versa. Since you are discovering the real world, you will realize that for exploited people to exist there must be exploiters. And if there is an exploiter, it is because those who are exploited accept this situation. You will see that all of this is part of the history of Brazil that you know. But the story always changes, and you can help write a new story.[128]

128 Pamphlet of the school Jardim Sinhá, CEDEC/EMURB, São Paulo, 1992. Archive Mayumi Watanabe Souza Lima. In: Cássia Schroeder Buitoni, "Mayumi Watanabe Souza Lima: a construção do espaço para a educação" (Universidade de São Paulo, 2009), 166-167. [Assim você vai entender porque a sua escola, que fica no bairro Jardim Sinhá, tem no frontão a figura dos capoeiristas negros, e na caixa d'água a figura de um leque. Nós quisemos lembrar a você que as sinhás de antigamente não poderiam existir sem que houvessem escravos para lhes server, e vice-versa. Então, você que está descobrindo o mundo real, vai perceber que para existir explorados tem que existir exploradores. E se existe explorador, é porque os explorados aceitam essa situação. Você vê que tudo isso faz parte da história do Brasil que você conhece. Mas a história sempre muda, e você pode ajudar a escrever uma nova história] (my translation).

By using these two symbolic figures together – the *capoeirista* (the person who plays *capoeira*) and the *sinhá* (a corrupted form of the word *senhora*, used by slaves to describe the landowning class),[129] Mayumi and the CEDEC team were evoking one of the most striking relationships during the colonial past of Brazil, namely the interaction between slaves and members of the rural oligarchies, key elements for understanding the country's culture.[130]

But to return to the factories, the problem of the metallic framework, increasingly common at both FAEC and CEDEC, became primarily an issue of maintaining the viability of production. This is because the threat of a supply shortage of steel mesh had an impact on a national level after the Federal Government decided in 1991 to install the factories to produce the CIAC schools on a large scale. In the face of such great demand for the essential material, it was obvious that there would be a price increase, as well as the imminent risk of the product being destocked on the market.

As a result, a new study was initiated at CEDEC's facility to assess the feasibility of the replacement of the welded steel mesh by a solution that was economically more viable, whose supply was guaranteed and whose technical properties ensured the same characteristics of the precast elements using mesh reinforcement. The intensive testing and in-depth analysis performed at both the CEDEC and the São Carlos School of Engineering led to the conclusion that synthetic discontinuous filament fibers of polypropylene, when inserted into the *argamassa armada* mix, performed the same function as the steel mesh.

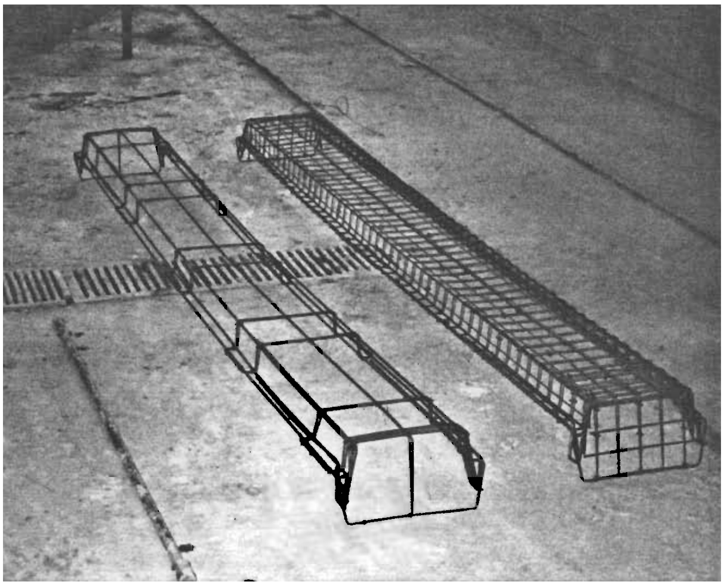
Fig. 3.62 Comparison between the same roof element produced with welded steel mesh (right) and polypropylene fiber (left). Ruy Franco Bentes, master thesis (Universidade de São Paulo, 1992), p. 89

In simple terms, "the reinforcement arrangement would provide the necessary steel section for the structural strength of the element, while the fibers would control the cracking of the *argamassa.*"[131] Thus, as Ruy Bentes reported, in September 1992, 75% of the volume produced at the CEDEC precast factory already incorporated the new technology, a strategy that aimed for the complete elimination of the welded

129 The original definition includes the words "sinhá" and its male variation "sinhô", given by Gerard Taylor in *Capoeira: The Jogo de Angola from Luanda to Cyberspace* (Berkeley: North Atlantic Books, 2005), 518.

130 For a comprehensive overview of this topic, see the following fudamental works: Gilberto Freyre, *The Masters and the Slaves: A Study in the Development of Brazilian Civilization* (New York: Knopf, 1946) [originally published in 1933]; Sérgio Buarque de Holanda, *Roots of Brazil* (Notre Dame, Ind.: University of Notre Dame Press, 2012) [originally published in 1936]; Caio Prado Junior, *The Colonial Background of Modern Brazil [Translated by Suzette Macedo]* (Berkeley, Los Angeles: University of California Press, 1967) [originally published in 1942].

131 Bentes, "Considerações sobre Projeto e Produção de Componentes Pré-Fabricados de Argamassa Armada," 89. [O arranjo da armadura proviria a seção de aço necessária à resistência estrutural da peça, enquanto as fibras controlariam a fissuração da argamassa] (my translation).

wire meshes. The replacement resulted in production cost savings of 40%, without a loss in quality.

Therefore, the unanswered question is, if Lelé himself showed many times a certain readiness to instigate technological changes, why did he not incorporate polypropylene fiber into his manufacturing production at that point? Despite concerns about the fibers and their capacity to provide the precast *argamassa armada* elements with effective resistence at early ages, all the results of the tests carried out in São Paulo and São Carlos confirmed the suitability of the polypropylene filaments for replacing the steel mesh.[132] Curiously, Lelé, who also struggled with the metal sector across his factories, had shown himself willing to change the old procedures:

> I've done everything to try to rationalize the rebar manual work: with welding, soldering points, and so on. There is, first, an uncontrollable waste of material in the cut and fold process of the welded mesh, just as there is an excess of labor. It is not possible to rationalize production process of the reinforcement because the material does not allow it. So, in that case, I am in favor of changing the material. This replacement will eliminate manpower, although the idea is not mechanizing to eliminate manpower, but to make the thing more economic, more logical. If we have a material that does not allow for better industrialization, we must abandon it.[133]

After trying hard, Lelé had to give up the attempt to maintain the FAEC in operation. The factory closed its activities shortly after Mário Kertész left Salvador City Hall in 1989. The CEDEC facilities were discontinued in 1993 after Paulo Maluf's victory in the São Paulo municipal elections in the previous year. The activity of both factories was declared over for the same reason, that is to say, due to the incomprehension and greed of public men at the service of construction companies that turn political lobbying into a valuable exchange tool.

Although the CEDEC failed to provide cheaper solutions for public works in São Paulo when compared to private building companies,[134] the technological center played a crucial role in enhancing certain operations of Lelé's production method underway at FAEC. The architect,

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132 For further information and more technical details, see Ruy Franco Bentes and Luiz Engler Vasconcellos, "O Reforço das Fibras," *Téchne* 1, no. 3 (1993): 28–30.

133 In Lima, "João Filgueiras Lima, Lelé [Entrevista a Adriano Carneiro de Mendonça]," 125. [Já fiz de tudo para tentar racionalizar a mão de obra de uma armação: com solda, com ponto de solda, e por aí vai. Existe, primeiro, um desperdício de material incontrolável no corte e na dobra da tela soldada, assim como existe um excesso de mão de obra. Não é possível racionalizar o processo de produção das armaduras porque o material não permite. Então, nesse caso, sou favorável a mudar o material. Essa substituição vai eliminar mão de obra, mas a ideia não é mecanizar para eliminar mão de obra, e sim tornar a coisa mais econômica, mais lógica. Se tivermos um material que não permite uma industrialização melhor, devemos abrir mão dele] (my translation).

134 According to the architect Vera Pastorello in an interview with Cássia Buitoni, because of CEDEC's short operating period, the initial investment in machinery could not be diluted over the years. Therefore, in absolute terms, the factory never achieved lower costs than the private construction sector. In Buitoni, "Mayumi Watanabe Souza Lima: A Construção Do Espaço Para a Educação," 97. [devido ao curto período de funcionamento da fábrica, o investimento incial em maquinário embutido no custo não pôde ser diluído, e o Cedec não chegou a atingir custos menores que a iniciativa privada, em termos numéricos absolutos] (my translation).

who in the first instance was reluctant to adopt the CEDEC's innovations, did not hesitate to incorporate some of them into his practice a few years later, like the thermal vapor cure and the fibers adopted at the CTRS. Aware of how certain limitations of the manufacturing process affected his work, Lelé seemed more prone to changes than before. Some of these limitations, such as the manual work at the metal sector, prompted new technologies that made his most important plant – the Technology Center of the Sarah Network (*Centro de Tecnologia da Rede Sarah,* CTRS) in Salvador – a turning point in his career. It is time to see how the CTRS optimized Lelé's manufactured architecture and favored such transformation.

10. The end of an optimized manufacturing method

In October 2008, a few months before leaving the CTRS, an interview with Lelé was published in a special issue of the Brazilian architectural journal *AU* (*Arquitetura e Urbanismo*). In an excerpt from the conversation, the architect talked about the works developed at the CTRS and concluded: "We are not producing a masterpiece, in an exclusive sense. We produce a process for doing many things, which is the principle of industrialization."[135] It is worth noting that on the brink of the center's foreclosure, Lelé still retained an understanding of industrialized architecture through process.

But this process, backed by 30 years' experience of developing new tools, knowledge and practical know-how, was about to be interrupted due to the stagnation of a promising network of high-quality public hospitals for those with motor disabilities: the Sarah Kubitschek Chain (*Rede Sarah*). "Lelé's most important achievement, both architecturally and as a production system," as defined by Max Risselada,[136] the Sarah hospital ensured that the architect's prefabricated system benefited from a stronger design and greater constructive liberty, mostly because it spelt the end of the integral construction model in *argamassa armada* hitherto operating in his factories.

The combination of a metallic structure (for collumns, beams and roofs) and *argamassa armada* (for slabs, wall panels and foundations) not only resolved old problems such as the schools' roof infiltration and the small cover thickness of the structure's building framework, but it also allowed for new shapes and wider spans for his buildings. The precasting activity remained restricted to a few elements, since new expensive metallic molds were no longer needed. But, despite the longer endurance of CTRS (1992-2009) – if compared to Lelé's previous fatories – the new plant did not survive the anachronisms of Brazil's public administration.

135 João Filgueiras Lima, "Fábrica de Humanidade [Entrevista a Bianca Antunes]," *Arquitetura e Urbanismo* 23, no. 175 (2008): 70. [Não estamos produzindo uma obra-prima, exclusiva. Produzimos um processo para fazer muitas coisas, que é o princípio da industrialização] (my translation).

136 Max Risselada, "A Culture of Materials and Art of Production. The Auditor Courts of João Filgueiras Lima," in *Teatro Do Mundo*, ed. Carla Carrondo, Cristina Marinho, and Nuno Pinto Ribeiro, vol. 11 (Porto: CETUP, 2016), 158.

The fact that the Sarah direction had decided not to expand its hospital network after the inauguration of the Rio de Janeiro unit, in May 2009, meant that any possibility of further development at the technology center was hindered. Clearly contradicting one of the six aims of the Sarah Chain defined in the management contract (1991) signed between the central government and the Association of the Social Pioneers (*Associação das Pioneiras Sociais*, APS)[137] – which envisaged the construction of new hospital units and the expansion of services to other regions of Brazil[138] – the decision also affected the continuity of Lelé's most recent research in the field of folded steel sheeting.

Perhaps the activities of the CTRS may have turned out differently if the center had diversified its production beyond the limits of the hospital domains, as the nine court buildings (eight Auditor Courts[139] and one Electoral Court in Bahia) constructed across different Brazilian states from 1996-98 proved totally feasible. However, the same court that benefited from Lelé's expertise in the design and building of its headquarters using the new mixed constructive system decided in 2000 that the CTRS was no longer legally authorized to produce outside the hospital area of the Sarah Chain.

It is highly ironic that at the moment when Lelé's industrial process reached a stage of maturity in which the role of materials and his manufacturing system were technically redefined in a more integrated manner, the architect's professional activities were curtailed due to the Court of Auditors' decision that his practice was competing with the private sector.[140] Since public power in Brazil maintains close links with the construction market, the CTRS needed to refrain from signing agreements with other municipalities and public bodies. Therefore, the result of this backward administrative decision impacted directly on the Center's prolific production, which seemed to operate through two distinct phases over the years: a first period, from 1992-2000, when there was a visible concentration of new themes, shapes and technical solutions, and a second phase, from 2000-2009, when the language of the Sarah aesthetics no longer seemed to possess the same breadth of creativity as in former years.

137 The *Associação das Pioneiras Sociais* (APS) is the manager of the Sarah Chain of Rehabilitation Hospitals. Its history is associated with the construction of Brasília (1957-60) and the name of the then First Lady Sarah Kubitschek. In the 1990s, its administrative status changed (Law 8246 of October 22, 1991) and the expansion of the hospital network was authorized, together with the creation of a technology center (CTRS).

138 Objective n. 5 "Build and implement new hospital units, expanding the management model and services of the Sarah network to other regions of the country." [Construir e implantar novas unidades hospitalares, expandindo o modelo gerencial e os serviços da Rede para outras regiões do país] (my translation). In João Filgueiras Lima, *CTRS: Centro de Tecnologia da Rede Sarah* (Brasília: Sarah Letras, 1999), 11.

139 From 1996 to 1998, eight Federal Courts of Auditors (*Tribunais de Conta da União, TCU*) were inaugurated in the following Brazilian states: Bahia (August, 1996), Rio Grande do Norte (October, 1996), Minas Gerais (December, 1997), Sergipe (February, 1997), Espírito Santo (March, 1998), Alagoas (September, 1998), Piauí (October, 1998), and Mato Grosso (December, 1998). The Bahia Electoral Court (*Tribunal Regional Eleitoral da Bahia*) was inaugurated in early 1998. See Max Risselada and Giancarlo Latorraca, *A Arquitetura de Lelé: Fábrica e Invenção* (São Paulo: Imprensa Oficial SP, MCB, 2010), 191. The TCU Building in São Luís, Maranhão state, did not go beyond the design level.

140 See Lima, "Fábrica de Humanidade [Entrevista a Bianca Antunes]," 67.

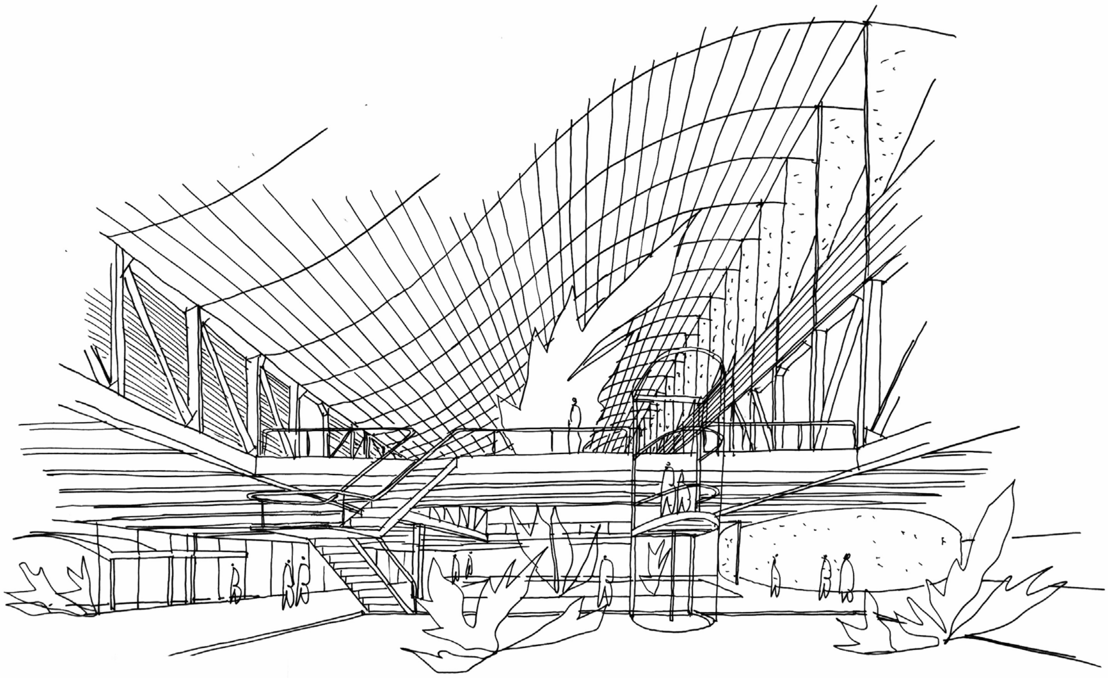

Fig. 3.63 Bahia Electoral Court (*Tribunal Regional Eleitoral da Bahia*) in Salvador. Lelé, 1997. Inaugurated in January 1998, the building was produced by the CTRS and assembled in a few months. Arquivo João Filgueiras Lima, Salvador

This seems to be true if we consider that, except for the Hospital in Rio de Janeiro (2009), all the outposts (Belém, 2007 and Macapá, 2005), along with the children's rehabilitation center at Pombeba Island (Rio, 2002), reproduced spaces previously designed for the hospitals on a smaller scale.[141] "As expected, the time came when the Sarah Chain had no more resources, potential, dynamism, or capacity for continuing the construction of new hospitals. Its administrative and training capacity for receiving new staff to keep all these hospitals in operation came to an end."[142]

With production reduced to zero, the CTRS had its manufacturing activities shut down in in 2009, and was restricted from then onwards to minor repairs and the maintenance of the Sarah Chain's existing structure. Reduced to a condition of "technological cemetery,"[143] as defined by the anthropologist Roberto Pinho, the technology center in Salvador closed its doors in December 2017, while this thesis was being written. It represents the end of Lelé's long-lasting and most relevant experience with prefabrication: the factories.

141 Despite being inaugurated in the period 2000-2009, the construction of both the Sarah Hospitals of Fortaleza (2001) and Brasília Lago Norte (2003) began in 1993 and 1997 respectively.

142 Roberto Pinho, "Lelé: Um Arquiteto Universal," in *A Arquitetura de Lelé: Fábrica E Invenção*, ed. Max Risselada and Giancarlo Latorraca (São Paulo: Imprensa Oficial SP, MCB, 2010), 54. [Como era previsível, chegou o momento em que a Rede Sarah não tinha mais recursos, nem potencial, nem dinâmica, nem capacidade de dar prosseguimento à construção de novos hospitais, uma vez que sua capacidade administrativa e de treinamento, de novos quadros, para pôr em funcionamento todos esses hospitais, havia se esgotado] (my translation).

143 Ibid., 55. [Cemitério tecnológico] (my translation).

Only by revisiting the closure process of the CTRS and the range of problems that surrounded its functioning during its last years could one understand the dramatic shift in Lelé's production method. In addition, when the center began operating in his definitive headquarters, in 1994, Brazil was heading in another political and economic[144] direction. It was a time for new clients and a new patron (APS) for Lelé. No more populist leaders at the healm of the architectural and urban infrastructure production. Thus, the questions to be answered in the following pages are: how did the optimization of Lelé's manufacturing method contribute to consolidating the Sarah hospital model? And how did it help the architect to advance even further towards an integrated framework of assembled architecture?

10.1 The CTRS as a turning point for Lelé and his industrialized architecture

The physical space and the integrated functioning of the CTRS were perfectly in line with the values and goals of the Sarah Chain of hospitals, which prioritized a more 'humanized' medical approach. Lelé realized very early on that formulating the spatial conception of his designs through a close collaboration with the medical and nursing teams would enable him to meet both the philosophy of the proposed care treatment[145] and the building system requirements.

But it should be remembered that this collaborative practice took place at the beginning of the Sarah project, in 1974, when the economist Eduardo Kertész (brother of Mário Kertész), the physician Aloysio Campos da Paz and Lelé drew up a national plan for the creation of a health subsystem for the motorially disabled. As recalled by Lelé, "in this context, the Locomotor Hospital System – Sarah Brasília – originated in the new capital in accordance with three basic premises: the concept of progressive care, the consequent creation of adequate treatment environments for patients according to the evolution of their clinical case and the production of hospital equipment specially designed to meet these characteristics."[146]

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144 Another currency, Brazilian Real (BRL), came into circulation on 1st of July 1994, putting an end to the hyperinflation that had corroded the country for decades.

145 The Sarah hospitals adopted "a form of treatment in which the centrality of the Intensive Care Unit is relativized and new methods are incorporated into the treatment, among them, the comprehensive penetration of sunlight in the hospital environment, particularly in the wards, which directly influences the patients' recovery." In: Ibid., 52. [Forma de tratamento na qual a centralidade da Unidade de Terapia Intensiva é relativizada e novos métodos são incorporados ao tratamento, entre eles, a penetração abrangente da luz solar no ambiente hospitalar, particularmente nas enfermarias, o que influi diretamente na recuperação dos pacientes] (my translation).

146 João Filgueiras Lima, "Muito Além da Máquina de Curar," *Projeto*, no. 187 (1995): 78. [Nesse contexto se originou o Hospital do Aparelho Locomotor de Brasília – o Sarah Brasília – com suas premissas básicas: o conceito de *progressive care*, a consequente criação de ambientes adequados ao tratamento dos pacientes de acordo com a evolução de seu quadro clínico e a produção de equipamentos hospitalares especialmente desenhados para atender a essas características] (my translation).

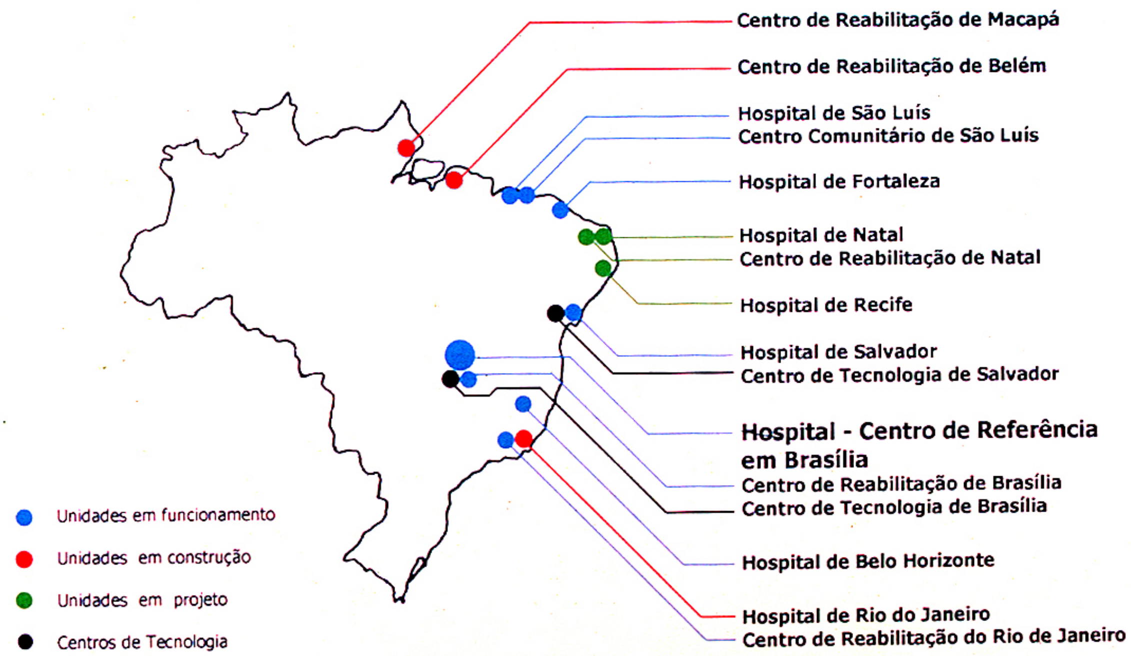

Fig. 3.64 Map of the Sarah Chain of hospitals throughout Brazil, 2004. Blue: units in operation. Red: units under construction. Green: units designed. Black: technological centers. Arquivo João Filgueiras Lima, Salvador

It is this last item mentioned in the Sarah project's guidelines – the production of hospital equipment – that we shall concentrate on. Even before the inauguration of the hospital in Brasília in 1980, another center of technology was already in operation: the EquipHos[147] (*Centro de Produção de Equipamentos Hospitalares*). Financed by public funds coming from the National Council for Scientific and Technological Development (CNPq), the EquipHos not only started to produce furniture and hospital equipment for the Sarah hospital in Brasília, such as the *cama-maca* (gurney-bed),[148] but it also paved the way for the installation of the CTRS 15 years later in Salvador.

Lelé's progressive involvement on a smaller (but not less important) scale of hospital building changed his perception of industrialized architecture. From the CTRS onwards, we can see an architect more dedicated to solving other stages of construction, including furniture and the medical equipment necessary for the functioning of the establishment. If in the previous factories Lelé was more concerned about the production of schools and larger pieces for urban infrastructure such as sanitation channels, bus shelters and footbridges, after the CTRS his

147 According to Luiz Carlos Toledo, the origin of EquipHos dates back to the small carpentry workshop for orthopaedic equipment located in the rehabilitation center of the *Pioneiras Sociais* (*Sarinha*), in Brasília. Designed by the architect Glauco Campello in 1959 and built in 1960, the center was coordinated by the designer Alex Chacon and the anthropologist Roberto Pinho. Luiz Carlos Toledo, "Feitos Para Curar: A Arquitetura como um Gesto Médico e a Humanização do Edifício Hospitalar" (Universidade Federal do Rio de Janeiro, 2008), 159.

148 See Adalberto Vilela, "João Filgueiras Lima: Uma Ponte Entre a Arquitetura E O Design," in *Mobiliário Moderno: das Pequenas Fábricas ao Projeto da UnB*, ed. Alex Calheiros, Marcelo Mari, and Priscila Rufinoni (Brasília: Editora Universidade de Brasília, 2014), 114–118.

attention was also turned to the serial production of tables, chairs, wheelchairs, beds, prostheses and orthoses.[149]

This does not mean that the Center was not involved in the design and production of the biggest and heaviest items. Beyond constructive elements, elevators, buses, a crane system to lift patients up, and even boats also featured in the catalog of the CTRS, showing the scope of their research in the field of both mechanics and mechatronics. Thus, the small carpentry at EquipHos evolved and gave place to a technology center destined to build and equip hospitals. According to Lelé's master plan, the CTRS was designed to occupy the lower part of a 295,000 square-meter area of land in Salvador, located two kilometers away from the shore in the middle-class district called Stiep.

Fig. 3.65 Development of the gurney-bed (*cama-maca*) over the years. Design of the first model: Alex Chacon, 1976. Above: Lelé's sketches for an updated version produced by the CTRS. Below: 2007 model (CTRS). Arquivo João Filgueiras Lima, Salvador

The idea was to group production and research in a single building, with the factory placed in the left-hand section and the "post-graduation courses with laboratories of biomechanics"[150] on the right. This way, and separated by a small, dense forest, the hospital occupied the upper part of the terrain, 24 m above. If on the one hand the idea of accommodating post-graduates was never realized, frustrating one of Lelé's oldest dreams – namely the approximation of industrialized construction with education

149 An orthosis is the correct term for an externally applied device that is designed and fitted to the body to achieve one or more of the following goals: control biomechanical alignment, assist rehabilitation, increase mobility, correct or accommodate deformity, etc. A prosthesis is an artificial device attached or applied to the body to replace a missing body part. The Australian Orthotic Prosthetic Association, "About Orthoses and Prostheses," accessed January 15, 2017, https://www.aopa.org.au/careers/what-are-orthoses-and-prostheses.

150 João Filgueiras Lima. Conference video. Arq. Futuro. São Paulo, November 23, 2011 at the Auditorium of Ibirapuera Park. Accessed January 21, 2018. http://arqfuturo.com.br/evento/arq.futuro-sao-paulo-2011. [cursos de pós-graduação com laboratórios, inclusive, de biomecânica, etc.] (my translation).

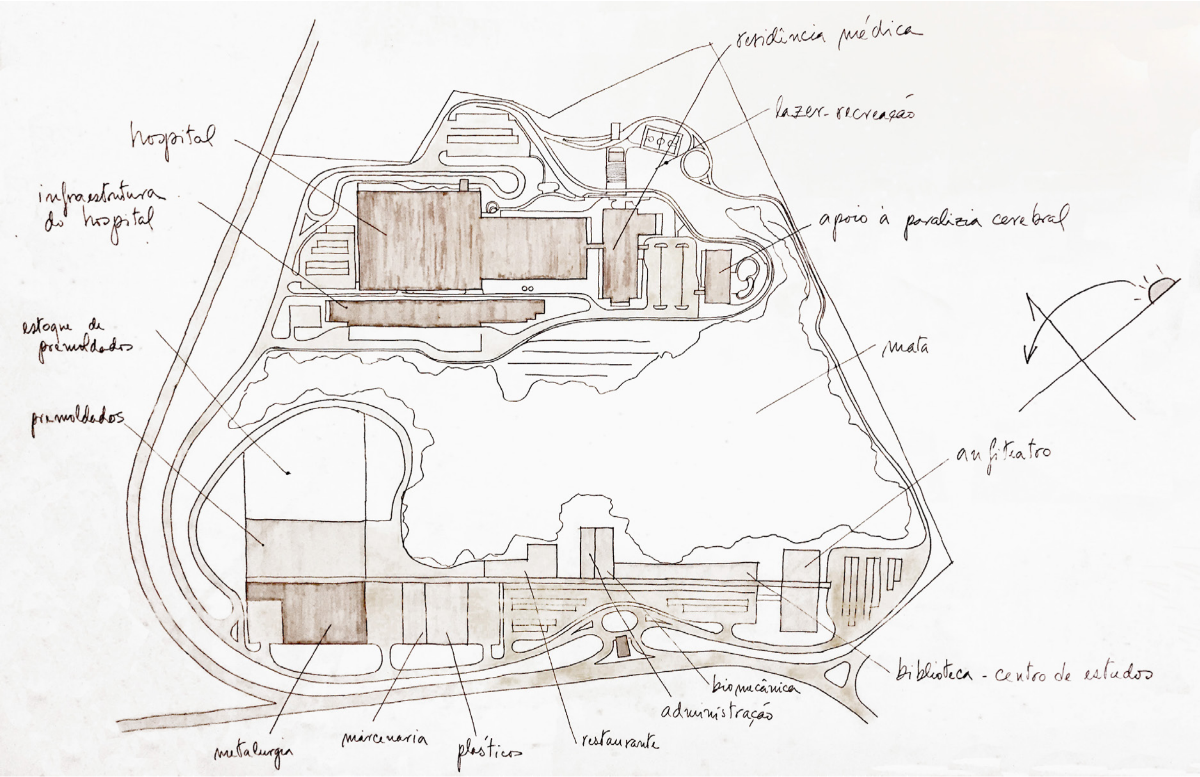

Fig. 3.66 Lelé's original proposal for the CTRS. The hospital (Sarah in Salvador) is located at the upper part of the urban plot. The factory and its sectors were positioned at the lower level. Arquivo CTRS, Salvador


Fig. 3.67 Aerial view of the hospital and the factory in Salvador. The expansion area of the CTRS (dedicated to the post-graduation courses) remains undeveloped (on the right). Arquivo João Filgueiras Lima, Salvador

Fig. 3.68 View of the light metallurgy sector of the CTRS showing how the two-storey workshops are visually connected to the gallery (double storey mezzanine plus underground). Photograph by Akemi Tahara, 2017. Courtesy of José Fernando Minho

– on the other hand, the original structure of the CTRS factory was enlarged to a level of specialization and mechanization never before experienced by the architect.

With 20,000 m² of constructed area, the technology center in Salvador was divided into five distinct workshops: heavy metallurgy (trusses, columns, roofs, beams, etc.), light metallurgy (window and door frames, tables, chairs, gurneys, etc.), *argamassa armada* (slabs, foundations, panel walls, etc.), woodwork (doors, tabletops, partition walls, etc.), and plastics (fans, speakers, reinforcement spacers, parts for the gurney-bed, etc.). The way these production sectors were organized in the CTRS plan – with the workshops arranged on both sides along a horizontal circulation axis – can be understood through an analogy with the Sarah hospital model of functional flows. In addition, and more relevant for this study, the CTRS layout made a clean break with Lelé's previous method of organizing the factory floor.

His new working method integrated both the production processes and the workers. Lelé set out all of the double-height manufacturing areas in such a way that they overlooked a three-story gallery with a width of 5 meters. The previous organization of his plants based on a linear sequence of work islands separated by large patios (curing tanks, stock area, parking lot and input storage) was no longer suitable. This is because, with a higher level of mechanization, the reduction of both storage areas and workforce led to a concentration of activities. For example, the *argamassa armada* workshop at the CTRS operated with only 50 employees,[151] a significant difference when compared to the 2,000 workers at the City Factory (FAEC).[152]

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151 João Filgueiras Lima, *Arquitetura: Uma Experiência na Área da Saúde* (São Paulo: Romano Guerra Editora, 2012), 142.

152 Lívia Pedreira, "Fábrica de Cidades: Estética da Repetição," *Arquitetura e Urbanismo* 4, no. 20 (1988): 30.

The reduced number of staff in the workshops not only reflected a better synchronization between the production, transport and assembly operations, but it also confirmed a new dynamic of work output and efficiency within the factory. As Francisco Alves Nascimento, manager of the CTRS, recalls "I realized that keeping several projects in different stages of production – one with the construction in progress, one at the beginning of works, and another being designed – would favor the team formation, as well as the purchase of inputs and products from third parties."[153]

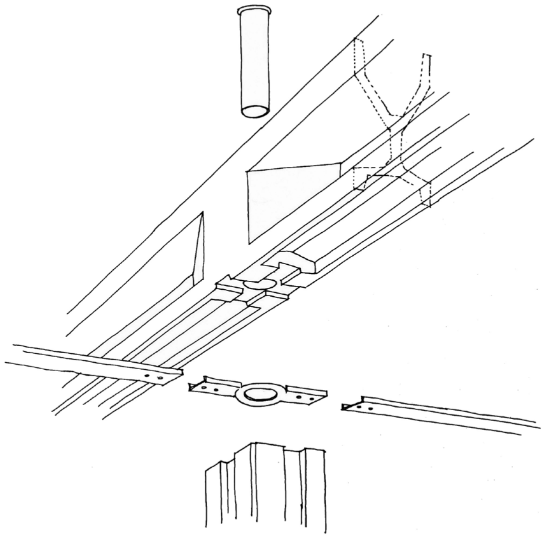

Fig. 3.69 Connection point of the *argamassa armada* system. The beam and column are bound together by a metallic tube. João Filgueiras Lima. *Escola Transitória Modelo Rural*. Brasília: MEC/CEDATE, 1984, p. 71

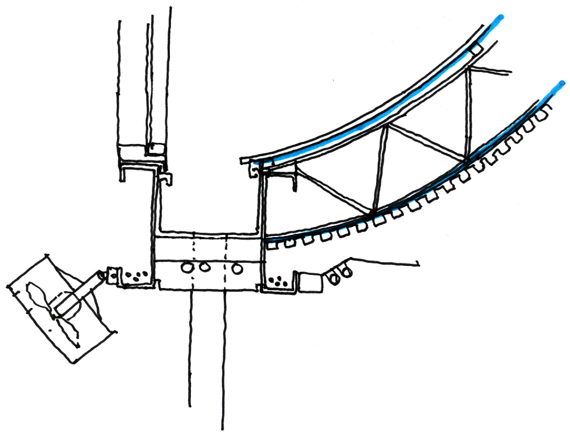

Fig. 3.70 Connection point of the CTRS's mixed system showing how the metallic structure assumes other functionalities. Arquivo João Filgueiras Lima, Salvador

The statistics are beguiling. However, Lelé continued to incorporate manufacturing practices that appeared to contradict the industrial logic. For example, we could cite his decision to enter the folded metal sheet technique without systematic practical experience or previous training in the field. Despite the architect's long involvement with the material throughout his career – with particular emphasis during the FAEC factory in Salvador, when the metallic footbridges were developed – the use of bent steel plates first emerged from the need to fulfill very specific tasks.

It was only after the CTRS that folded metal sheet elements went from being an artifice used to solve small problems for ad hoc applications – such as connectors and supplementary finishes between the roof and the wall panels of the schools – to becoming the main element responsible for shaping architecture. In this way, Lelé incorporated the technology of the bent steel plates into structures themselves, which was highly unusual among blacksmith industrialists, in a way that enabled the integration of functions, thanks to the specific design of components. A single beam, for instance, assumed a wider role, from the moment it combined the passage of conduits and cable trays with the incorporation of equipment supplied by the CTRS workshops, such as fans, luminaires, speakers or displays.

153 Francisco Alves Nascimento. Telephone interview with Adalberto Vilela on December 8, 2017. [Percebi que ao manter três projetos simultâneos – um executando, um começando a produzir, e um na prancheta – isso viabilizaria tantos as minhas compras quanto a formação de equips, dentre outras coisas] (my translation).

Fig. 3.71 External view of the CTRS's *argamassa armada* workshop showing the small storage area for the precast elements. Arquivo João Filgueiras Lima, Salvador

The way these workshops were arranged next to each other at CTRS gives us some information about the division of production in the factory, but it says little about the differences that existed on the level of automation in each manufacturing space. In this case, it is no coincidence that the *argamassa armada* workshop was more highly automated in comparison to the others. The reason for this is simple: "Lelé's long-lasting experience with the material ended up creating a compendium of problems around its use and fabrication process, which favored the investment in automation at the CTRS,"[154] recalled Fábio Savastano.

If one looks at what comprised the *argamassa armada* workshop's main operational changes, one realizes that they were derived from a closely related set of casting and conveying techniques. It is curious to observe that techniques which had been used by Lelé in his previous factories – such as the thermal cure and the fiber reinforcement[155] (both defended by the CEDEC team as shown in the previous chapter) – assumed a wider role in Salvador after the experience in São Paulo had proved their feasiability on the basis of scientific analyses.

154 Fábio Savastano. Telephone interview with Adalberto Vilela on January 16, 2018. [A longa experiência do Lelé criou uma coleção de problemas consolidados na argamassa armada e na sua fabricação, o que levou a uma maior automação da oficina no CTRS] (my translation).

155 According to Adriana Filgueiras, Lelé started to use the steel fiber reinforcement (Dramix) at the CIAC schools. Later, at the CTRS, he tried out a nylon fiber instead. In: Adriana Filgueiras. Interview with Adalberto Vilela on April 10, 2016 in Rio de Janeiro.

Lelé designed the CTRS' *argamassa armada* workshop with a different vision of the production process. He already knew that by mechanizing certain procedures of the manufacturing chain he could step up the pace of production and consequently reduce its operational cost. In other words, more machinery and fewer staff to increase production for a lower price. Even if this old industrial formula may seem contradictory – since we have seen that for Lelé the traditional method of producing *argamassa armada* using abundant labor helped to combat unemployment – the architect had to create the right conditions whereby the inevitable variation in customer demand did not affect the production costs.

The solution he found was to invest in an efficient system of production which abandoned the use of long above-ground curing tanks in favor of a sequence of underground chambers (with a depth of 3 m), where vertical elements were cured in hot water (between 60 and 70°C) produced by means of a steam boiler. Just 8 hours after the beginning of the curing process, the precast elements were already ready to be lifted, demolded and finally moved to the repair sector (if necessary) or separated for delivery.

This procedure, that took anything from 24 hours to one week at previous factories, depending on the weather conditions, was significantly reduced to 8 hours at the CTRS, and this helped to reach a production rate of 40 m^3 per day. As José Fernando Minho remembers, "this new process allowed Lelé to pour *argamassa* into the formwork three times a day, in the morning, afternoon and evening. If the factory had, for instance, 100 wall panel molds, it would be possible to produce 300 elements per day."[156]

Of course, this operation in three subsequent shifts only happened at production peaks with a tight schedule. The important point here, though, is the set of measures that enabled this new production rhythm which drove the curing process. If it were not for the modifications in both the preparation and the speed of transporting *argamassa armada* (as moisture or molded parts) within the plant, Lelé probably would not have reached this stage of optimization. This is due in large measure to the automation of certain processes, such as the batching, mixing and conveying of *argamassa armada*. To understand these three key steps in the production of *argamassa* precast elements, a detailed look into the process carried out at the CTRS is needed.

Lelé designed and built a central-mix plant, combining dimensions and functioning characteristics that fitted together for his particular mode of precasting elements. In a gravity-flow system, the cement bin discharged the precise programmed weight of cement vertically downwards towards to mixer, along with the aggregate (rock dust) measured by volume, therefore contradicting the recommendation to batch concrete according to the dry mass of the material. "This is because bulking of damp sand causes inaccuracies in measurement."[157]

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156 José Fernando Minho. Interview with Adalberto Vilela on April 20, 2016 in Salvador. [Esse novo processo permitiu Lelé realizar três concretagens por dia. Realizava-se uma concretagem logo pela manhã, outra à tarde e outra à noite. Se a fábrica, por exemplo, tivesse 100 fôrmas de painel de parede, seria possível produzir até 300 peças por dia] (my translation).

157 P. Kumar Mehta and Paulo J. M. Monteiro, *Concrete: Structure, Properties, and Materials*, 2nd ed. (New Jersey: Prentice Hall, 1993), 311.

Fig. 3.72 Overview of the *argamassa armada* workshop at the CTRS showing the four production lines, the sliding gantries and the electric hoists. Photograph by Akemi Tahara, 2017. Courtesy of José Fernando Minho

Fig. 3.73 The CTRS's *argamassa* central mixing plant. After the mixture is prepared, the *argamassa* is dumped into the yellow hoppers and lifted to the casting area. Photograph by Akemi Tahara, 2017. Courtesy of José Fernando Minho

The water was released automatically by the mixer system, whose operation provided proportions of fresh *argamassa* mixture (ratio 50 kg of cement to 0.0875 m^3 of rock dust). The mixture was then dumped into hoppers, which were carried upwards by electric chain hoists to the pouring platform, from where the *argamassa* was poured into the formwork. After the casting operation, the metallic molds, duly filled and vibrated, proceeded to the curing chambers to conclude the cycle with the palletizing of the elements.[158]

The reduction of the CTRS' production lines to only four bays seems to be a symptom of the optimization process described, which confirms on the one hand an approximation with the compact industrial layout implemented by the CEDEC factory in São Paulo; and on the other the definitive abandonment of a manufacturing model in which weather conditions affect the speed of production. Moreover, the addition of nylon fiber reinforcement to the *argamassa*, subsequently changed to steel,[159] ensured not only an increase in the flexural strength of the elements,[160] but also a remarkable economy of time, as a result of the removal of welded mesh from wall and floor panel elements.

The impact of such economy on the production chain was obvious in works such as the Sarah Hospital in Fortaleza (2001), which had all its internal and external walls (besides the slabs and solariums) made of *argamassa armada*. Without the new curing method associated with the steel fiber-reinforced elements, it is unlikely that the CTRS could have produced, stored and delivered (1,189 km from Salvador) such a high number of precast units in due time.

In the end, the Technology Center of the Sarah Chain fulfilled an important role in the course of Lelé's factories: it proved that, despite the mechanization of production and the rationalization of the manufacturing method, the architect's concept of industrialization was clearly bound to an artisanal dimension of architecture. In this sense, the creation of new standardized elements was driven more by the aspiration to achieve the technical object in a manual fashion than the need to solve the jointing and assembling of components.

In his observations of the adoption of a hexagonal section for the diagonal web members of the footbridge trusses, Fábio Savastano drew attention to an intriguing construction detail that rather represents the artisanal orientation that characterized Lelé's approach. Unlike all the other rectangular sections of the pedestrian bridge's framework, the diagonal curiously consisted of a single folded SAC 50 steel plate (8 mm thickness) welded at the extremities to form a hexagonal profile. But why?

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158 The CTRS' casting procedure, from the batching of the *argamassa* ingredients to the element's curing process, is described in more detail in: Cristina Câncio Trigo, "Pré-fabricados em argamassa armada: material, ténica e desenho de componentes desenvolvidos por Lelé" (Universidade de São Paulo, 2009), 61-67.

159 According to Ana Améia Monteiro, some tests were carried out at the CTRS with nylon and steel fibers for reinforcement. At the end of the test period, Lelé came to the conclusion that the metallic fiber was more appropriate due to the increase of tension and compression strength observed in some elements. Ana Améia Monteiro. Email interview with Adalberto Vilela on January 19, 2018.

160 The data from the tests by H. Krenchel on both plain and steel fiber-reinforced mortars showed that the incorporation of 0.9 and 2 percent fiber by volume of concrete increased flexural strength by approximately 15 and 30 percent, respectively; however, in both cases the elongation at rupture was 9 to 10 times that of the unreinforced mortar. In: Ibid., 407.

Fig. 3.74 Assembly process of the *Pernambués* footbridge in Salvador showing the diagonal elements of the metallic truss. Lelé, 1986-88. Arquivo CTRS, Salvador. Courtesy of Waldir Silveira

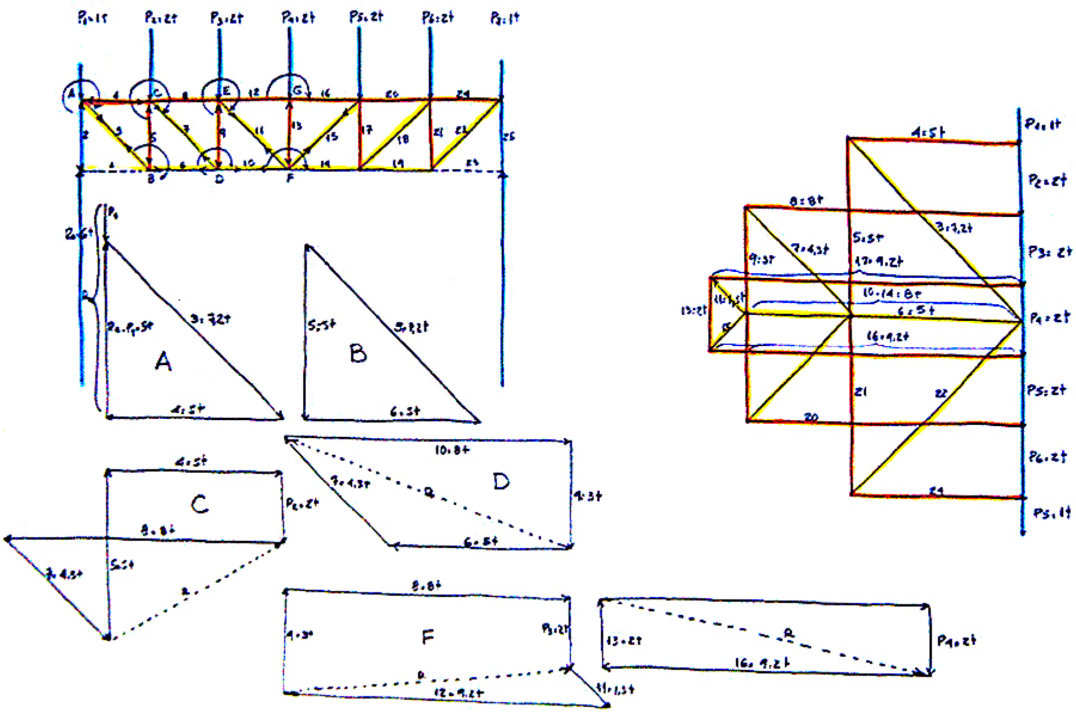

Fig. 3.75 Lelé's studies on trusses using the Cremona diagram to graphically determine the structure. The colors of the edges of the truss graph indicate compression (red) or tension (yellow). Arquivo João Filgueiras Lima, Salvador

According to Jaap Wardenier, “in common lattice structures (e.g. trusses), about 50% of the material weight is used for the chords in compression, roughly 30% for the chord in tension and about 20% for the web members or braces. This means that with respect to material weight, the chords in compression should likely be optimized to result in thin-walled sections.”[161] In the case of the CTRS footbridge, a Warren type truss,[162] the top and bottom chords are respectively under forces of compression and tension, with loads on the web members (diagonals) alternating between compressive and tensile stress as they approach the center.

Familiar with the features of the Cremona diagram[163] and the material weight distribution over the structures of the truss, Lelé opted, even though uneconomically – as more material than necessary was employed – to keep the same rectangular section for both the top and bottom chords of the footbridge. In contrast, when he chose to modify the section of the diagonals, he clearly took advantage of the weight reduction allowance to visually assimilate the idea of lightness into the appearance of his pedestrian bridge. Given that tubular profiles were not produced at the CTRS, and that calendering such narrow steel plates (299 mm width x 2700 mm length) would be impossible with the available machinery, Lelé decided to craft his own profile instead of ordering a customized metallic tube.

In addition to being a cheaper option, the solution of folding the footbridge’s diagonal illustrates perfectly how craft skills typified the architect’s approach to his industrial work, to “heighten the conscious value of objects”[164] and not merely reproduce them blindly on a large scale. By not following the standards and formats available on the market, Lelé ended up creating, paradoxically, a tailored industrialized architecture. If, on the one hand, “this aspect obstructed Lelé’s work”[165] – because it compromised the maintenance and replacement of parts out of catalog – on the other, the architect showed that it was possible to produce manufactured architecture using conventional materials and technology.

To a certain extent, the CTRS enabled Lelé to move beyond the capitalist framework of prefabrication, here understood as a set of practices which seek exclusively to increase the manufactured output. The way production was reorganized at the technology center in Salvador around the meticulous tasks accomplished in the specialized workshops defined another pace of productivity, where “growth” was not always measured in terms of the number of unities produced. Most of the time, the potential sources of product creation – from a single plastic joint to a metal component for hospital equipment – included the joint actions of teams involved

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161 Jaap Wardenier, *Hollow Sections in Structural Applications* (Delft: CIDECT, 2000), 6.2.

162 The Warren Truss is a very popular truss structure system and is easily identified by its construction from equilateral triangles. One of the main advantages of a Warren Truss is its ability to spread the load evenly across a number of different members. “Types of Truss Structures,” last modified March 30, 2015, accessed March 28, 2018, https://skyciv.com/education/types-of-trusses/.

163 The Cremona diagram, also known as the Maxwell diagram, is a graphic approach used to determine the forces acting on truss members (graphic statics) prior to the advent of computers. For more information, see: “Analysis of Trusses” in Daniel L. Schodek, *Structures* (Upper Saddle River, NJ: Prentice Hall, 2001), 136-183.

164 Richard Sennett, *The Craftsman* (London: Penguin, 2008), 141.

165 Fábio Savastano. Interview with Adalberto Vilela on May 31, 2016 in Brasília. [Isso de certa forma prejudicou a obra do Lelé] (my translation).

on two fronts, whether as designers/producers or operators/final users.

This opened up the space for another sort of industrial dynamics whereby the manufacture workspace (CTRS) and the hospital (Sarah in Salvador) mutually assessed anything that diverged substantially from the mode of cooperation at the architect's previous factories. With the advent of the CTRS, Lelé glimpsed the opportunity to benefit from this synergetic mechanism – which involved a wide range of professionals, such as physicians, nurses, architects, engineers, technicians, and medical practitioners – to gauge his technical solutions within the ambit of industrialized architecture.

In this sense, even if the CTRS had successfully managed to transport and assemble precast building parts across the vast dimensions of Brazil, it seemed that, in the early stage of the manufacturing process, the proximity between the plant and the components' final destination favored more accurate work and fewer errors. It is hardly surprising, then, that the first Court of Auditors designed by Lelé (TCU Bahia, 1996) was built a few meters from the CTRS, before the subsequent construction of the tribunal's head offices in other Brazilian states.

Therefore, even in the face of the persistent labor division and rigid hierarchy[166] observed in the CTRS' building sites, Lelé realized that the fragmentation of the building activities impacted on quality and, consequently, on the final price of construction. The architect's close and permanent involvement in the works, in a mutually enriching exchange with all participants in the process, may have prompted the crossbreed of the industrialist and the craftsman in Lelé.

In the quest for answers to explain the optimization of Lelé's production, it has become apparent that the advances obtained by the architect in the field of industrialization of construction in Brazil permeate more the dichotomies between standardized/artisanal than properly mechanized/rationalized. Yet if in some respects Lelé's solutions contradicted the logic behind the building industry, in other ways they clearly matched the spirit of mass production. Rather than serving homogeneous interests, he embraced a practice on his own terms, constantly reaffirming his long-standing commitment to bridge the crucial gap between professional training, the factory and the building site.

166 See Adriana Filgueiras Lima. Interview with Debora Verniz on June 27, 2011 in Rio de Janeiro. Debora Verniz Pereira, "Industrialização Das Construções Complexas: Estudo de Obras Hospitalares" (Universidade de São Paulo, 2012), 135.

Epilogue

In 2007, in his old age and battling against cancer, Lelé founded[1] the Brazilian Institute of Technology of Habitat (*Instituto Brasileiro de Tecnologia do Habitat*, IBTH), a non-profit organization aimed at the development of public interest projects. In other words, the IBTH (2007-2013) was Lelé's last endeavor to overcome the type of administrative constraints that had hampered the CTRS factory. Operating exclusively under and for the Sarah hospital domain, the architect broke free from the ties imposed by the Federal Audit Court (*TCU*). This enabled him to enter into agreements, partnerships or similar joint projects with third parties, and therefore recover "the social role of his factories, seeking to introduce in these experiences the educational character that motivated him so much."[2]

Although this subject is only now being presented, at the very end of this thesis, it does not mean that it came later for Lelé. On the contrary, the use of precast factories as a vehicle for architecture training and craftsmanship began during the construction works he carried out in Brasília. Chronologically, the architect's lifelong dream to treat the factory not merely as a space for production but as an opportunity for promoting technical training dates back to the beginning of the University of Brasília (UnB, 1962). However, another crucial question for Lelé needed to be resolved before his plans could take root, namely the dichotomy between on-site prefabrication and precast plants.

As we saw in Part I, the architect's decision to precast his components at the building sites of the new capital was not taken on the basis of efficiency and economy. Instead, it was a solution within his reach. Apart from the obvious absence of practical knowledge in the field of building industrialization at that time, Lelé also had to face resistance from building companies who were unwilling to finance his precast plants. Therefore, how could the architect possibly carry forward an educational proposal that depended on a factory if he did not have a clear picture of how it would be to set up a factory in Brazil? It would certainly turn out to be very different from what he had seen in terms of prefabrication in several Eastern European countries in 1963.

During the difficult period of the UnB's first few years (1962-65), Lelé and Darcy Ribeiro dreamed about creating a major center for building industrialization[3] on campus, for the benefit of the university and the newly founded city. "It was the first time that I glimpsed the possibility of including a factory in the training of engineers and architects. I have pursued

1 The IBTH Institute was constituted on May 16, 2006 as an Association. In July 2007, with a new legal statute, the Institute entered into its activities and objectives as a Civil Society Organization of Public Interest (OSCIP). See: Reforma do Estatuto do Instituto Brasileiro de Tecnologia do Habitat, 2007.

2 Sergio Kopinski Ekerman, "Pré-Fabricação e Transformação de Áreas de Urbanização Informal: Experiência de Lelé em Salvador," in *11. Seminário Docomomo Brasil* (Recife: Docomomo Brasil, 2016), 9. [o papel social de suas fábricas, buscando introduzir nestas experiências o caráter educacional que tanto o motivava] (my translation].

3 João Filgueiras Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes* (Rio de Janeiro: Editora Record, 2004), 51.

this goal throughout my life,"[4] recalled Lelé many years later. But good intentions alone do not suffice to achieve such ambitious reforms. With the military's rise to power in 1964, the possibility of introducing the most advanced methods of building prefabrication to higher education became a "forbidden ambition,"[5] to cite Ribeiro when he looked back at the ruined project of UnB.

Twenty years later, in 1982, Lelé made his first real attempt to integrate an architecture school into a building site, which was governed by an unorthodox construction method, namely *argamassa armada*. Thanks to the initiative of the architect and professor Edgar Graeff, Lelé started to teach[6] at the Catholic University of Goiás (*Universidade Católica de Goiás*, UCG). At the center of their pedagogical plan was the prototype school erected in Abadiânia, regarded less as a result of the multidisciplinary joint action carried out in the small town, and more as a building venture of greater didactic potential.

Both Graeff and Lelé knew that exploring the school project within academia would help not only to disseminate precast building techniques among the students, but also to assure the local government of the adequacy of prefabrication as a simple and accessible technology. Nevertheless, what appeared to be a promising assembly system – worth teaching at the architecture schools – proved difficult to incorporate into their curriculum framework because of Lelé's intense involvement with his factories throughout the 1980s.

If it were not for the personal effort of the architect Kristian Schiel in elaborating an agreement plan[7] between the *Argamassa Armada* Factory in Ceilândia and the University of Brasília, the transitory school system of Abadiânia – which began in the Federal District in 1985 – would have remained restricted to its production chain. Although the academic deal did not succeed in making further progress, it called into question the limitations which Lelé's work had been subjected to. Some of the architect's most creative and socially impactful solutions might have gained international recognition had it not been for the way in which his project conceptions and their manufacturing methods were regarded as being far more complex and laborious than those involved in traditional construction.

Lelé's failure to disseminate his architecture beyond his patronage circles demonstrated the determinant role of favorable political environments in his practice. Opportunities for exporting the architect's ideas to other Latin American countries – like the precast elements for sanitation works in poor areas which were approved by the World Bank,[8] UNESCO's

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4 Susana Olmos and Chango Cordiviola, "L'Humain Au Cœur de la Fabrique Architecturale / The Human at the Heart of the Architectural Factory," *L'Architecture d'Aujourd'hui*, no. 396 (2013): 55.

5 Darcy Ribeiro, *UnB: invenção e descaminho* (Rio de Janeiro: Avenir, 1978), 41. [A UnB é uma utopia vetada, é uma ambição proibida, por agora, de exercer-se] (my translation).

6 João Filgueiras Lima, *O que é ser arquiteto: memórias profissionais de Lelé (João Filgueiras Lima); em depoimento a Cynara Menezes*, 58.

7 In a letter addressed to Frank Svensson (1934-2018), professor at the Faculty of Architecture in Brasília, Kristian Schiel explained how this pedagogical agreement between the university and the precast factory would work. *Fábrica de Argamassa Armada – Ceilândia*, Universidade de Brasília, undated (1990?). Arquivo Kristian Schiel, Brasília.

8 n.d., "Missão Do BIRD Faz Uma Visita Às Obras," *Jornal Da Bahia* (Salvador, May 9, 1981).

proposition to implement footbridges all over South America,[9] or the women's care centers (Project *Ciudad Mujer*) designed by Lelé for the government of El Salvador,[10] in Central America – always came up and were taken into consideration. But somehow, his approach towards prefabricated construction based on strict production methods may have doomed the reception of his creations by public institutions and private companies that were least likely to endorse them. Despite the provocative nature of Lelé's final comments, the architect's interpretation of the situation could not have been otherwise:

> "But the idea (to spread the footbridge to other countries) never left the drawing board because no company was interested. The footbridge is logical and simple, so much so that it continues to be produced today. But not by the private initiative, because it means they would have to invest in formwork. And they do not even know what it is. They only build using primitive technologies."[11]

In 1992, Lelé transformed the difficulties involved in the industrial production of *argamassa armada* into a positive experience that opened up opportunities between architecture and healthcare and tightened the bonds between them. The promising union – which today benefits from a high level of integrated manufacture – encouraged the architect to organize, once again, a joint workshop bringing together the factory (*Centro de Tecnologia da Rede Sarah*, CTRS) and post-graduation courses in the field of medicine, nursing and architecture. However, nothing has come of this promise yet. Worse still, the Sarah Chain, which was supposed to establish the operational basis of this integrative process of learning, suffered from unfortunate decisions that restrained the successful functioning of its own technological center.

It seemed logical and coherent that in view of this scenario Lelé decided to channel his efforts, expertise and resources to focus on the development of his Institute of Habitat. But the newly created IBTH did not go far enough. "More than 20 projects were designed, some developed in depth, but none of them went ahead,"[12] recalled Lelé in one of his last interviews. Except for the Darcy Ribeiro Memorial, built at the University of Brasília's campus in 2010, the other projects were systematically shelved. Nevertheless, one aspect of the bitter disappointment that ailed Lelé deserves special attention. I refer to the small and temporary factory desiged to produce the precast components of Lelé's social housing project.

9 João Filgueiras Lima, "João Filgueiras Lima, Lelé [Entrevista a Adriano Carneiro de Mendonça]," in *ENTRE, Entrevistas Com Arquitetos Por Estudantes de Arquitetura* (Rio de Janeiro: Viana e Mosley, 2012), 131.

10 The unexecuted *Ciudad Mujer* project was designed by Lelé in 2009 and developed under the domain of the IBTH, the *Instituto Brasileiro de Tecnologia do Habitat*.

11 Ibid. [Mas a ideia nunca saiu do papel porque nenhuma empresa se interessou. Esta passarela é lógica e simples, tanto que continua a ser feita até hoje. Mas não pela iniciativa privada, pois isso significa que ela terá que investir para fazer moldes. Ela nem sabe o que é isso, só faz as coisas mais primitivas] (my translation).

12 João Filgueiras Lima, "Filgueiras Lima, Lelé [Entrevista a Evelise Grunow]," *Projeto*, no. 397 (2013): 27. [Foram mais de 20 sugestões de projetos, alguns desenvolvidos com muita profundidade, mas que acabaram não acontecendo] (my translation).

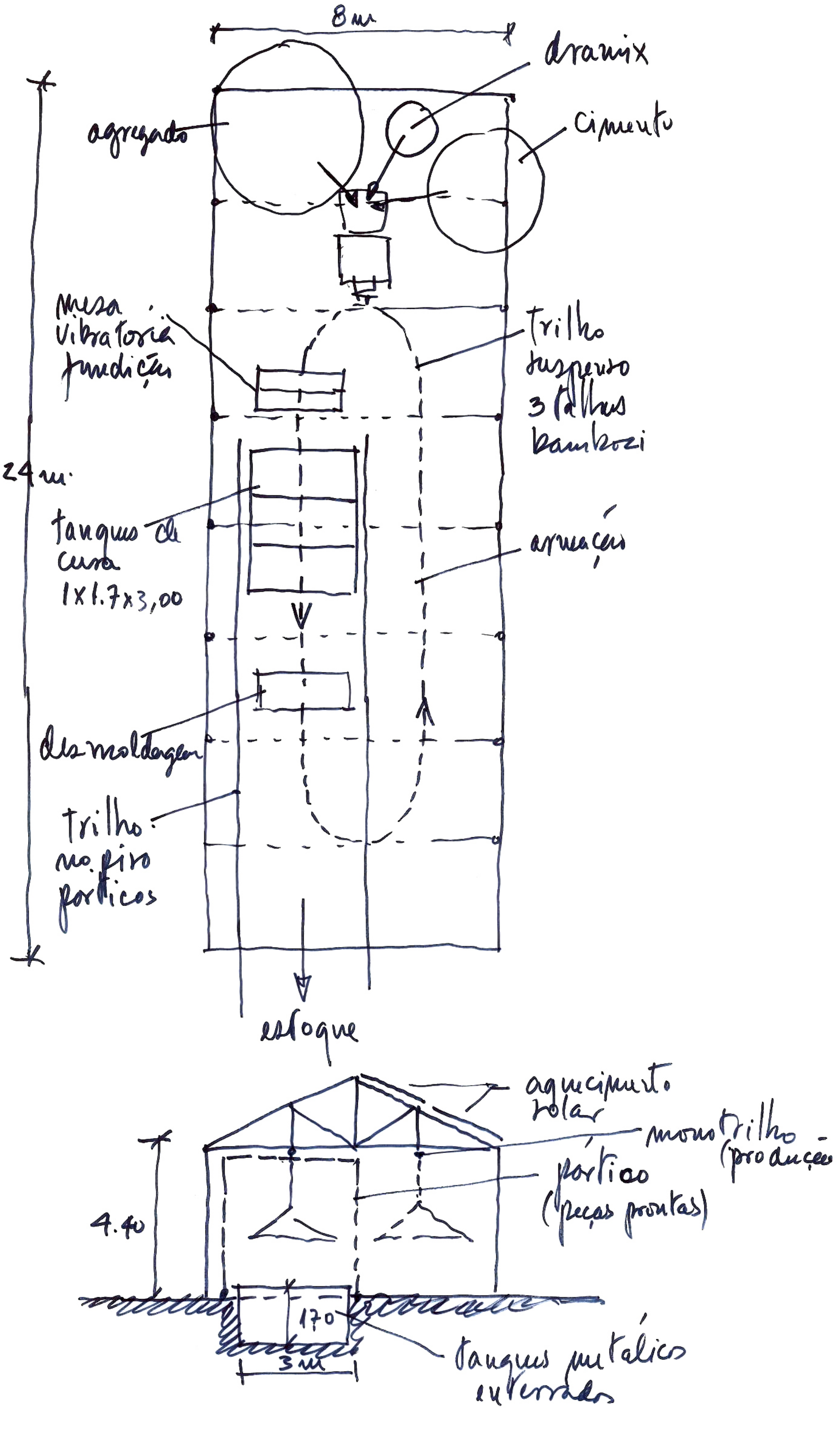

Fig. i.iii The small factory of *argamassa armada* precast elements designed by Lelé to be erected at the building sites of the *Minha Casa Minha Vida* housing program in Brazil. Arquivo Instituto Brasileiro de Tecnologia do Habitat (IBTH), Salvador

Fig. i.iv Aerial view of the housing complex at the district of Pernambués, Salvador. Project by Lelé, 2011. Arquivo Instituto Brasileiro de Tecnologia do Habitat (IBTH), Salvador

Fig. i.v View of the funicular railway of the housing complex at the district of Pernambués, Salvador. Project by Lelé, 2011. Arquivo Instituto Brasileiro de Tecnologia do Habitat (IBTH), Salvador

Invited by the President Dilma Rousseff (2011-2016) to technically review the *Minha Casa Minha Vida* (My House, My Life) federal housing program[13] in Brazil, Lelé developed a project in January 2011 based on the combination of rows of stilt houses and residential buildings. The proposal was also meant to be applied to hilly terrains using a mixed structure of steel and *argamassa armada* walls. Although unexecuted, the project reveals a production method that converged with the architect's training aspirations. By using a small and provisory *argamassa armada* plant installed at the building site and operated by the local community, the architect found a way to combine the old dream of the factory school with craftsmanship in the context of prefabrication.

With one single production line, the small factory offers a relevant counterpoint to the idea of great manufacture complexes, around which Lelé's career was mostly built. Except for Abadiânia – whose facilities were equally reduced – all the other plants set up by the architect in Brazil relied on large structures for industrial production. But what is at stake here amounts to more than a difference of scale between the factories he installed over the years. Rather, it is a question of the role of that small space of production, disassembled at the end of the works.

During the construction of the envisioned housing complex, the training of the future residents to control various equipment, batch *argamassa*, and precast their own constructive elements would have an impact far beyond the mere completion of the buildings. By allowing the local community to produce as well as assemble their own components – which did not happen in previous projects – Lelé essentially assigned a broad technological value to labor. Unlike manpower in his preceding factories – whose activities were based on the division of work – the small plant of the housing project depended on the sharing of knowledge between the resident builders.

Reflecting on the nature of the collaborative work proposed for the *Minha Casa Minha Vida* housing program, I tend to think that Darcy Ribeiro and Lelé might have been right when they first decided to marry the factory with the school. After Lelé's death, in May 2014, the prefabricated building systems created by the architect served as didactic material in at least two courses taught in Brazil and Switzerland. In Lausanne, the "*Argamassa armada* in Salvador de Bahia" course[14] addressed the "mobile mini-plant" of the federal housing program and used its building system as a starting point to situate the contribution of Lelé to the building culture and examine his approach towards social technologies.

In São Paulo, the solid legacy left by the architect inspired the creation of the "*Escola de Humanidades* João Filgueiras Lima – Fábrica,"[15] a high school focused on the training of

13 See Marc Angélil et al., *Minha Casa Nossa Cidade! Innovating Mass Housing for Social Changes in Brazil* (Berlin: Ruby Press, 2014); Cláudia Estrela Porto, "Nossa Casa, Nossa Vida," *Arquitetura e Urbanismo* 26, no. 208 (2011): 38–45.

14 The course "Argamassa armada in Salvador de Bahia" is proposed and conducted at the ALICE Laboratory (*Atelier de la conception de l'espace*), a teaching unity linked to the School of Architecture, Civil and Environmental Engineering (ENAC) of the École polytechnique fédérale de Lausanne (EPFL), Switzerland. The first module of the course was launched in the autumn semester of 2016 and assigned to master students.

15 *Escola de Humanidades* João Filgueiras Lima – *Fábrica*, a project created in 2015 by the *Escola da Cidade*, is a

students through solid humanistic principles and technical values. The School of Humanities includes the combination of manifold fields of knowledge,[16] alongside the essence of its pedagogical project: the workshop. By placing the term "*fábrica*" in their name, the institution reinforces both the compromise with technical education (non-academic) in Brazil – a crucial gap in the country's professional schooling system that has been neglected by society and the government – and the renewal of the values behind Lelé's practice, centered on the idea that conception and production are inseparable parts of the same process.

In the end, the methods of training "unskilled labor," architects or engineers involve common needs, regardless of educational level. The idea of innate talent or intuitive ability applied to the workplace was questioned by Lelé in favor of other forms of manufacturing organization, where priority was given to a "learning by doing" mindset. When drawing attention to Richard Sennett's defense of technical understanding as something developed on the inextricable basis between ideas and practice (The Craftsman, 2008), Filipe Guidetti raised a central question: "Repetition allows for self-criticism, allows one to modulate the practice from the inside out. Moments of creation are actually anchored in the routine."[17] His words seem to describe Lelé's own understanding of building prefabrication, in which creation is a term more associated with the notion of continuation than invention.

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non-profit organization focused on the training of architects and urbanists based in São Paulo. The architect Paulo Mendes da Rocha will be in charge of the project for the headquarters of the School of Humanities. For further information concerning the goals and administrative structure of the *Escola de Humanidades João Filgueiras Lima*, see: "Conselho escola de humanidades (fábrica)," Escola da Cidade. Last modified May 26, 2015. Accessed April 13, 2018. http://www.escoladacidade.org/conselhos/nucleo-ex-alunos/

16 The curriculum of the *Escola de Humanidades* encompasses various disciplines, such as: history, ecology, physics, arts (drawing, cinema, theatre, music, and literature), geography, chemistry, biology, sociology and philosophy. The names of the instructors responsible for each of these fields are available at: ibid.

17 Filipe F. Guidetti, review of *O artífice*, ed. Rio de Janeiro: Record, 2009. 364 p. In: *Horizontes Antropológicos* 19, no. 40 (2013): 458, accessed February 13, 2018. [Repetir possibilita a autocrítica, permite modular a prática de dentro para fora. Os momentos de criação estão, na verdade, ancorados na rotina] (my translation).

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Biography and Work

João Filgueiras Lima (1932-2014)

Brazilian. Born in Rio de Janeiro, 10 January 1932. Educated at the Colégio Santa Catarina, Rio de Janeiro, 1939-43; Colégio Militar, Rio de Janeiro, 1943-49; Escola Militar, Agulhas Negras, 1949; National Faculty of Architecture, University of Rio de Janeiro, 1950-55, Dipl. Arch. 1955. Married Alda Rabello Cunha in 1960; children: Luciana, Adriana, and Sônia. Worked as a clerk in the Naval Ministry, Rio de Janeiro, 1949-50; Technical Designer, Arquitec Ltda., Rio de Janeiro, 1950-52; Technical Designer, 1952-55, and Architect, 1955-58, 1961-62, IAPB (Institute for Retirement and Pension of Bank Employees), Rio de Janeiro; Managing Architect, IAPB, Brasília, 1957-60; Executive Secretary, with Oscar Niemeyer, Planning Center, University of Brasília, 1962-65; Worked in collaboration with Oscar Niemeyer, Brasília, 1962-70; Head Architect, Department of Architecture, Projectum Ltda., Brasília, 1970-73; Coordinator of the postgraduate course, Faculty of Architecture, University of Brasília, 1962-65. Architectural consultant, Hospital Foundation, Brasília, 1969-72; In private practice, Brasília, 1971-78; Technical Coordinator of the RENURB Office, Salvador, 1978-81; Infrastructure Coordinator of the AMA Project, Abadiânia, 1982-84; Guest Professor at the Catholic University of Goiás, Goiânia, 1983-85; Technical Coordinator of the School Factory, Rio de Janeiro, 1984-86; Technical Consultant for the Argamassa Armada Factory, Brasília, 1985-91, Technical Coordinator of the FAEC Office and Factory, Salvador, 1986-88, Technical Coordinator of the Public Transportation Office (TMS), Salvador, 1986-89; Technical Consultant of the CEDEC/EMURB Factory, São Paulo, 1989-90; Technical Coordinator of the FABES Factory, Ribeirão Preto, 2001-02; Project Coordinator of the APS (Associação das Pioneiras Sociais) and the CTRS (Centro de Tecnologia da Rede Sarah), Salvador, 1992-2009; Chief Executive Officer at the Instituto Brasileiro de Tecnologia do Habitat (IBTH), Salvador, 2007-14. Deceased in Salvador, 21 May 2014.

1. Work

(Factories Highlighted in Bold Letters)

1958	Temporary residence for the IAPB employees, Brasília
1961	César Prates House, Brasília
1962	Colina Housing Complex, University of Brasília
	General Services Building, University of Brasília
	Friar Mateus Rocha's House and Chapel, University of Brasília
1963	ICC Building, University of Brasília (with Oscar Niemeyer)
1965	Disbrave Volkswagen Workshops, Brasília
1968	Taguatinga Hospital, Brasília
	National Congress Annex II, Brasília (with Oscar Niemeyer)
	Army Headquarters, Brasília (with Oscar Niemeyer)
1969	Aloysio Campos da Paz House, Brasília
1970	Residence for the Minister of Planning, Brasília
1971	Rogério Ulyssea House, Brasília
	R. Bougleux House, Brasília (unexecuted)
1972	Tennis Academy, Brasília

Nivaldo Borges House, Brasília
National Congress Annex III, Brasília (with Oscar Niemeyer)
Assembly Hall, Chamber of Deputies, Brasília (with Oscar Niemeyer)
Ford Planalto de Automóveis Workshops, Brasília
1973 José da Silva Netto House, Brasília
Portobrás Building, Brasília
DASP Training Center, Brasília
Bahia Administration Center Secretariat, Salvador
1974 Camargo Corrêa Complex, Brasília
CAB Exhibition Center, Salvador
Commercial Federation of Brasília Headquarters, Brasília
1975 Mercedes-Benz Codipe Building, Brasília
CAB Church (Church of the Ascension), Salvador
Portobrás Garage Building, Brasília (unexecuted)
Aloysio Campos da Paz House, Expansion Project, Brasília (unexecuted)
Disbrave Volkswagen Workshops, Building Complex Expansion, Brasília
1976 Sarah Rehabilitation Hospital, Brasília
1977 Mario Kertész House, Salvador
Daher Clinic, Brasília
1978 Research Center for the Cerrado Regions (Embrapa), Brasília
1979 RENURB Factory, Salvador
Public Schools (RENURB), Salvador
Military Police Head Office (RENURB), Salvador (unexecuted)
Mario Kertész House, Pituba Beach, Salvador (unexecuted)
Lapa Station (RENURB), Salvador
Alagados Church (RENURB), Salvador
Central of Police Stations (RENURB), Salvador
Police Stations (RENURB), Salvador
Sé Belvedere (RENURB), Salvador (unexecuted)
Bus shelter (RENURB), Salvador
Precast Benches (RENURB), Salvador
1980 Camurujipe Valley Project (RENURB), Salvador
São Joaquim Market's Footbridege (RENURB), Salvador
Brotas Convent (RENURB), Salvador (unexecuted)
1981 Eletrobrás Headquarters, Rio de Janeiro (unexecuted)
1982 Gil Santini and Albineiar Plaza House, Abadiânia, Goiás
João and Divina Benko's Plant Nursery, Abadiânia, Goiás
1983 Abadiânia Factory, Goiás
Rural bridge, Abadiânia, Goiás

Prefabricated Wooden School, Abadiânia, Goiás
1984 Precast Rural School, Abadiânia, Goiás
School Factory, Rio De Janeiro
Children's House (School Factory), Rio de Janeiro
Argamassa Armada Footbridge, Rio de Janeiro
Precast Benches (School Factory), Rio de Janeiro
Ilha do Governador Auditorium (School Factory), Rio de Janeiro
Portuguese Association, Taguatinga, Brasília
1985 **Argamassa Armada Factory, Brasília**
Bus shelter (School Factory), Rio de Janeiro
Nivaldo Borges Jr House, Brasília (unexecuted)
Disbrave Volkswagen Workshops, Workshop Entrance Marquee, Brasília
1986 **FAEC Factory, Salvador**
Salvador City Hall (FAEC), Salvador
VLT Project (Bonde Moderno), Salvador (unexecuted)
Aeroclub Park (FAEC), Salvador (unexecuted)
Bathing Facilities (FAEC), Salvador (unexecuted)
Largo da Mariquita Project (FAEC), Salvador (unexecuted)
Ladeira da Misericórdia Project (FAEC), Salvador (with Lina Bo Bardi)
1987 Footbridges (FAEC), Salvador
Public Childcare (FAEC), Salvador
Psychiatric Hospital of Taguatinga (FAEC), Brasília
Community and Sindical Center (FAEC), Camaçari, Bahia
Ceilândia City Hospital, Brasília (unexecuted)
Essential School Model, Minas Gerais (unexecuted)
Community House, Minas Gerais (unexecuted)
Integrated Community Equipment Centers (NIEC), Minas Gerais (unexecuted)
1988 Headquarters of the Bahia Tourism Office (FAEC), Salvador (unexecuted)
Sarah Rehabilitation Hospital, Curitiba (unexecuted)
Sarah Rehabilitation Hospital, São Luís
Public Schools (FAEC), Salvador
Footbridges (FAEC), Florianópolis
Footbridges (FAEC), Brasília
Iguatemi Station (FAEC), Salvador
1989 **CEDEC Factory, São Paulo** (consultancy)
Sarah Rehabilitation Hospital, Salvador
Footbridges (FAEC), Belo Horizonte
1990 **CIAC Factory, Brasília**
1991 Sarah Rehabilitation Hospital, Fortaleza

First CIAC School Prototype, Paranoá, Brasília

1992 **CTRS Factory, Salvador**

Footbridges, Rio de Janeiro

Jerivá Restaurant, Abadiânia, Goiás

1993 Sarah Rehabilitation Hospital (CTRS), Belo Horizonte

1994 Community Center (CTRS), São Luís

João Santana House, Ilhéus, Bahia

Aloysio Campos da Paz House, Expansion Project, Brasília

1995 Sarah Chain Warehouse (CTRS), Brasília

TCU Audit Office (CTRS), Salvador

Sarah Rehabilitation Hospital (CTRS), Recife (unexecuted)

Sarah Rehabilitation Hospital (CTRS), Lago Norte, Brasília

Auditorium of the Sarah Rehabilitation Hospital (CTRS), Brasília

1996 TCU Audit Office (CTRS), Natal, Rio Grande do Norte

TCU Audit Office (CTRS), São Luís, Maranhão

Sarah Rehabilitation Hospital (CTRS), Natal (unexecuted)

Road Tax Office (CTRS), Estiva, Maranhão

Darcy Ribeiro Foundation (IBTH), Brasília

1997 TCU Audit Office (CTRS), Aracajú, Sergipe

TRE Bahia Electoral Court (CTRS), Salvador

TCU Audit Office (CTRS), Teresina, Piauí

TCU Audit Office (CTRS), Cuiabá, Mato Grosso

TCU Audit Office (CTRS), Maceió, Alagoas

TCU Audit Office (CTRS), Belo Horizonte, Minas Gerais

TCU Improvement School (CTRS), Brasília

São José de Ribamar Chapel (CTRS), Maranhão

City Halls in the States of Maranhão and Amapá (CTRS)

1998 TCU Audit Office (CTRS), Vitória, Espírito Santo

Casa de Caboclo (CTRS), Maranhão (unexecuted)

2000 Sarah Rehabilitation Hospital (CTRS), Rio de Janeiro

Sarah Rehabilitation Outpost (CTRS), Macapá

2001 Waldir Silveira House, Lauro de Freitas, Bahia (unexecuted)

Vale dos Rios Project (FABES), Ribeirão Preto, São Paulo (unexecuted)

2002 **FABES Factory, Ribeirão Preto, São Paulo**

Sarah Rehabilitation Outpost (CTRS), Belém

BAC Community Support Office (FABES), Ribeirão Preto, São Paulo

BAC Rocinha (FABES), Rio de Janeiro

BAC Freguesia do Ó (FABES), São Paulo

2003 Christiana Brenner House, Brasília (unexecuted)

	Tumucumaque Museum, Macapá (unexecuted)
2005	Jurandir Amorim House, Lauro de Freitas, Bahia (unexecuted)
2006	TV Tower, Brasília (unexecuted)
2007	**IBTH Factory, Salvador (unexecuted)**
	Roberto Pinho House, Brasília
2008	TRT Regional Labor Court (IBTH), Salvador
2009	Athos Bulcão Foundation (IBTH), Brasília (unexecuted)
	São Joaquim Public Market (IBTH), Salvador (unexecuted)
	Creche Ciudad Mujer (IBTH), El Salvador (unexecuted)
2010	Pituaçu Bridge (IBTH), Salvador (unexecuted)
	UPA Healthcare Unit (IBTH), Salvador (unexecuted)
	IPHAN Annex (IBTH), São Paulo (unexecuted)
2011	Minha Casa Minha Vida Housing Project (IBTH), Salvador (unexecuted)
	Ecumenical Church (IBTH), Santa Catarina (unexecuted)
2013	Casa da Mulher Brasileira Project (IBTH), Brazil (unexecuted)
	Regional Airports (IBTH), Brazil (unexecuted)

2. Undated and unexecuted projects

Bahiatursa Outpost, Salvador
Banco do Brasil Agencies
Correio Braziliense (building extension), Brasília
Appartments for Lybia, Tripoli
Urbanization of the Barra da Tijuca district, Rio de Janeiro
R9 Building (Rabello), Guará, Brasília
Shopping Mall Venâncio, Brasília
Community Center, Planaltina, Brasília
Municipal Administration Centers, State of Maranhão
COMIND Insurance Company, Açailândia, Maranhão
COMIND Insurance Company, São Paulo
Embassy of Côte d'Ivoire, Brasília
Embassy of Syria, Brasília
Embassy of Paraguay, Brasília
Brasília Music School (CTRS), Brasília
TCU International School of Audit and Inspection, Brasília
Eduardo Kertész Farm House
Alexandre Rodrigues House
Carlos House
Disbrave Farm

Darcy Ribeiro House
House of the Architect, Salvador
Eduardo Ramos House
Eusiles Pastori House, São Paulo
Fátima Zugaib, Ilhéus, Bahia
Francesco Carlo Gentilli House
Gilberto House
Jair House
João House
Neide Trindade House
Oliveira Brito House
Wilson House
Tereza-Dadinho House
Healthcare Station Eletrobrás, Sobradinho, Bahia
Belo Horizonte City Hall, Belo Horizonte
Superquadra SQS 204, Brasília
Superquadra SQS 311, Brasília

3. Awards and Individual Exhibitions (selection)

1973	São Paulo 1st Architecture Biennial, São Paulo | Exhibition
1986	Estácio de Sá Award, State of Rio de Janeiro Government
1998	Oscar Niemeyer Award, the Federal District Government
1998	I Bienal Iberoamericana de Arquitectura e Ingeniería Civil
	First Prize (architecture) Sarah Rehabilitation Hospital, Salvador
1998	Special Room at the São Paulo 4th Architectural Biennial, São Paulo
2000	Grand Golden Collar Award, Brazilian Institute of Architects (IAB)
	7. Mostra di Architettura di Venezia | Brazilian Pavilion
2001	IX Buenos Aires International Biennial
	Grand prêmio latinoamericano
2002	III Bienal Iberoamericana de Arquitectura e Ingeniería Civil
	Award for the work as a whole
2003	Doctor Honoris Causa | Federal University of Bahia
2004	Doctor Honoris Causa | Braz Cubas University, São Paulo
2005	Emeritus Professor | University of Brasília
2010	A Arquitetura de Lelé: Fábrica e Invenção | Exhibition
	Museu da Casa Brasileira (MCB), São Paulo
2012	Lelé: a culture of materials and the art of production | Exhibition
	Nederlands Architectuurinstituut (NAi), Rotterdam

2014 14. Mostra di Architettura di Venezia | Brazilian Pavilion
2015 Lelé: a culture of materials and the art of production | Exhibition
AIT ArchitekturSalon, Köln | AIT ArchitekturSalon, Hamburg

4. Sources

Arquivo João Filgueiras Lima, Salvador

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Risselada, Max, and Giancarlo Latorraca. *A Arquitetura de Lelé: Fábrica e Invenção*. São Paulo: Imprensa Oficial SP, MCB, 2010.

Vilela, Adalberto. *A Casa na Obra de João Filgueiras Lima, Lelé*. Brasília: Editora Universidade de Brasília, 2017.