

Transferring Research Knowledge into Urban Design Education

Book Chapter

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objectifying as possible. There are so many underlying assumptions and conventions that we take for granted when we design, like how many lights somebody will use, what constitutes the width of a building, what constitutes good mobility and so on. Many design choices deserve to be questioned, and under closer scrutiny they often fall apart.

PM *So how do you involve the scientific community in your projects, and at what stage?*

ADH To me, it's interwoven. In Antwerp, we mobilised the scientific community to perform an important role in the evaluations of the quality of life projects. It started with a dispassionate enquiry, followed by pushing forward a hypothesis and drawing it up, then there was another round of dispassionate enquiry. The designers should be mobilised in the design project and the design team should be externally validated or invalidated, in other words confirmed or falsified by the two stages of enquiry. And indeed, design projects may raise their own scientific issues or questions, which could then be transposed into the bigger research agendas that run in parallel and autonomously over a decade or more.

PM *What was the interaction process between the scientific, architectural and civic communities in Antwerp? And how did that differ to, let's say, creating a smaller building?*

ADH The biggest recurring issue that we now see is that most of the important decisions that need to be made in our democracies with regard to space and urban space have to do with infrastructure and its relationship with urban growth and development. What we often see is that the effects of one are never calculated in the other. To evaluate a potential solution, you need to map out what economists call 'negative externalities'—what the predicted effects will be. Admittedly, there will be a fork of possibilities but, nevertheless, you can still get an idea of what the effects are going to be and within which range. These effects are linked to future growth, health, air pollution, where growth will accelerate or reduce and ecological concerns, such as damage to the environment or the ecosystem. Although it's possible to map out the negative externalities or the positive externalities, it just doesn't happen. We don't include this process in our policy and regulatory frameworks. And when we do, it's very basic and simplistic. However, it is actually a huge undertaking in larger projects.

PM *Why is the scale of such large projects so important?*

ADH A big piece of infrastructure has a tremendous impact on the next 50 years of growth, that's why a section of highway is different from a building. The amount of concrete used may be the same but a building is a destination while a highway is a generator of future growth. A piece of infrastructure can bring incredible, generative power to urban growth, especially a piece of transportation infrastructure. It's a huge responsibility. Even if you don't do anything with the [planning] law, you have determined the law by your infrastructure choices. That's why an infrastructure development plan needs to have an integrated evaluation analysis whereby a number of key design options are compared.

PM *Is this the point at which science and research enter into the evaluation?*

ADH I would say so. And also in developing and offering integrated tools to do the evaluation properly, to try to find the loopholes and problems. The role of the scientist, for me, is to play the role of the sceptic. We have to play this role ourselves as designers but, in order to do it properly, we sometimes need external help.

PM *What is the biggest challenge in bridging research into practice?*

ADH In many cases, it's the regulatory frameworks that stand in the way. We have evidence that it is possible to translate insights from science into policy, or into broader collective benefits. Regulatory frameworks are often constructed painstakingly over 10 years and then implemented over the next 30 to 40 years. They reflect the situation in which they were created. These policies, which are often half-a-century old, are not equipped to deal with the current challenges that we face and, as they do not reflect current scientific insights, they often create problems.

Clients are often concerned about their own interests. Sometimes, using the right arguments, it is possible to convince powerful people to agree to a really bold hypothesis. But, sometimes, regulatory frameworks are so detailed, so finely prescriptive, that it's hard to get across the points that really make sense.

PM *Professor D'Hooghe, thank you for the fascinating discussion!*

Aurel von Richthofen

Transferring Research Knowledge into Urban Design Education

Aims

In 2014, led by Beatriz Colomina, a group of Ph.D. students of the Princeton University School of Architecture presented *Radical Pedagogies* at the 14th Venice Biennale. This collaborative research project aimed at 'reconstructing the pedagogical shift [in architecture education] in the late 1960s and 1970s'. It showed a panoply of experimental educational approaches from around the world that challenged the establishment, broke with conventions and hierarchies, engaged with politics and responded to the rapid technological changes of the time. The exhibition reflected on 90 case studies, including Kenzō Tange's Tange Laboratory (Tokyo, 1948–73), which was 'the crucible for the formation of the Metabolist group, counting amongst its ranks Kisho Kurokawa, Maki Fumihiko and others', and the work of the group around Aldo Rossi, Bruno Reichlin, Fabio Reinhart and Eraldo Consolascio at ETH Zürich in 1976 that gave rise to *The Analogous City*, to name just two examples (Colomina et al. 2014).

Due to the social and political aspirations of these programmes, many architecture schools expanded their educational curriculum to address societal questions on larger urban scales through design. The educational projects within the online repository can be searched by tags such as #City, #Cities, #CityAsLaboratory, #CityInTheCity, #Planning, #Territory, #UrbanDesign, #Urbanism, #UrbanRenewal and #UrbanResearch. If *Radical Pedagogies* emerged in the 1960s in response to a fast-paced world with pressing social, ecological and political

challenges, one could argue that it should be obvious to find the same today.

However, a survey of contemporary educational programmes in urban design across 15 leading universities in Asia, Europe and North America shows much less diversity and radicality than 50 years ago¹. The current urban design education programmes are generic in their approaches to urban phenomena, labelling their master's programmes using such terms as 'good city', 'urban places', 'urban form' and 'the new normal'. They are design-centric, with a majority of credit points given to various design projects. The programmes are self-referential and opaque to an extent that makes interdisciplinary collaboration impossible. They are thematically located in the Global North and are gradually irrelevant in the international discourse on urbanisation in the Global South. Finally, all programmes respond to professional accreditation schemes and, as a result, are not primarily research-driven but instead market-driven. These programmes display an uncanny convergence of economy and sustainability discourses around a watered-down core of form-driven 'design'. Such an urban design education is purely reactive and simply fails to address the challenges posed by extensive urbanisation and climate change.

This raises the question: Has urban design education lost faith in its own profession and its capacity to tackle complex, large-scale questions? On the one hand, one could argue that architects and urban designers have lost the naiveté of the 1960s with respect to the potential of social and political change induced by design, and that the present global challenges are far too complex to be handled by a single profession. On the other hand, architects and urban designers remain some of the best-equipped professionals to actually identify, structure and project answers to these challenges. This is not to say that urban and architectural thinking has become irrelevant. On the contrary, architectural intelligence, as the ability to 'incorporate technologies—including cybernetics and artificial intelligence—into [the architectural and urban design] work and influence

¹ Educational programmes in urban design scanned in this survey were: Architectural Association, Berkeley, CEPT University, Columbia University, Edinburgh University, EPF Lausanne, ETH Zürich, Harvard University, National University of Singapore, Politecnico di Milano, RWTH Aachen, Tongji University, TU Delft, TU München, Strelka Institute.

digital design practices', has seen a recent renaissance precisely because of its ability to project, include and synthesise complex and dynamic phenomena (Stenson 2017).

Analysis of urban conditions with the use of computer programmes that harness ever increasing data creates a new nexus of design and code. The two concepts become interchangeable and offer, in return, new avenues to explore urban design and representation of space (de Monchaux 2016). Design and digital media have been a constant in the otherwise dynamic and shifting field of architectural and urban education and production (Goodhouse 2017). Urban data offers new information sources for urban design (Valls et al. 2017). Given these exciting movements in urban design research, reforms in urban design education are urgently needed.

Methodologies and Approaches

The research conducted at Future Cities Laboratory (FCL) is anchored in scientific methods, collaborative processes, imaginative strategies and transdisciplinary knowledge formation (Cairns and Tunas 2017). Schneidewind and Singer-Brodowski (2013) call for a 'climate change' at universities towards the inclusion of transformative science in education and research. Extending its research ambition to the domain of education, FCL developed its Education Research Programme in 2017.

The programme starts by defining education research topics arising from FCL projects and scenarios. It aims to transform the interdisciplinary research conducted at FCL into communicable, teachable and applicable outcomes for urban design. All topics, whether applied or fundamental research, are investigated for their potential to inform urban design education at large. This continuous dialogue with the FCL research community shapes the education research focus. It creates the sort of crucial feedback system that classic university settings offer: one which reinforces research through education and vice versa. Within the framework of the Education Research Programme, participants inquire about particular aspects of research and relate these to their academic or professional work. Researchers can present their tools and applications to gather user feedback. In this sense, the programme has a double educational function. It aims to educate both

the audience and the early career researchers of FCL who aim to hone their pedagogic skills and build up their teaching curriculum vitae.

The Education Research Programme develops methods of knowledge transformation via urban design education. The programme explores the intersection of research, technological application and education, eventually triggering new forms of collaborations, projects and research fields, and thus actively transferring knowledge. Education is at the core of knowledge transfer and is seen as a vehicle for sharing early research results in a controlled environment. Co-design teaching methods for tacit knowledge transfer are explored by Dorta et al. (2016, 171). The format of a symposium, seminar or course offers researchers and their audience the space to present, discuss and evaluate research methods and preliminary findings. The students, ranging from undergraduate to graduate students, fellow researchers and professional practitioners, in Singapore and abroad, act as a sounding box for ideas. The public reflects on research hypotheses, validates models or embraces tools. FCL research gets activated beyond the confined academic space and reaches various stakeholders in industry and government.

The programme brings together researchers from various disciplines that contribute to teaching. This necessitates the formation of new collaborative platforms for open and interdisciplinary discourse on urban design. This conceptual platform demystifies the concept of design. Instead, it positions the dialogue and negotiation of transdisciplinary elements as the key process of knowledge dissemination and acquisition. This notion expands the student-instructor model to a collaborative setting. As Dorta, Kinayoglu and Boudhraâ stated:

The concept of design studio formalized at Gropius' Bauhaus supported the transfer of tacit knowledge within design education by having 'Workshop Masters' instruct 'Apprentices/Students'. This should be reinvented in the new context of co-design in education, converting the teacher to a new role that fits this co-design learning situation. The teacher has also to design with the student in order to teach him/her how to design. (2016, 172)

With respect to the fields of architecture and urban design, Hebel and von Richthofen (2015)

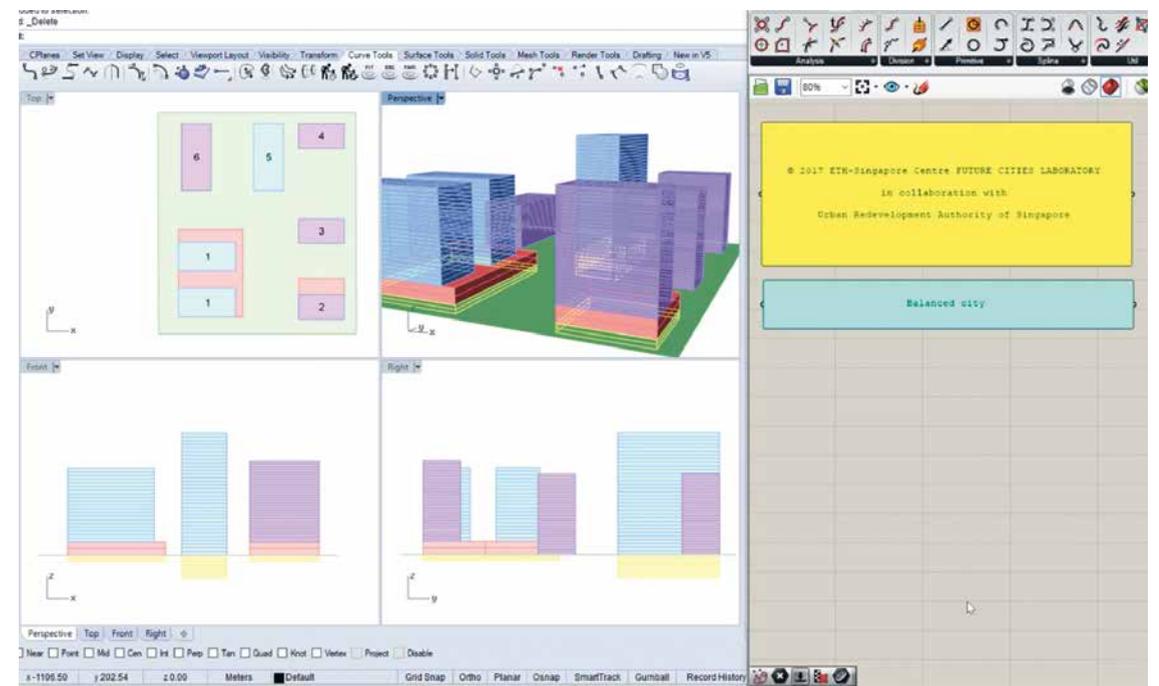


Fig. 1 Parametric design support tool *Balanced City*, developed by URA participants of AS-UD course 2017 using Grasshopper for Rhino 3D.

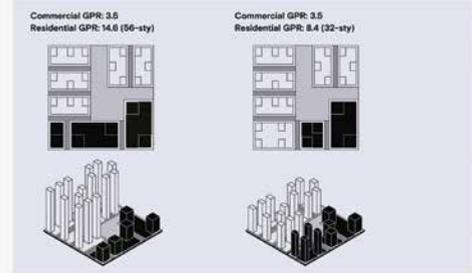
argue for an extended, transdisciplinary and inclusive understanding of design and a resultant paradigm shift in design education. In that sense, the Education Research Programme becomes transformative: it allows the reformulation of research findings into applicable thresholds and rules for urban design. To give an example, the assessment of ecosystem services in urban landscapes is very complex. One research question is to assess the contribution of urban vegetation to the mitigation of urban heat island effects. This is dependent on a multiplicity of factors, such as local climate, urban building geometry, vegetation cover, energy emissions and many more. In a traditional urban design process, the ecosystem service assessment will happen at a later stage of the project, when urban design decisions have been made. Yet, addressing the ecosystem services problem from an urban design point of view will reformulate the question as follows: What area of vegetation cover is necessary to contribute to a mitigation of the urban heat island effect by 1°C? This insight will inform the urban design process from the beginning.

The programme aims to develop and use digital tools for education that harness data and technology both critically and productively. These tools address the analytical, generative, simulation,

visualisation and communication domains of the urban design process. Experiments on the integration of parametric urban design and studio-based learning were conducted by von Richthofen (2010). With respect to the quick generation of urban design alternatives, parametric digital design support tools such as Grasshopper for Rhino 3D and Esri CityEngine are used. These require the explicit statement of design intents to create the design-determining rule sets. The use of parametric tools in design education trains participants to develop ranges of potential solutions. This means that students need to think of solution spaces instead of focusing on one seemingly optimised solution, and further that the digital tools can help to visualise those. A student contribution can thus be evaluated transparently. This approach requires standardised input data to produce results.

All the research topics of FCL can potentially contribute to parametric urban design via unified protocols. Such protocols would call for the identification of relevant input parameters, constraints and application limits and assure the early inclusion of all contributing disciplines. The use of digital tools blurs the antiquated concept of design authorship in favour of collaborative concerted efforts to tackle complex and dynamic problems at urban scales.

Balanced City



The city should have a network of pedestrian lanes and thoroughfares designed at comfortable scale, so as to allow for intimate street activity.

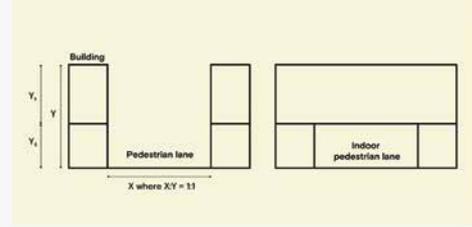
The streets of the city is often what gives it its character and generates urban life. One such typology is the pedestrian lane, which can provide comfortable, intimate environments between buildings. This can be observed in cities like Melbourne, London, and Tokyo.

Prototype Script
 Input: x, x_2, y, y_2, y_2 (street width, building height)
 Rule: $x = 6\text{ m} - 14.6\text{ m}$ (see Annex, 2a and 2b); $y = 6\text{ m} - 21.9\text{ m}$ (see Annex 2c and 2d); xy must be at least 11, up to 12 (see Annex, 1) $y_2 = 3 - 6\text{ m}$, which should be well-articulated and activated (see Annex, 3)
 Output: Street cross-section of a laneway

BUILDING	+	+	+	+	-
STREET ARMATURE	+	+	+	-	-
BLOCK PLAZA	+	+	+	-	-
QUARTER DISTRICT	+	+	+	+	-
FABRIC NETWORK	+	+	+	+	+

References
 • Moughtin, C. *Urban design: street and square*. Routledge, 2003.
 • Watson et al. *Time Saver Standards for Urban Design*. McGraw Hill, 2003.

Lane City (Section)



The city should have a network of pedestrian lanes and thoroughfares designed at comfortable scale, so as to allow for intimate street activity.

The streets of the city is often what gives it its character and generates urban life. One such typology is the pedestrian lane, which can provide comfortable, intimate environments between buildings. This can be observed in cities like Melbourne, London, and Tokyo. Particularly in the context of Singapore, laneways can allow for the creation of human-scale developments, in place of large urban blocks.

Prototype Script
 Input: x, x_2, y, y_2, y_2 (street width, building height)
 Rule: $x = 6\text{ m} - 14.6\text{ m}$ (see Annex, 2a and 2b); $y = 6\text{ m} - 21.9\text{ m}$ (see Annex 2c and 2d); xy must be at least 11, up to 12 (see Annex, 1) $y_2 = 3 - 6\text{ m}$, which should be well-articulated and activated (see Annex, 3)
 Output: Street cross-section of a laneway

BUILDING	+	+	+	-	-
STREET ARMATURE	+	+	+	-	-
BLOCK PLAZA	+	+	+	-	-
QUARTER DISTRICT	+	+	+	+	-
FABRIC NETWORK	+	-	-	-	-

References
 • Alexander, Christopher, et al. *A pattern language*. Gustavo Gill, 1977.
 • Moughtin, C. *Urban design: street and square*. Routledge, 2003.
 • Watson et al. *Time Saver Standards for Urban Design*. McGraw Hill, 2003.



Fig. 2 Urban Elements developed by URA participant of AS-UD course 2017.
 Fig. 3 Final review of urban design projects in AS-UD course 2017 at URA.

The ubiquity of digital tools and a growing digital literacy amongst young researchers and students has the effect of flattening hierarchies (Dorta et al. 2016, 171). The parametric digital design support tools developed by the programme in 2017 are already being used in scenario and synergy projects across FCL (see digital and physical tool taxonomy chapter in this book). The tools expand innovative educational formats and digital technologies, such as massive open online courses (MOOCs) already used by ETH, e-learning platforms and blended learning formats.

The programme conceived of a specific vehicle to define urban design principles as urban elements. Urban elements operationalise the theoretical principles introduced in topical lectures and combine them with parametric design tools for rapid prototyping and dynamic design exploration. Urban elements combine, or knot together, different aspects of introduced themes in the city. They are typical features of good city form that can range in scale from the texture of a pavement, building entrance, shopfront or pocket park to that of a plaza, street, even up to a neighbourhood or an entire precinct. The term relates to concepts of urban typology, genre, patterns and formats in urban design, and heuristic approaches to knowledge formation (or rules of thumb). Urban elements can be observed empirically in everyday urban settings in any city and, as such, they can be recorded, studied and discussed. They can also be discerned through published case studies.

In one study, urban theses were assembled into element sheets according to a prescribed format. Individual urban elements were collated and cross-referenced to produce an operation catalogue. Students began working with a set of partially completed element sheets. They were invited to study, discuss and test these further and to add to the stock of urban elements by researching and diagnosing others that may be discerned from sites in Singapore and from international best practices (see Figure 2).

These examples aspire in different ways to capture in a systematic way the relationships between form, practice, materials, flows and ecology. The concept of urban elements critically revisits the work of Christopher Alexander in *A Pattern Language: Towns, Buildings, Construction* (1977). Our adaptation of his pattern language has enabled us to model alternative scenarios, visualisations and quantifications deriving from these urban elements.

Finally, the Education Research Programme questions fixed design studio cultures as the sole locus of knowledge transfer. Instead, the programme engages in multiple locations, including FCL's Value Lab, training and teaching spaces at the Urban Redevelopment Authority (URA), studios at the National University of Singapore (NUS), and fabrication labs. It further understands the city as a laboratory to be explored, through site visits, as places of participation and discussion, and as a repository of conditions that constantly challenge research production. The spatial needs are tailored to a project-oriented approach to learning. Thus, a design studio space is just one possible framework for knowledge production. A reinvented studio culture is no longer the privilege of the designer, but an arena for all researchers and students; it is 'integrated knowing, situated practice, and shared repertoires' (Adams et al. 2016, 30).

The Education Research Programme was enabled through third-party funding in 2016, 2017 and 2018. This allowed for the development of a framework for a series of ongoing courses: an undergraduate course in Urban Spatial Reasoning and Representation for the Urban Studies programme at Yale-NUS College (since 2016); a post-professional course in Advanced Studies in Urban Design (AS-UD) for URA (since 2017); and an option studio at NUS (since 2018). The courses aimed to deliver specialist urban design knowledge, skills and understanding as a means to integrate the diverse disciplinary skills that participants had, such as architectural design, landscape design, and social and environmental analysis. All topics require a theoretical body that can be acquired by reading selected literature and by following input lectures.

Due to the nature of each topic, specific design studio formats need to be developed. The AS-UD course, in particular, saw participants strengthen their theoretical knowledge of urban design, develop an operational lexicon to translate theoretical knowledge into parametric form, and use this background to develop urban design proposals for various sites in Singapore. The integration of conceptual urban elements and parametric urban design support tools developed specifically for the URA course has been described in detail by von Richthofen et al. (2018).

Challenges and Lessons Learned

The set goal of the programme is to define education research topics at FCL, to contribute to knowledge transformation via urban design education, to create platforms for interdisciplinary research, to develop conceptual frameworks (urban elements) and digital tools (parametric design support tools) for education, and to reinvent studio culture as an arena for project-oriented knowledge production and learning. It does so by developing courses and programmes for universities, authorities and institutions of professional education, through capacity building and international exchanges. These courses test a set of ideas: Can interdisciplinary research findings be integrated into urban design education? How can knowledge transfer take place between the fundamental research findings of FCL and application in the profession? What are adequate digital design support tools within a changing professional context? Is the format of urban elements versatile enough to adapt to the challenges of the future of urban design in Southeast Asia? The answers all point towards the development of a new urban design education.

The Education Research Programme cannot replace a fully developed curriculum at the level of an educational institution or university. It does not have the capacity or the mandate to teach a full degree programme. Instead, it aims to revisit some core aspects of urban design education and speculate about their future. For one, it wants to challenge the premise of design in opposition to, and in a superior position over, other research entities. It does so by delivering parametric digital design tools for analysis, generation, visualisation and communication for synthetic thinking that was previously in the knowledge domain of the designers. Secondly, it challenges the designer's role as sole author of an urban design project. The programme aims to replace this single author with a collaboration of interdisciplinary researchers, including urban designers, engineers, software specialists, geographers, sociologists and psychologists. Therefore, the sole focus on the author-designer in urban design education needs to shift towards a collective understanding of design processes. Finally, it understands education as reciprocal dialogue that enables knowledge transfer in both directions: from research to application and from the professional field back into research.

The Education Research Programme is free from the historic legacies that define the range of possible pedagogic actions of conventional educational institutions. Yet, due to its emergence midway into FCL's second programme and its being funded by third parties, it needs to lobby for resources. These are: the immaterial resources delivered by FCL researchers who contribute to teaching in return for academic exposure; the financial compensation back into FCL research projects for teaching assistants who dedicate a portion of their working time to courses; and the human resource costs for the coordinator. Thus far, the added value in knowledge transfer to FCL and other indirect benefits, such as tool development and platform prototyping triggered by the programme, have not been formally acknowledged. But the Education Research Programme is already a revenue stream for FCL. Diverse formats in the future could develop this economic aspect further to co-finance research projects. While feedback from partner institutions Yale–NUS, URA and NUS has been positive throughout, and the continuation of the courses and their funding is very likely, the future of the Education Research Programme should be anchored firmly into the next FCL programme as an integrated research pillar.

A firmly supported and integrated Education Research Programme could then also scale up to become a larger international exchange programme between ETH Zürich and FCL. It could support a 'hyper-loop' of ideas and people in a formalised exchange between Singapore and Switzerland. This ETH Asia Term could be organised around big-challenge questions that can only be tackled in close collaboration with interdisciplinary students, researchers, industry and institutions, taking advantage of the strategic position of the Singapore–ETH Centre in Southeast Asia and building upon its extended network. An FCL Education Research Programme, through science, by design and in place, might just disrupt the contemporary educational landscape just as much as *Radical Pedagogies* did in the 1960s.

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