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Technology Intelligence in the Front End of New Product Development

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Technology Intelligence in the Front End of New Product Development

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The constant observation and analysis of the environment are important strategic tasks to all companies, this includes also technology intelligence. Without complementing internal core technologies from time to time with external technologies core competencies can become core rigidities. To increase the usage of external technologies there is a need of knowing more about, how to use technology intelligence in the front end of new product development (NPD).

This paper describes the deduction of a prescriptive model of the technology intelligence in the front end of NPD. The main part of the model is the distinction between four types of technology observation: Targeted Observation, Coincidental Observation, Search Observation and Technology Studies. The model can be used as an orientation how to organize technology intelligence in the front end of NPD. For every type of technology observation it gives implications, in which form it is possible to set and systemize observation areas, who should do the observation and what kind of observation methods can be used. The model was checked and refined by comparison with five in depth case studies, also presented in this paper, one of them in full length.

1. Introduction

Nowadays more and more companies concentrate their R&D-activities on their core competencies. This concept helps to use resources efficiently however it a potential threat: Without complementing internal core technologies from time to time with external technologies core competencies can become core rigidities (Leonard-Barton 1995). So, technical intelligence is one important element of strategic management of every company.

The potential benefits of technology intelligence are:
- To identify technologies, that imply opportunities or threats to the company,
- To enable idea generation based on new technologies,
- To find solutions for problems in current development projects,
- To collect information as a basis for decisions on the start of NPD projects and which technologies should be used in these development projects,
- To identify potential technology suppliers in order to integrate them into the development projects,
- To complete technological core competencies and use them in an optimal way,
- To enable the buildup and use of new technological competencies.

Though there are several concepts of organizing technology intelligence (e.g. (Ashton and Klavans 1997)) there is a need to know more about, how to use technology intelligence in the front end of NPD.

2. Purpose of the Paper and Research Methodology

The topic of technology intelligence in the front end of NPD was worked on in a focus group together with representatives of eight Swiss and Austrian companies. In this project a prescriptive model of technology intelligence in the front end of NPD was developed. Section 3 summarizes the deduction of the model. The model was checked and refined by comparison with five in depth case studies. Section 4 presents the case studies, one of them – Zumtobel Staff – in full-length.

1 For detailed description of the project see (Kobe 2001).
Section 5 draws the conclusion from model and case studies: The model can be used as an orientation how to organize technology intelligence in the front end of NPD. For every type of technology observation it gives implications, how to set and systemize observation areas, who should do the observation and what kind of observation methods can be used.

3. Development of the Model

There are many useful sources for technological information: customers, suppliers, universities and research institutes, competitors, or companies in other industries. Trends like the increasing availability of formalized information via the internet and databases enable the successful search for technology information. Though there are so many technology sources it is not possible to monitor every new technology. So a choice has to be made: which are the technology areas to observe, and who can collect and process the technology information in these technology areas.

**Decision process**

Following classical decision process models (e.g. figure 1) the identification of a problem precedes the search for alternatives to solve the problem. Transferred to the front end of NPD the problem could for example be an identified market requirement or also a new technology. The problem representation could read then: “How can we fulfill this market requirement?” or “How can this new technology be used?” The formulation of the question shapes the search for technology solutions and alternatives. So by asking questions, one can give a focus to the technology observation.

**Garbage Can Model**

Decisions are not always temporally structured. According to the Garbage Can Model of (Cohen, March et al. 1976) problems as well as solutions are collected coincidentally without concrete adjustment (Figure 2). Only if one or more participants happen to meet a decision situation, they supply a part of their collected problems and problem solutions, from which the decision alternatives are then generated.

![Choice opportunities](https://via.placeholder.com/150)

**Figure 2**: Garbage Can Model: choice opportunities, problems, solutions and decision makers are not attached to each other

To rely on the actual “solutions” of the engineers in the company means to stick with the actual core competencies and let them become core rigidities. According to this model the variety of possible problems and solutions can be increased, by ensuring that as much as possible participants are involved in the decision process, who have an extensive experience and knowledge beyond the actual fields of activity of the company. Additionally it has to be assured, that no language or other barriers block the participants from contributing their experiences and ideas to the creative process.

So every engineer, who will be involved in any problem solving, should continuously do some technology observation. This observation can be targeted to areas, where future problems are expected to arise – in this paper we name this kind of continuous observation of defined areas targeted observation. To be prepared for a well-founded problem solution, it is perhaps not enough to do only technology observation in defined areas – so the question is how to conduct a more open observation.

**Whirling Up Sucking In Machine**

There are contradictory objectives for the organization of technology observation: It is impossible to look at everything, but it is absolutely necessary not to open the search beyond obvious topics. With the metaphor of the whirling up sucking in machine (Kirsch 1991) describes a way to deal with the inherent conflict: Information on strategic relevant developments is gathered or, if more extensive, compiled in projects. The observation areas are selected, partly by strategic decisions, partly by coincidence without hard selection criteria, as the wind coincidentally whirls up dust here and there. The “whirling up sucking in machine” does not fulfill a completeness requirement. Only within some core observation areas a relatively complete observation level can be reached.
Because a complete observation in all potentially relevant areas is not possible all other areas are observed consciously coincidentally. The results of this whirling-up-observation get evaluated - in the picture of the machine: Weak signals are sucked in and led by a filter system. The filter system is not static: it must be dynamically adapted following the company vision and strategy.

The principle of the “whirling up sucking in machine” can be transferred to technology intelligence: apart from the observation of defined areas – technology studies and targeted observation – other observation forms should be used which go beyond. Two forms of technology observation go beyond a defined and targeted observation: search observation and coincidental observation. *Search observation* means an active, planned search for technological developments, which could become relevant for the company, e.g. organized as a strategy workshop. The identified technologies can then be investigated in studies and projects.

*Coincidental observation* means observations employees “coincidentally” make in the context of other tasks. The possible observations are indirectly determined by the fields of interests and activities of the employees. The observation takes place coincidentally – it has to be supported, that the observation results are collected and used. The results of the coincidental observation can be taken up in a search workshop or directly with a technology study, new topics identified by search observation can become temporarily limited technology studies or long-term obligation target areas.

**Four types of technology observation**

The four types of technology observation, which are deduced in the above text, can be categorized in two dimensions: time and focus. **Time:** There are two types of technology observation, which are conducted only temporarily (technology studies and search observation), and two who should be conducted continuously (targeted observation and coincidental observation). **Focus:** There are two types of technology observation focused to defined areas (targeted observation and technology studies) and two open types of observation (coincidental observation and search observation).

### Table 1: Four types of technology observation

<table>
<thead>
<tr>
<th>Observation area</th>
<th>Involved persons</th>
<th>Process control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeted observation</td>
<td>Observation areas defined in job description (periodically reviewed)</td>
<td>Employee with observation order</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coincidental observation</td>
<td>Areas of interests and activities of the employees</td>
<td>Coincidentally besides other tasks</td>
</tr>
<tr>
<td>Search observation</td>
<td>Active search for relevant technologies</td>
<td>E. g. workshop participant</td>
</tr>
<tr>
<td>Technology studies</td>
<td>Observation area defined in the project order</td>
<td>Project team</td>
</tr>
</tbody>
</table>

**Figure 3:** Four types of technology observation

### 4. Short Descriptions of Case Studies

Five case studies were investigated in order to check and refine the model. On the basis of these case studies the following research questions are further examined:

- What are “targeted observation” areas? How are they determined? Are defined patent classes observed?
- In which form is search observation operated?
- Which qualification profile do those persons have, who are responsible for the technology observation?
- Which information sources are accessible? Which sources are used?
- Are coincidental observations taken up during idea generation? How are coincidental observations collected?
- To which topics are technology studies executed? How are they started up?

The five case studies were focused on different organizational levels of the investigated companies: *ABB Turbo Systems* belongs to the ABB group, which is active in different product areas. In this case study the technology observation of the ABB Turbo Systems development department was investigated, which concentrates on the development of turbochargers (improvement of products and new products).

*Zumtobel Staff* belongs to the Zumtobel group. The Zumtobel group and all its subsidiaries are active in the lighting industry. The Group Technology at Zumtobel Staff conducts technology observation - by the specification "lighting industry", not necessarily limited to
the actual field of activity of Zumtobel Staff, to find opportunities for product improvements, new product and possibly new business fields.

The case study Schindler was focused on the Technology Management department, which belongs to the central R&D and is responsible for the development of new elevator generations and new technologies.

Sulzer Innotec conducts technology observation to support the development of product improvements and new product together with the product areas and to identify opportunities for new business fields.

The central research department Hilti has a Search-Team, which is in duty to identify new business fields within the area “building professionals”.

All five case studies describe research and development units or special groups within research and development units. This paper presents only one out of the five case studies in full length, the case study Zumtobel Staff.

Case Study Zumtobel Staff

The case study Zumtobel Staff consists of three parts: a general introduction about the company, the innovation strategy and the R&D organization, answers to the research questions and one project example of the integration of technology observation and the start of new product development based on LED technology.

The Company

The Zumtobel group is, with over 9’000 employees and revenues over 18.1 Billions ATS (1.3 Billion €), one of the biggest companies of the international lighting industry. The group is divided is active in the business segments lighting solutions (Thorn and Zumtobel Staff), components und joining techniques (Tridonic Atco), light management systems (Luxmate Control) und lighting components (Reiss International). After integration of the British Thorn group (acquisition in spring 2000) the newly formed Zumtobel group has manufacturing plants in Europe, USA, Australia, Asia, and South Africa, distribution companies in 25 countries on five continents as well as sales agents in over 70 countries.

Thorn and Zumtobel are positioned in different market segments. Zumtobel Staff acts as an innovation leader in the upper market segment. Thorn aims for quality and price leadership in the middle market segment. Together they have a market share of round about 15% in the market of professional building lighting. This Market is extremely dependent on the economic situation of the office building market.

Beside the pure physical products such as single lights, which distributed over wholesale and electricians, Zumtobel Staff offers also more and more services. The offer of lighting installations, consisting of lights, the control and emergency lighting, contains also the consulting service for architects, illumination planning as well as later system support.

Innovation Strategy and R&D Organization

Since its founding in 1950 the Zumtobel group has a high innovative performance. In the end of 1970s it used as one of the first companies of the lighting industry the advantages of electronics. Today it is leading in digital control gears as well as in light management systems. The R&D ratio amounts for 3%.

The company vision “build worlds of experiences with light” shapes the direction of possible innovations: all applications and technologies concerning light, maybe product improvements, new product or even new businesses are possible.

There is no R&D department on group level. But joint projects on group level are conducted on demand. Within Zumtobel Staff there is a strict distinction between technology and product development. Technology development is led by the Group Technology (20 employees). Product development takes place in the Centers of Competence (COCs), which are also responsible for production. New markets and new technologies are risky and therefore do not belong to the daily business of Zumtobel Staff. The Group “Technology” has some scope for new technologies. It serves as the technology observer.

Targeted Observation Areas and Search Observation

At Zumtobel Staff there are to kinds of observation areas: Monitoring of already identified technologies and Scanning of areas, in which new trends and technologies can be found. All identified technologies, which are not taken up in a technology development project, are monitored until a development project is started or they are categorized as irrelevant. All technologies are evaluated one to two times a year.

On search of new technologies following areas are scanned:

- Own industry (competitors products),
- Related industries, i.e. with same target (e.g. automobile lighting), same environment (e.g. office furniture) or same product technologies (e.g. metal forming),
- Up- and downstream industries, suppliers (e.g. lamps, or building control),

Figure 4: Target areas for technology observation at Zumtobel Staff
- Customers – two groups of customers can be differentiated: the more conservative customers like electricians and the more open customer like architects. These areas are too large to observe than in a systematic manner, they are just randomly scanned.

**Patent Monitoring**

Additionally all patents of selected patent classes are sighted. They are delivered in pdf-format by a patent service. The patents are presorted by an employee belonging to the Group Technology: 50% are sorted out; the 50% are distributed to other development departments for further investigation.

The selection of patent classes is very stable. Seldom new patent classes are added, like for example after the identification of LED technology.

**Technology Observers**

Both the technologies to be monitored and the areas to be scanned are assigned to particular employees. Monitoring is mainly done by the Research and Predevelopment Department (6 employees), which is part of the Group Technology. The other observation areas are scanned also by other departments (e.g. Strategic Marketing).

The assignment of employees to the observation tasks results out of their technology or market knowledge. To do scanning and monitoring you also need some competencies in doing database, internet, literature or market research. It is expected that professional also have that kind of competencies.

**Information Source**

For observation and investigations employees at Zumtobel Staff can use following sources:
- all members of Group Technology and Group Marketing have free internet access,
- the department have libraries,
- diverse professional journals,
- patent databases offered by the patent offices,
- intense collaboration with standard committees and other expert committee,
- fairs and exhibitions,
- patent investigations done by a patent attorney,
- collaboration for investigations with universities.

**Idea Data Bases**

To collect and to make coincidental (technology as well as market related) observations and ideas available for further processing an intranet based data base was build up in 2000. All members of the Groups Technology and Strategic Marketing, of all product development departments and executive board members have reading access to this data base. All contributions are first send to the data base redactor, who edits it, bundles similar topics and gives personal feedback.

Sales personnel do not have reading access to this database: on the one hand to protect good ideas from finding their way to the competitor, on the other hand to avoid non-existing products from being sold to the customer.

The database is actively used for documentation of technology observation results. The honor that every article is signed with the name of the authors, the “Idea of the Month”-award, personal feedback and the experience, that the documented ideas and observation results are followed up made 12 employees contribute over 40 entries. The database is not so actively use for documentation of market observation results. This may be resulted by the deserative publicity of the database in the marketing departments – the database was developed by the Group Technology.

**Technology Snapshot**

The selection process of new technologies is divides into two main phases: Technology Snapshot und Technology Assessment. The systematic evaluation of new technologies is done by the Group Technology. Two employees select interesting technologies, of which a “Snapshot” should be done. For this first step no concrete idea of application is necessary. For further investigation it is however an indispensable prerequisite.

A Technology Snapshot contains all easy to get information about the technology. Additionally a rough estimation of potential and attractiveness is conducted. A Technology Snapshot cost one to five man-days and additionally 2'000 € for other expenses on average.

The manager of the Group Technology gives the order and clearance for these budgets. Ideally the Technology Snapshot is conducted by the person who had the idea to investigate this technology.

All Technology Snapshots are stored in the research data base. For each new technology also possible contact persons are searched for inside the company, which are interested in further investigation and application development. Only when the Snapshot looks good, the technology reaches the next step, the formalized assessment.

**Formalized Technology Assessment**

Selected technologies and related application are assessed concerning technology and market aspects. The assessment costs 40 man-days and additional 1'000 to 20'000 € at average. The manager of the Group Technology approves the assignment for each technology assessment.

Information is collected on a broad base, including external research facilities, suppliers and customers, literature research and patent research. Two main criteria – technological maturity and strategic relevance – are evaluated based on detail questions as:

- Technological maturity:
  - How well is the technology controlled?
  - How well do we control the technology?
  - Which developments of the technology are to be...
expected?
Strategic relevance as measured on company strategy:
- Which technologies could become substituted?
- Which distinguishers does the technology bring with itself?
- Are cost advantages to be obtained?
- What happens, if we do not enter into the technology?
The answers to the detail questions are consolidated by intuitive decisions. There are no defined weighting factors used.
The technology assessment is completed by a detailed investigation report, a short report, and a discussion about the positioning of the technology in the technology portfolio as well as a suggestion for further actions. A possible next steps are a feasibility study at an amount of 3000-5000 €, on which the Group Technology manager can decide, or a technology development project, on which the technology committee has to decide. The technology committee consists of roundabout ten deputies of technology, product development and manufacturing departments. It holds a meeting every six months.

Product Innovation Process
At Zumtobel there is strictly distinction between technology and product development projects. Product development project are market driven – applications are only a subsidiary aspect of technology assessment.

Depending on the type of technology feasibility studies and research projects precede possible technology development project. All these projects are led by the Group Technology, but conducted in cooperation with external and internal partners. Typical technology development projects result in functional prototypes or operations improvements. The consolidation of new technologies and new market requirements takes place in the market technology circle.

Approx. ten representatives of strategic marketing, product marketing, sales, technology, product development and manufacturing departments belong to this circle. This circle meets every six months and defines future lighting solutions and products, which are then integrated into the development project portfolios of the Centers of Competence.

Project Example LED Technology
1994 a Zumtobel Staff employee found an announcement, that blue LEDs with higher candle power are available. He forwarded this announcement to the Group Technology manager together with the idea to combine red, green and blue LEDs to get white light.
The idea was taken up. For first technical investigations (Technology Snapshot) a company, which produced display lighting, was contacted. At that time the best available blue LED had an efficiency of 0.1 Lumen/Watt. (To compare: The efficiency of a classic light bulb is 10-15 Lumen/Watt, that of fluorescent lamp 100 Lumen /Watt). This efficiency was far to low to use LEDs for illumination. But discussions with experts showed, that increase of efficiency was expected to happen in short time. From then the LED technology was monitored.
1998 brought two substantial progresses of LED technology: 1. Blue LEDS reached an efficiency of over 1 lumen/Watt, and a further increase of the efficiency around the factor 10 within two years was prognosticated. The green and red LEDS reached an efficiency of 10 lumen/Watts already at the time. 2. A research institute succeeded in developing a white LED in co-operation with Siemens.
Thus LED technology was not yet useful for room lighting, but first ideas for decorative applications with white and colored light were developed. As a part of Technology Assessment an application idea was converted into a preliminary prototype and introduced in-house. The evaluation of the technological characteristics resulted that the LED was a very interesting, worth to pursue technology.

Next step was the make-or-buy-decision for LED control components. A feasibility study with an extent of approximately 20'000 € Materials and a half man-year personnel expenditure gave basis fort he decision.
In summer 1999 the result of the study was presented: The external purchases of the necessary components were not possible. Therefore they had to be developed – by Zumtobel or together with external partners.
Also in summer 1999 a joint development project was started by Zumtobel Staff, Tridonic Atco and Luxmate control
This development project covered exceptionally both the technology and the product development, which made the project completion more difficult. In March/April 2000 the functional prototypes were completed.
Since it was decided to develop LED products, the prototypes were already presented on a fair in April 2000. Now they can be viewed at www.zumtobelstaff.com/products/.
The LED technology enables a dynamic composition of lighting with color effects. It crosses the borders between applications with white or colored light, as well as between lighting and accentuation.

A further advantage is the long life span of LEDS: An LED holds 100’000 operation hours – a halogen bulb under favorable conditions only 2’000 operation hours, a fluorescent tube nevertheless 10’000 operation hours.

5. Analysis of the case studies
In the following the analysis of the five case studies (ABB Turbo Systems, Zumtobel Staff, Schindler, Sulzer Innotec, and Hilti) concerning the questions: “Are the four types of technology observation conducted? How are they conducted? Who is in charge for technology observation?” is presented.
Targeted observation

In the case studies ABB Turbo System, Sulzer Innotec and Hilti it is explicitly mentioned, that the technology experts are responsible to observe the current development in their technology areas. The case studies Schindler and Zumtobel Staff show that targeted observation can be more than that. At Zumtobel Staff selected persons are designated to observe specified areas where new technologies can occur (Figure 4).

Schindler and Zumtobel monitor interesting, new technologies until they take them up in technology studies or projects or sort them out, because they are classified as useless for the company. The examples Schindler and Zumtobel Staff show that targeted observation can be more than that. At Zumtobel Staff selected persons are designated to observe specified areas where new technologies can occur (Figure 4).

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Search observation

In strategy or “search” workshops also technologies and product ideas can be gathered, which do not occur out of rigidly defined observation areas. Definition of observation target areas or identification of new technologies, which are taken up in technology studies, can be results of search workshops. Schindler collects possible new technologies - which are taken up as observation target areas for the Technology management – with “core competence workshops” executed in all development centers. The Hilti search team is on the search for new business fields. Expert and possible idea carriers are contacted and invited to workshops. In particular for the search for new business fields the open search observation is very important. Clear guidelines and definitions of the observation areas, like they are necessary for targeted observation and coincidental observation, cannot necessarily be formulated for the search for new business fields.

Technology studies

Technology studies represent the preparation for technology development projects. In all examined case studies technology studies were executed, in order to identify the current efficiency of a technology, the

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2 For more information about the technology portfolio see (Boutellier, Gassmann et al. 2000), p. 492.
The technology studies are small projects. Investigation object, investigation target and budget are determined in a project plan.

Technology Observers

According to the majority of the investigated companies (ABB, Zumtobel, Sulzer, Hilti) technology observation is carried out by technology experts. However each technology expert also has certain basic skills in the provision of information. ABB offers training courses about the operation of the internal technology data bases. At Zumtobel one trusts in the fact that at least some of the technology experts have the necessary implicit search know-how. Additionally search support is supplied by patent departments (at ABB, Hilti), the department “InfoNet” at Sulzer Innotec, external patent attorneys or search services (Zumtobel).

Schindler represents a special way: technology experts and search specialists are integrated in the Technology Management department. The technology experts have basic search skills – the information experts have extensive experiences within the area of the elevator technique.

The case studies showed that there is frequently a flowing transition between technology observation and project start. The technology studies represent frequently the first phase of the technology development projects. The technology observation, which is aligned by innovation projects to the start, should take place therefore in those departments, in which also at least the first phase of the actual technology development project is then accomplished.

6. Conclusion

A prescriptive model of technology intelligence in the front end of NPD was deduced and refined by case studies. It includes following recommendations for technology observation:
- Four different types of observation can be combined (Targeted Observation, Coincidental Observation, Search Observation and Technology Studies),
- For every observation type either the target areas or the objectives should be defined,
- Technology observation activities should be executed particularly by the departments also responsible for the start of the innovation projects,
- Observation methods and sources of information should be selected related to the type of observation.

Table 2: Common sources of technology information

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<thead>
<tr>
<th>Formal sources of information</th>
<th>- Internet</th>
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<tbody>
<tr>
<td></td>
<td>- External and internal database</td>
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<td></td>
<td>- journals</td>
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<td></td>
<td>- literature/libraries</td>
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<tr>
<td>Informal sources of information</td>
<td>- Fairs and exhibitions</td>
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<td></td>
<td>- Conferences</td>
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<td>- Networking</td>
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<td>Information Services</td>
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<td>- Market intelligence and competitive intelligence department</td>
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7. References