# Information Technology Strategies and Adaptation of Knowledge - a Conceptual Analysis in the Construction Industry

Marja Naaranoja, Vaasa Polytechnic, Wolffintie 30, FIN-65200 VAASA, marja.naaranoja@tec.puv.fi
Leif Östman, Swedish Polytechnic, PL 6, FIN-65201 VAASA, leif.ostman@syh.fi

This is an analysis of the preparations, made for strategic decisions, on information technology (IT) development. It is an initial part of a larger research project concerning the development of tools and methods for coordinating and integrating design processes in the construction industry. The goal of this study is to construct an understanding of the use of knowledge. The focus is on adaptation of knowledge and the types of knowledge adapted.

## 1. Introduction

This is a paper on the knowledge base of decisions on *information technology* (IT) strategy matters. It is part of a research project concerning communication of drawings and specifications. The study has been prepared as an *analytical case study* and consists of analysis of decision-making preparations. The goal is to construct an understanding of the use of knowledge and how companies react to changes in the IT-field. Most companies suffer from an unpredictable market situation, where the speed of software development exceeds the possibilities of a close follow-up within the company.

In order to obtain a preliminary view of the situation, the analysis was narrowed down to two cases. The two target companies were selected according to their attitude towards CAD development, belonging to two ultimate classes: *pioneer* and *follower*. The selection was not the object of any comprehensive comparison, but based on previous experience of these and other companies in development projects (Naaranoja, 1994-1996). The intention was to examine the situation in two different organisations - on the adaptation of knowledge and the types of knowledge adapted - without aiming at isolating a complete theory. Due to the recession in the construction market in Finland, there are few construction companies that act as pioneers. Most of them act as followers. Thus, the choice fell on a multinational engineering company that is not a pure construction company, but has a clear pioneer strategy in its attitude towards IT-development.

The first chapters give some explanations on matters of strategy. The second chapter introduces the companies and a brief description of the IT development in these companies. In two cross-case analyses we analyse the IT development, with emphasis on the similarities in the cases. One conclusion is that both the purchaser and the software developer use the purchase process for knowledge acquisition purposes. Another conclusion is that the IT strategy is an integrated part of the business strategy and companies use a lot of time to prepare for strategic decisions in IT, more than the investment cost itself would require. IT investments are important also since they effect the working methods.



## 2. Information Technology Strategies

Strategy is a master plan that delineates the critical courses of action toward the attainment of company objectives and a blueprint that defines the means of deploying resources to exploit present and future opportunities and to counteract present and future threats.

Information Technology (IT) strategy supports the firm's total strategy. IT-strategy gives the basis for tactics - an organised but ceaseless stream of actions designed to execute strategic decisions. Elements of IT strategy in the design office are planning, information forms, technical platform and intentions (figure 1)(Wikforss, 1995). The information should have continuity; production and facility management should use the same databases (Wikforss, 1995). Current IT systems in construction industry are poor in integrated software.

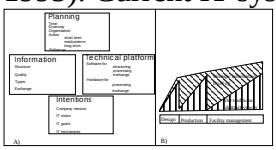


Figure 1. A) Elements of IT strategy.
B) Information continuity. (Wikforss, 1995)

## 3. CASE descriptions

Theme interviews were carried out in JEO- group and Wärtsilä Nsd during 1995-1996 and during winter 1998. The interviewees were responsible for CAD development in their companies.

**JEO- group** is a goup of companies (Jeo talot Oy, Jetta-talot Oy and Jet-Puu Oy) , mainly active in the regional market. The company designs and produces small prefabricated buildings according to the specifications of its clients. The total turnover in 1997 was 121 million FIM, and the company had about 190 employees. JEO-group has faced the threat of unstable markets due to market recession. The company has its own element factories, saw mill, construction groups and architectural and technical design office.

The company can be classified as having an *early adapter* background in the beginning of the 1980's, but after it they sustained the level of IT-technology as it was for over ten years by updating the software only a little. In this paper we describe the method of choosing new CAD software in 1996.

The company had faced outdated software already for years, but had not been able to make any major decisions. The test use of one software was started in 1994. However, that software did not fulfil the company's needs. In 1996 the manager and one of the authors started the strategic planning by environmental analysis and internal assessment; objective setting was done later in the company.

The objectives were set as being improvements in the design routines, presentation quality, etc. and competitiveness. The information exchange with designers in the export markets has also become more important. To obtain knowledge of alternative CAD solutions the company

collected information offered by the software companies, studied their references, the language of interface and service possibilities. After this preliminary stage the company rejected the proposed software alternatives that would not fulfil its needs. The company finally selected two suitable alternatives to be checked thoroughly.

These alternatives were studied by visiting the software developers. About 6 days were used for these visits. During this purchase process the company gained knowledge of the software, its opportunities and costs. The purchasing company kept the two software companies in a competitive situation. The exchange of information was mutual. The software developers acquired knowledge of production processes through the bargaining. The software developer could integrate the customer's wishes into new updates and sell it to other customers. These discussions were found very important since only a minor part of the possibilities could be understood beforehand. Based on this kind of knowledge, the company made benefit, cost and risk evaluations and pay back period calculations. Still, it was found difficult to estimate the financial profit and the importance of the contributory factors. However, the decision was made to purchase a CAD tool.

**Wärtsilä NSD** is divided operationally into four business areas: marine, power plants, service and manufacturing. The company is multinational with operations in different countries. Net sales of Wärtsilä Diesel Oy – the Finnish part of the Wärtsilä Group- were 4 048 million FIM, of which 98 % represented exports in 1996. Manufacturing and design has been integrated for over ten years. The experiences of a mechanical engineering company, with a pioneer attitude towards IT-development have been introduced in order to reflect on the development possibilities in construction industry.

Wärtsilä Ntd can be classified as having selected a pioneer role in IT development. It started to use CAD in 1982 and integrated it into production 1984. In the beginning some development steps were taken every year but then afterwards every fourth year.

Wärtsilä Ntd was able to see an opportunity for growth and formed its business and IT strategy according to this in 1995. Knowledge of the market environment forced the company to take a big step in the development of the design process and tools. Looking back, it seems to have been a successful strategy.

One of the long term objectives of CAD development has been shorter design time. In the beginning of the 1990's there was a bottleneck in the information exchange between analysis and design, FEM calculation and drawings. Before choosing new software, four designers in design offices in different countries tested the alternatives during 7-8 months in 1994. The decision was made together in order to commit every department to the selected software. Nowadays the company has defined the interface rules. The design time of product development has shortened from five years to two or even one and half years. In addition, sound analysis is made at the same time, which was earlier impossible.

Due to changing circumstances Wärtsilä Nsd has decentralised the project development into five countries. When starting a new motor design the production factory and the design groups are chosen. The company needs a rapid connection between these countries and clear rules for documents. The rapid connection had to fit in the company's own interface. The CAD

software developer was selected since it was believed that an optimal tool could be programmed. The designers tested and asked for the possible functions. In 1997 after half a year's testing and putting up the system, project databases could efficiently be used in real life situation. This means that the designed file is taken from the project database and after modification it is returned back. This needs to be fast and rather automatic. However, some expert designers have had to be moved abroad to teach other designers to use the interface in the agreed way, normally in areas other than the project database.

## 4. Cross case analysis

In this chapter we verify how the case processes fit with the theory of strategic decisions, and what kind of knowledge can be found within the case processes.

### Strategic decisions

According to Naaranoja (1997; based on Gilligan et al 1983, Jones 1962, Bates et al. 1984) strategic decision-making should consist of the following stages: setting objectives; choice of action plan; preliminary development review; estimation of future scenarios, costs, benefits and risks for decision-making; managing the cost, benefit and risks during the investment process and result evaluation after implementation. Gaining a competitive edge is the aim of the whole process (figure 2). This analysis focuses the selection and the preceding stages.

The business strategy determined the IT strategies in both companies. The objectives for IT development were found from trying to achieve the overall goals of the company. For example the decentralisation of product development demanded rapid information exchange between different countries. Another example is that the company was aware of the fact that competitors had better presentation quality.

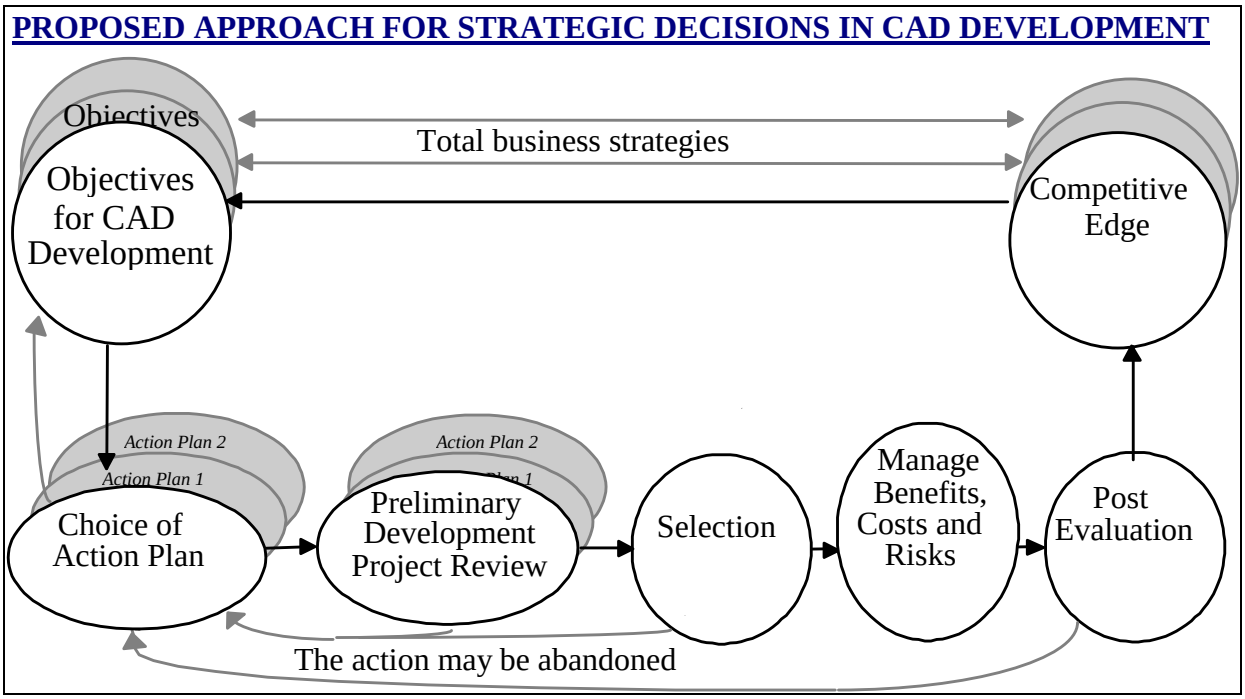


Figure 2. Strategic decisions in CAD development (Naaranoja 1997)

The action plan defines the overall plan of how the objectives are pursued. The choice of action plan is the choice between different kinds of projects. The project might be to start a new type of design. In Wärtsilä they studied, for example, whether the staff would be moved from Italy to Vaasa to achieve the objectives set for information exchange.

The preliminary development project reviews and evaluates alternatives before the next stage**.** The action plan gives a general outline in order to reject unrealistic ideas. The following opportunities should be scanned: function, information structure and technical platform. When the proposals are screened the following questions are addressed:

1) Is the proposal competitive according to the action plan?
2) Is the idea technically feasible?
3) Do the required resources (for example, skills, finance, time) exist?
4) Does the proposal need further development?

This kind of stage was reached but the review was fast**.** Only a small number of possibilities were checked. The companies made a rejective selection among the alternatives by using external information like references, language of the interface, possible functions given in the brochures. There were only a few alternatives left for closer investigation.

The selections including benefit, cost and risk analysis were based on thorough studies. The large company could use more resources, i.e. test four alternatives in real production activity, and had the possibility to ask for closer cooperation in the software development process, as when searching for exchange tools. A medium size company had to be satisfied with a few days study.

The companies had to make the decision by forecasting future actions. In the medium size company they said they made the decision well aware of the risks. In the large company they had to make the same kind of decision, for example based on assumptions of the required learning time. The costs of these projects were calculated by using rough methods and costs were verified at least as rough incomes. The cost - benefit analysis was made but it was clear that the decision was more based on the strategic advantage than calculated bigger incomes.

**Knowledge**

Knowledge is defined in different ways depending on whether it is based on a *positivistic* or *pragmatist philosophy*. The positivistic view of knowledge is that it is something separate and objectivated. The pragmatist includes this in his view of knowledge, but sees the whole *process of inquiry* and developing knowledge as an inseparable entity. The clearest definition concerning the pragmatist knowledge concept is presented by Dewey. We interact with the world, and this is the source of experience which can be elaborated into knowledge (1938, 1939, p. 35):

"Experience occurs continuously, because the interaction of live creature and environing conditions is involved in the very process of living. Under conditions of resistance and conflict, aspects and elements of the self and the world that are implicated in this interaction qualify experience with emotions and ideas so that conscious intent emerges."

The processual explanation of the pragmatist philosophy is used in order to explain the adaptation of knowledge in IT strategic planning decisions. In these two cases there are three sources of knowledge on which strategic decisions are based:

1) experiences from internal processes - restrictions, visions and problems
2) collection and elaboration of external information
3) exchange and communication of information between software and construction companies

Within the companies there is an accumulated knowledge derived from previous experiences and learning processes. Both in the construction and the software company this kind of experience exists, though concentrated on different subjects.

In a changing world and market the companies are forced to collect information. There is a large amount of information offered by software developers and other sources, but this is not enough. It needs to be evaluated according to the needs of the company.

The purchase of new software is in both cases used as a process of knowledge acquisition. The companies arrange competition between the software developers and start the negotiation and bargaining process. Both sides, in these cases, suffer from a lack of knowledge. The software developer does not know the current processes and problems of the construction company and the purchaser does not have a thorough knowledge of what it is possible to do with the software. By giving each other access to the knowledge they mutually improve their situation. The software developer improve their product. With the knowledge from the construction company they improve their product and offer the solution to their next client. Due to the

competitive situation, the construction company can bargain for the same solutions between competing softwares. By negotiating solutions they gain knowledge of specific software solutions, of which they had no any knowledge before.

It seems that this purchase process could be a major source for up-dating and acquiring thorough knowledge of current IT development. Most of the knowledge stays tacit and is not formally objectified, but rather used in the form of simplified concepts. Still, it is a rational process. It is used it to manage the problem of designing an IT strategy for the future, in a situation of changing market circumstances and a lack of IT knowledge.

One has to be aware of the fact that this kind of process and knowledge-exchange is probably possible only when the market is very narrow. When the software is produced for a broad market, the exchange of knowledge with an ordinary purchaser is of less importance for the developer. Of interest are mainly the pioneer companies.

## 5. Conclusions

IT-strategy and business strategy are not distinct from each other. Business strategy orders the objectives for IT development. In accordance with IT development, the functions are changing in the company, which is often one of the main objectives of IT development. It would be correct to say that IT development is often tactical. Companies use a lot of time to prepare for IT strategic decisions, more than the investment cost itself would require. IT investments are important also since they have an effect on the working methods.

The purchase of new software was in both cases used for knowledge acquisition. The companies arranged for competition between the software developers and started a negotiation and bargaining process which produced thorough knowledge of IT development. Most of the knowledge stays tacit and is not formally objectified, but rather used in the form of simplified concepts. Still, the knowledge exchange is a rational process. The companies use it to manage the problem of designing an IT strategy, despite the lack of IT knowledge. This kind of process is probably possible only when the market is very narrow.

## Bibliography:


Bates, D. L., Eldreedge, D. L. (1984), Strategy and policy, analysis, formulation and implementation, Wb. C. Brown Publisher, Library of congress catalogue card. USA.

Dewey, J. (1938, 1939). Logic: The Theory of Inquiry. Here from Ratner, J. (red.) Intelligence in the Modern World - John Dewey´s Philosophy, Random House, New York.

Gilligan, C., Neale, B., Murray, D. (1983), Business Decision Making, Philip Allan Publisher, Oxford.

Jones, M. H. (1962), Executive Decision Making, Richard D. Irwin, Homewood, Illinois.

Naaranoja M. (1997), Strategic Decisions in Computer Aided Design Development, Tampere University of Technology. Tampere.