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RATAS, A LONGITUDINAL CASE STUDY OF AN EARLY CONSTRUCTION IT ROADMAP PROJECT

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SUMMARY: *In smaller countries where the key players in construction IT development tend to know each other personally and where public R&D funding is concentrated to a few channels, IT roadmaps and strategies would seem to have a better chance of influencing development than in the bigger industrial countries. In this paper Finland and the RATAS-project is presented as a historical case illustrating such impact. RATAS was initiated as a construction IT roadmap project in 1985, involving many of the key organisations and companies active in construction sector development. Several of the individuals who took an active part in the project have played an important role in later developments both in Finland and on the international scene. The central result of RATAS was the identification of what is nowadays called Building Information Modelling (BIM) technology as the central issue in getting IT into efficient use in the construction sector. BIM, which earlier was referred to as building product modelling, has been a key ingredient in many roadmaps since and the subject of international standardisation efforts such as STEP and IAI/IFCs. The RATAS project can in hindsight be seen as a forerunner with an impact which also transcended national borders.*

KEYWORDS: *R&D strategy, product model, BIM, roadmap*

REFERENCE: *Björk B-C (2009) RATAS, a longitudinal case study of an early construction IT roadmap project, Journal of Information Technology in Construction (ITcon), Vol. 14, Special Issue Next Generation Construction IT: Technology Foresight, Future Studies, Roadmapping, and Scenario Planning, pg. 385-399, http://www.itcon.org/2009/25*

1. INTRODUCTION

The use of strategic roadmaps as a means of influencing research, standardisation and industry deployment of IT applications in the construction sector is by no means a new invention of this decade. Already in the 1990's there were a number of important "roadmapping like" initiatives, in particular in connection with the R&D programmes of the European Commission. Many conferences implicitly functioned much in the same way, in helping new aspiring researchers to set their research agendas as well as providing industry experts with input to their company development work (i.e. CIB1990, CIB1996). In addition international product modelling standardisation efforts, first the Building Construction group of the ISO STEP working group, and later the IFC definition work of the IAI (IAI 2008), have been focal points for strategy setting.

Even earlier the RATAS project brought together most of the key players in the Finnish construction industry in an effort to define key goals for a more integrated use of IT throughout the design, construction and FM process as well as means to achieve these goals (Enkovaara et al 1988). The development of what today would be called a BIM-standard was defined as the top priority in the RATAS "roadmap". Another important identified goal was the collection of digital construction information services to one portal. Since almost 25 years have elapsed since the start of the RATAS project, this is a good time to look back at the results of the project and to discuss what possible effects they had on developments later on in Finland.

2. THE BACKGROUND FOR THE RATAS PROJECT

Discussions about the integration of IT applications in construction started in Finland in 1982. A number of large engineering firms who had purchased turn-key CAD-systems in the beginning of the decade were the first to recognise a need for methods and standards that would enable the transfer of design information in digital form between designers. The Technical Research center VTT had also become aware of the need for research concerning CAD integration and carried out a study called Integrated computer-aided building design in 1983 (Björk and Keppo 1984).

As a result of these discussions an association called the Construction Industry Council for CAD in building, RACAD, was formed. The membership consisted mainly of bigger organisations, such as professional associations and government branches, who saw the agenda of RACAD as important for their own strategies. A board headed by a full-time employed secretary general was responsible for day-to-day activities.

During its existence (1983-86) RACAD served two main purposes. Firstly it provided a good forum for discussions and organised a number of seminars, where the latest news and development ideas were exchanged. Secondly it set out to plan a large co-ordinated research, development and standardisation effort, which later turned into the RATAS-project. RACAD also established contacts to similar organisations abroad, such as CICA, CIAD, CEPA and ACADS, via the International Federation of Associations of Computer Users in Engineering, Architecture and Related Fields (FACE).

The first R&D programme proposed in 1983 by the RACAD board had a budget of around 7 Million Euros, which in view of the ambitious targets of the programme and later experiences from R&D projects would have been quite realistic. After almost two years of difficult negotiations the budget of the programme was reduced to about half a million Euros, of which about one third in the form of a research grant from the Technology Development Centre of Finland TEKES. The rest was collected from the industry via the professional associations. The participation of the big contractors was crucial for the launching of the project. A project of similar size today would cost around 2-3 million, given the rise in nominal wages in almost a quarter century.

RACAD lacked the legal status enabling it to apply for the money for the programme from TEKES. For that reason the organisational responsibility for the project was transferred to the Building Information Foundation, a private non-profit organisation which de facto has a central role in the dissemination of general construction information in Finland as well as in construction standardization work.

At the same time the focus of the programme was shifted. Originally the aim had been to study the data flows between the different design disciplines, as well as between designers and contractors, and to standardise these data flows. A project for standardising the information content of different layers in CAD-systems had in parallel been started by VTT with participation from design firms. Due to the negotiations preceding the launch of the RATAS project and the emphasis on product modeling chosen in the project VTT's layering project was interrupted and later cancelled.

Simultaneously with these negotiations RACAD was dissolved and some of its functions were inherited by the project organisation which was formed under the Building Information Foundation for managing the starting roadmapping effort. The acronym which was chosen was RATAS which stands for the computer aided design of buildings.

The small size of the Finnish construction industry (Finland has around 5 mill inhabitants) was a positive factor working in favor of the RATAS project. In most countries, due to the fragmentation and size of the construction industry, it would have been impossible to get a large enough share of the decision makers that set the course of the IT-developments of the industry to sit down at the same table to discuss co-ordination of their strategies. In Finland, this was possible.

In the context of the Finnish construction industry the groups of people who were in a key position, and who in fact in one form or other became involved in RATAS-work are shown in Table 1:

TABLE 1: The principal actors involved in CIC strategy definition in Finland (Björk, 1994).

People in key positions	Influence on CIC development
The R&D directors and the directors of IT-development of the major ***construction companies***, ***consulting engineers*** and ***construction materials manufacturers***.	These executives control substantial development budgets and make decisions concerning the majority of the IT-investments of the industry.
The officials in charge of ***government funding*** to construction industry ***research and development***.	Through their funding decisions these officials have a strong influence on the direction of the industry's research efforts.
Representatives of the major ***construction clients*** and ***facility owners***, both public and private.	Building end users may not yet invest much in IT themselves, but they can make demands on the firms they do business with, for instance concerning data exchange standards.
Representatives of commercial ***construction information services*** as well as government officials in charge of the issuing of ***building regulations***.	These parties directly control the dissemination of general construction information of interest in CIC.
Representatives of the ***professional associations*** which look after the interests of the different types of enterprises making up this very fragmented industry.	Such associations have a strong say concerning standard forms of contracts, standards for documentation, inclusion of computing costs in fees etc.
IT experts from ***software firms*** specialised in construction industry applications	They implement the ideas from research and possible standards in commercial software
Construction IT experts from ***research institutions***	They inform industry practitioners about the possibilities of CIC, but also warn about what is unrealistic.

Experts from all the above categories participated actively in the RATAS-work. This did not occur coincidentally but as the result of a conscious strategy by the RACAD board, the RATAS committee and the TEKES fund. The argument was that often the commitment which can be achieved through the active involvement of industry experts in research projects, is as important as the quality of the results, for ensuring later commercial application of the results.

3. ORGANISATION OF THE PROJECT

The RATAS project was organised in phases. Phase 1 was a pre-study carried out in 1985 as committee work by a number of researchers and industry experts (Sarja and Leppänen 1987).

Phase 2 of the RATAS-project lasted from the beginning of 1987 until the spring of 1988 and produced four technical reports. The work done in this phase by the four technical committees has been very important for later developments. A synthesis of the reports was also published (Enkovaara et al 1988). Phase three (1988-91) consisted of a number of technical projects developing prototypes.

In the following the discussion is concentrating on phase 2 which was the roadmapping type of activity. The four committees involved in phase II were dealing with general data bases, standards for data exchange, the building product model, data needs and output documents. All of the subjects treated were, at the time of the project, deemed to be vital ingredients of the future computer-integrated construction process.

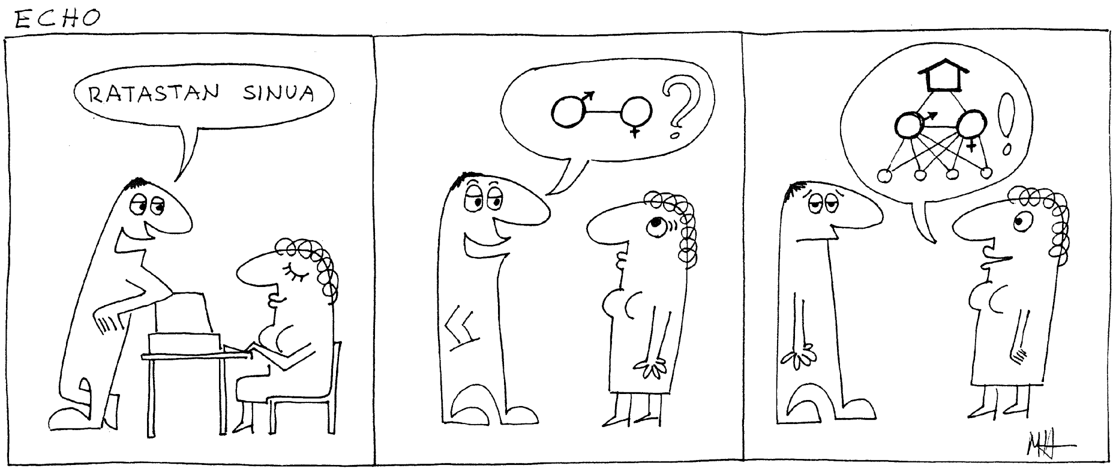

FIG. 1: Cartoon about the RATAS project, originally published in the journal of the Finnish CAD-association, Valokynä. "Ratastan sinua" is a wordplay with "Rakastan sinua", which in Finnish means "I love you". (Courtesy of Matti Hannus)

4. RESULTS OF THE RATAS PROJECT

4.1 General construction information services

Already in 1987 it was clear that construction material vendors and general construction information services world-wide were starting to convert their paper-based information distribution into electronic formats. Available technologies at that time were for instance centralised data bases which are accessed via telecommunication networks, laser disks and CD-ROM devices, expert systems etc. The report of this committee made a survey of such techniques as well as a survey of the types of general construction information available in traditional paper format.

As digital information sources start to appear on the market a crucial feature from the end user's viewpoint is that he needs to deal with as few different user interfaces as possible. The recommendation issued within the RATAS project was therefore to aim at one co-ordinated construction information service for the whole Finnish industry. The user interface and the access method to this "master database" would be uniform, but the origin and updating responsibility for the data could be decentralised to the different organisations and firms which already today publish the information in question.

4.2 Standards for data exchange

A proposal for RATAS data transfer standards for different categories of information was developed, partly based on results from the earlier BEC-project (Hannus 1987). The proposals dealt with the structure of the data in file format during the transfer itself. The internal structure of the data in each application was thus free, provided that pre- and post-processing software to and from the transfer format were available.

The categories of data which were covered were:

- unstructured and hierarchical text
- tables
- vector graphics
- raster graphics
- bar codes
- knowledge
- product model objects

The recommendations for the first five data types were quite specific including syntaxes. The two last categories of information contained in the recommendations differed radically from the first five, since they represented categories of information which were deemed to be important elements of information transfer in CIC in the future, but where there were no applications in use in the late 1980s.

Thus the transfer of knowledge was estimated to be a useful technique for the integration of different knowledge basis and expert systems. A knowledge description language based on production rules and the frame data model was defined in the project. The recommendation for a standard for the transfer of product model data was based on the notion of transferring objects one at a time. A syntax closely resembling the LISP language was recommended.

4.3 The Building product model concept and structure

The basic premise of the working group for product modelling was that there was a need to transfer data about the building and its components in a database form rather than as documents derived from such a database. During the project the object-oriented approach for structuring data was recognised as appropriate. On-going related research abroad, in particular in France (Le Quere 1986), Holland (De Jong 1985), (Gielingh 1987) and the United States (Law and Jouaneh 1986) was studied. As a synthesis of this a conceptual data model for the basic organisation of data describing a building was defined (Björk 1989).

On the level of the basic data model (fundamental data structures) the RATAS product model adhered to the Entity-Relationship data model enhanced with the notions of generalisation and specialisation. On top of this basic data model the

RATAS model superimposes the generic object classes needed for describing a building. The basic features were abstraction or decomposition hierarchies going from the building object down to detail objects. The other dimension consisted of the categorisation of attributes and relationships between objects into different categories. Attributes could be numbers, strings and even raster graphics pictures, quite near to the hypermedia approach. Relationships were subdivided into two generic categories, part of relationships and connected to relationships. Figure 2 illustrates the idea of an abstraction hierarchy as well as typical information collected in an object.

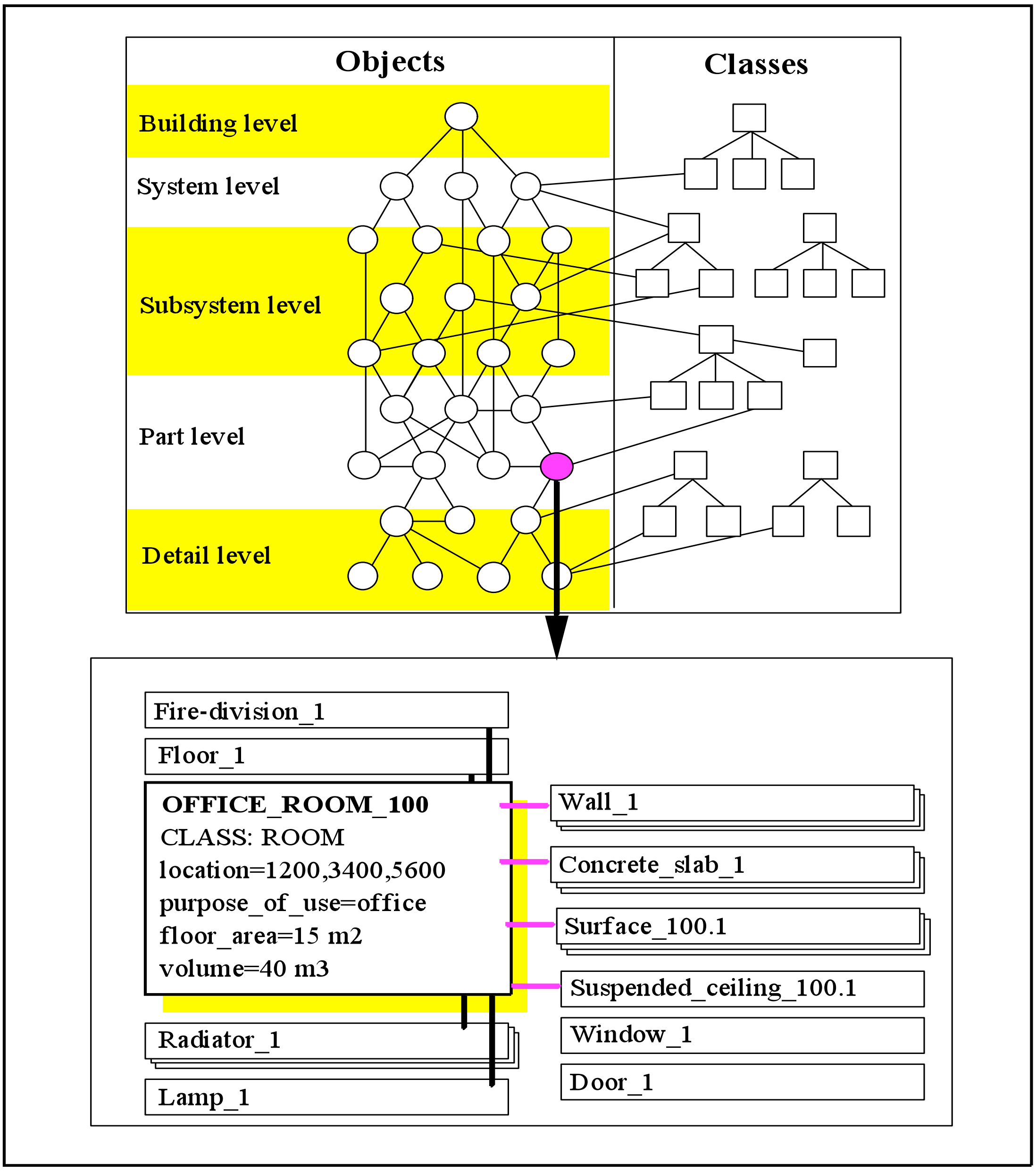

FIG. 2: The basic abstraction hierarchy of the RATAS product data model (Björk and Penttilä 1989)

The final report of this working group contained a lot of illustrations of possible more detailed object classes (i.e. floors, windows, slabs) but didn't provide a detailed recommendation using a formalised conceptual modelling language, as for instance in the Industry Foundation Classes.

4.4 Data needs and output documents in different phases of a construction project

The fourth working group focused its work on the information needs of different participants in a construction project during its different phases. The analysis was partly based on how the use of computers could enhance traditional documentation practice, partly on how new innovative kinds of documents could be extracted from building product models. Very useful for possible application developers were the examples of new kinds of documents which illustrated the report.

4.5 Scenario for moving towards the ideal RATAS process

The last chapter in the report presented a scenario for how the Finnish construction industry could gradually move toward an ideal RATAS construction process based on storing information structured according to the product data model. According to the report the ideal process should be achieved after a transition period of around ten years.

In the report short descriptions are given about what measures different stakeholders should take in order for this to be possible. The groups of stakeholders listed were:

- Building client organizations and end users
- Design consultancies
- Contractors
- Building materials producers and vendors
- The public authorities

5. DEVELOPMENTS IN FINLAND AFTER RATAS

5. 1 Overview of developments

After the RATAS project itself a number of major activities of national importance have been carried out, in differing degrees influenced by the RATAS results and recommendations. Table 2 shows these activities.

TABLE 2: Overview of the main national level research, development, standardisation and Ph.D. training actions since the RATAS project

TIME	NAME	CENTRAL ACTORS	TYPE OF ACTIVITY	PUBLIC FUNDING
1988-91	RTA-programme	VTT	Basic Research	≈ 3 M€
1990-92	TeleRatas	Building Information Institute	Development of commercial system	< 1 M€
1992-95	Depression			
1997-2002	Vera Programme	TEKES, companies, VTT, software companies	Applied research, Development work Standardisation	46 M€
2002-2005	ProIT	Industry associations, VTT, consultants	Standardisation, Education	< 1 M€
2001-	Guidelines for BIM	Senaatti	Standardisation	< 1 M€
2005-2009	KITARA Programme	VTT, the Technical Universities, Academy of Finland, TEKES	Basic Research	≈ 4,5 M€
2005-	KIRSU Ph.D. School	Universities	Researcher training	≈ 0,2 M€/y

5.2 The RTA programme

In the late 1980's the Technical Research Centre of Finland (VTT) launched a research programme of it's own, the so-called RTA-programme, which focused on different key elements identified in the roadmapping work of the RATAS project (VTT 1992). VTT was at that time in a good financial position to launch activities of a fundamental research nature in areas deemed to become important in a few years time. One of the main aims was to improve the know-how of key personnel in these emerging areas to meet a later demand for more industry near R&D. The project size was approximately 29 manyears.

Most of the funding for the RTA-programme (70 %) came from VTT itself, but TEKES and some companies also participated with a minor share. The different projects dealt with product modeling, construction robotics, expert systems and quite a lot of prototyping work was involved. There was also one project which continued the roadmapping work of RATAS by looking at the fundamental elements of computer-integrated construction (Björk et al 1991)

5.3 TELERATAS

The recommendation of the RATAS project to create one single uniform user interface to all kinds of general digital construction information services was followed up by two independent projects. The RATAS database directory project was carried out by the Building Information Institute and aimed at producing a shell for the uniform digital construction information service. Work on a building information thesaurus was also carried out in this project. The other project was initiated by Partek Oy and Rautarukki Oy, two major manufacturers of building materials. The prototype system included Autocad drawings of wall structures, information about building materials and an expert systems for fire regulations which is linked with the materials information included in TELECAD (Tuominen 1991).

During 1991 an agreement was reached between these parties to merge their projects. TELERATAS was chosen as the name for the synthesis of the two projects. The system was issued to pilot users in the winter of 1992 and became commercially available in the summer of 1992.

The overall architecture of TELERATAS was based on a central repository for the information combined with the possibility for users to download as much as possible of slowly changing types of information to their own hard disk to speed up access and save on telecommunications costs. Later a CD-ROM version of the system was developed. In this version a yearly updated CD-ROM contains all the information which is used locally. A example of the user interface of TELERATAS is shown in Figure 3.

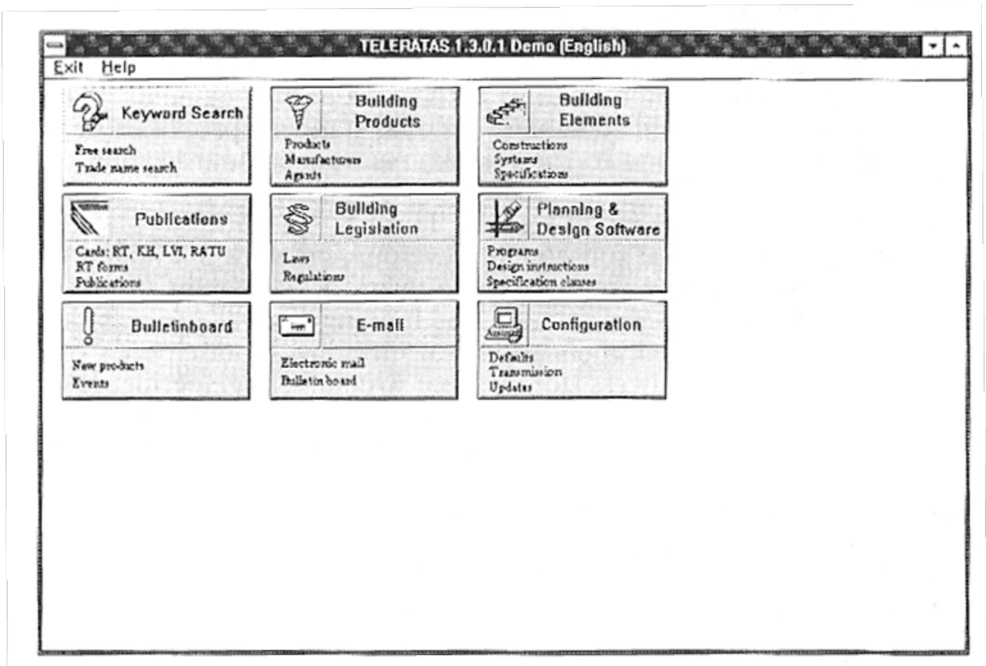

FIG. 3: An example of the user interface of the TELERATAS building information service

The TELERATAS system didn't contain enough information to create a critical mass and a snowball effect of attracting users. Also the timing was most unfortunate, since the technology was pre-Internet and the systems came on the market at the time a deep depression started to hit the Finnish construction industry, which meant cost cutting activities in all companies.

5.4 The Depression of the early nineties

Due to the overheating of the Finnish financial system in combination with the breaking down of the Soviet Union, which had been an important export market for Finland, the Finnish economy hit an unprecedented depression in the early 1990's. Unemployment swiftly rose to a record high 18 %. The construction industry was extremely badly hit. Only after 1995 the economy started to swiftly improve, partly due to the ripple effect of the success of Nokia in the mobile phone market.

Among other things the depression severely cut all spending on construction IT R&D, with the exception of a few companies with foresight, such as building services consultancy Olof Granlund, which used the period with less client demand to develop its IT competence, rather than just downsizing.

5.5 The Vera programme

The VERA programme, with a budget of 46 Mill Euros was one of the large priority setting R&D programmes of TEKES (TEKES 2002). TEKES provided some 22 Mill Euros of the funding with the rest coming mainly from participating companies. The 113 indivividual projects in VERA can be roughly grouped into the following categories (VTT 2002):

- Software products
- Service products
- Process development
- Basic technologies and know-how
- Surveys and reports

A very significant feature of the programme was that it required adherence to the emerging IFC standards for product models whenever applicable in all development projects, and that some part of the funding was used to support very active Finnish participation in the IFC work itself.

One of the effects of the VERA programme has been to strengthen the competitive position of a few select software companies who specialize in BIM-software (Froese 2002). The modeling applications of TEKLA have for instance been used in the design of the complex Olympic stadium in Beijing.

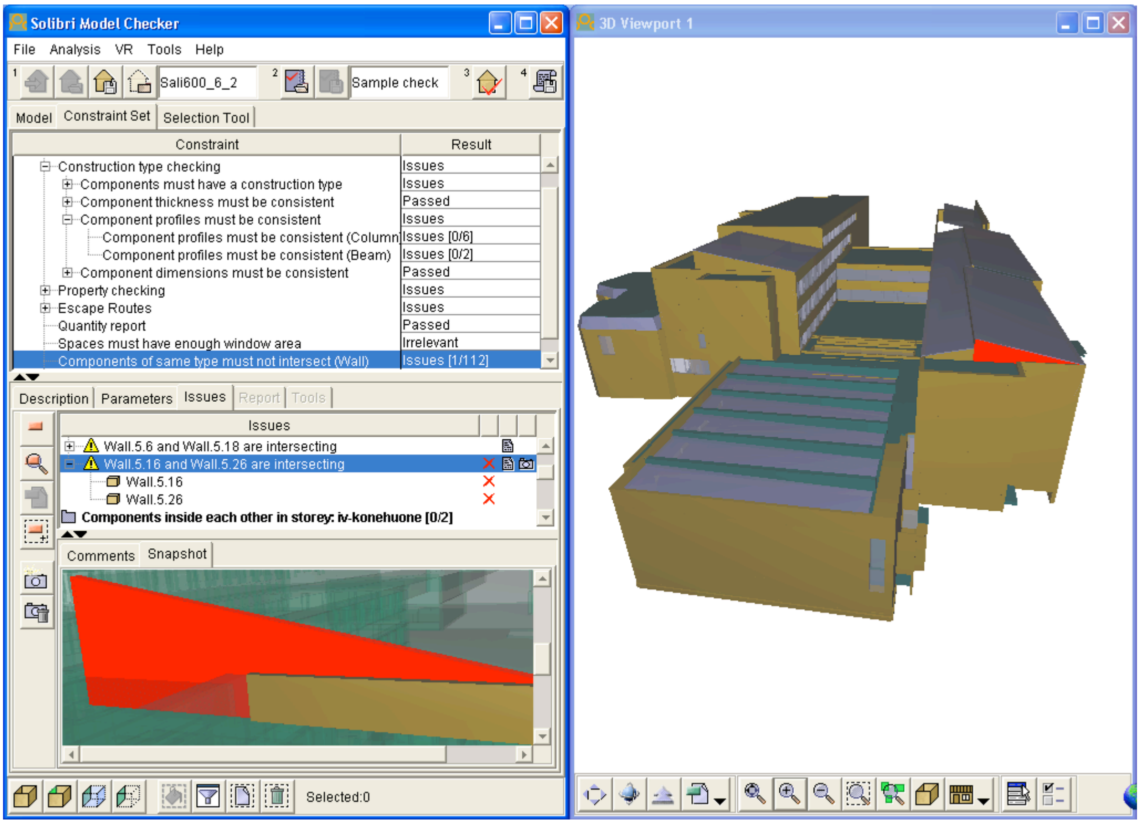

FIG. 4: Solibri was one of the software companies that got support from the VERA programme to produce BIM-applications

5.6 The ProIT project

The central outcome of the RATAS project had been to identify the building product modeling method as central to achieve the benefits of computer-integrated construction. Early on it was also realized that the necessary standardization of data structures should be done on the international level, rather than on the national level and this realization led to very active participation from VTT and Finnish companies first in STEP standardization and later in the development and testing of the IFCs.

But in addition to existing international standards and an emerging availability of software application that comply with them, the average design consultancy or contractor needs more explicit guidelines how to apply the standards in real work.

The ProIT project (2002-2005) was carried out not as part of VERA but of the later more general purpose SARA programme of TEKES (ProIT 2005). The initiative came from the umbrella organization of the building industry, Rakennusteollisuus (RT). The project issued general product modeling guidelines to industry.

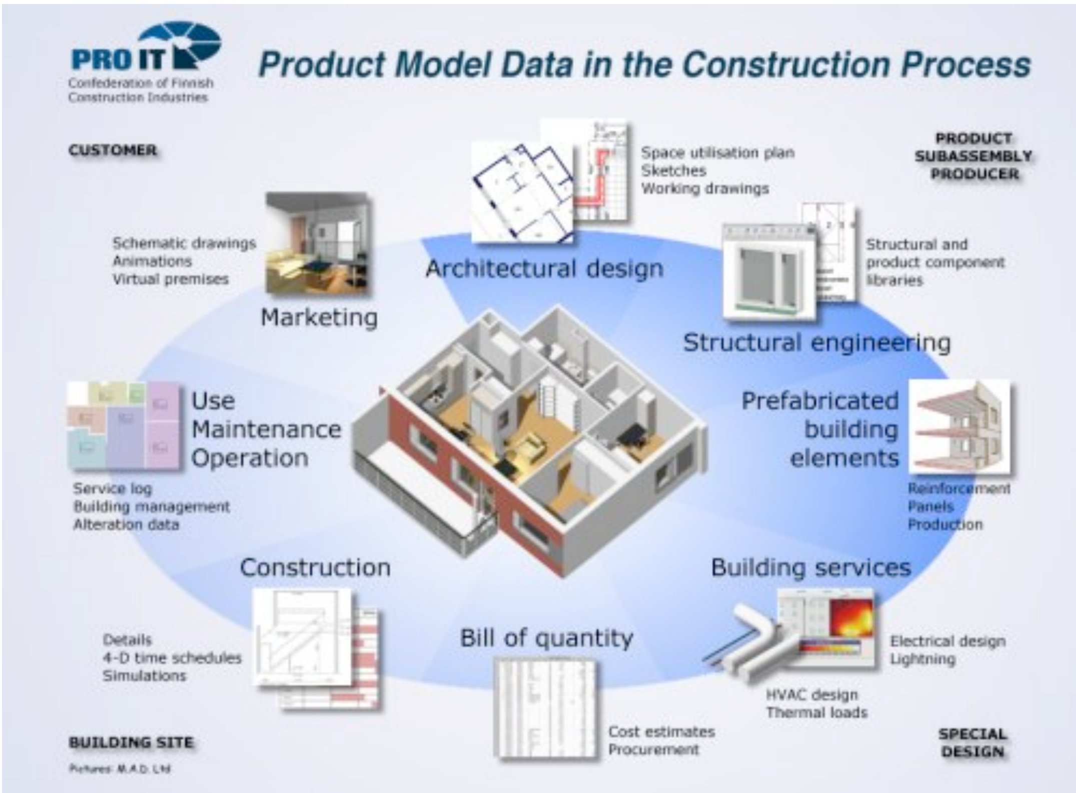

FIG. 5: Illustration of the building product modelling concept from the ProIT projektet

5.7 BIM-guidelines from the Senaatti property company

In order for BIM to become standard practice the involvement of strong stakeholders is also needed, for instance large client organizations procuring projects, that explicitly require the use of standards and issue guidelines. In Finland the large public property owner and manager, Senaatti has assumed such a role in issuing guidelines which have become effective in 2007. Some of the best experts from VTT and companies participated in defining the requirements, taking into account the experiences from a number of previous BIM pilot projects in Finland (Koppinen et al 2008).

5.8 The KITARA programme of the Academy of Finland

The central funding agency in Finland for fundamental research is the Academy of Finland. Traditionally construction and FM related research has received a very low share of the funding. This has partly been due to the fact that researchers in the civil and architectural departments of the technical universities tend to publish mostly in conferences and as technical reports, rather than articles in peer reviewed journals of high prestige (i.e. indexed by the Institute for Scientific Information and thus possessing so-called impact factors). Thus when they have competed for general Academy of Finland grants with scientists from other disciplines they have lacked credible enough CV:s to win the bidding contests.

A few years ago the Academy realised this chicken and egg problem and initiated a Research programme dedicated to the use of IT in traditional industries, of which programme roughly half of the funding goes to the construction and FM sector (Academy of Finland 2006). The aim is specifically to strengthen the fundamental research in the area. During the duration of the programme (2005-2009) six construction IT projects are carried out, partly also funded by TEKES and the Ministry of the Environment.

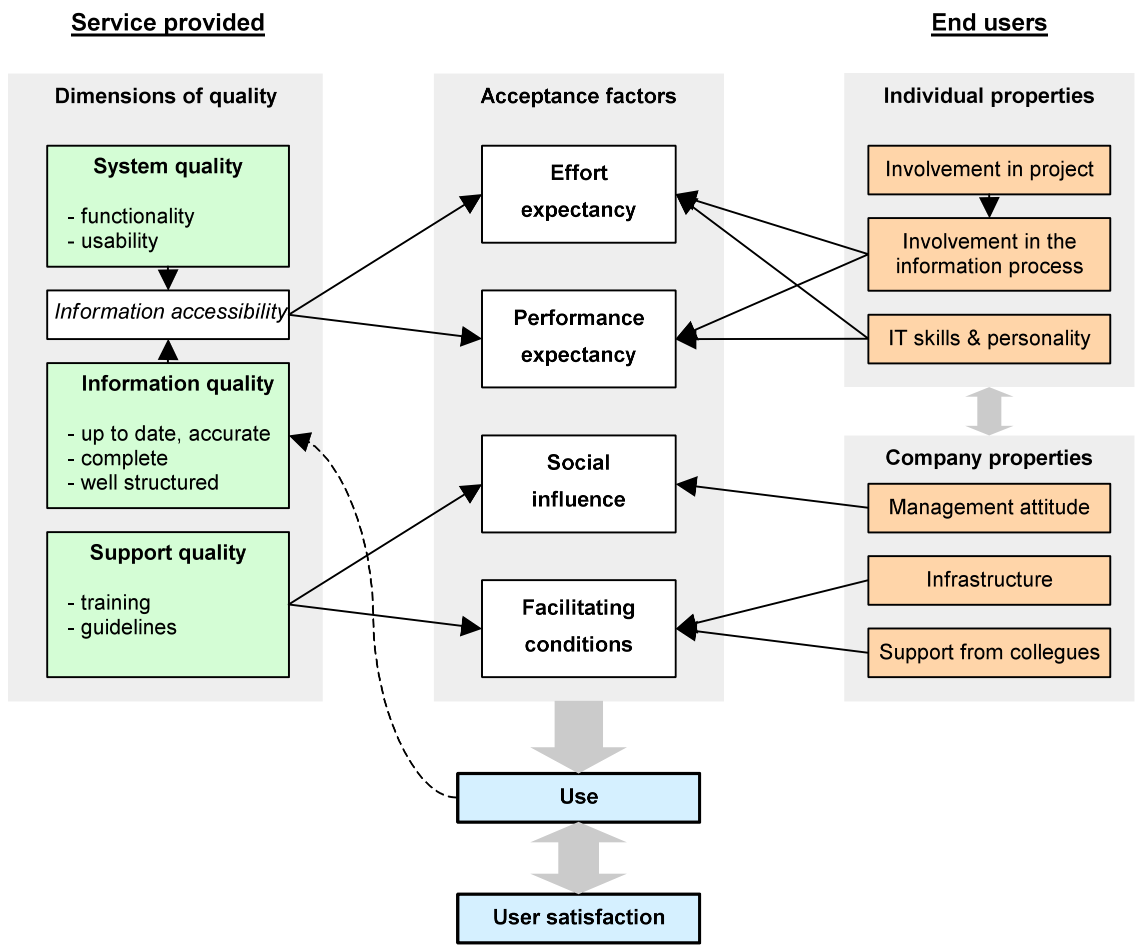

FIG. 6: In one of the projects of the KITARA programme the psychological factors influencing the adoption of new IT-technologies in construction have been studied, using the utilisaction of an Electronic Document Management system in the huge Kamppi bus terminal project as a case (Hjelt and Björk 2006)

5.9 The KIRSU Ph.D. School

Although Finnish researchers have engaged in high-level applied research in construction IT since the 1980's, mostly as employees of VTT, proper training of Ph.D:s had until around 2002-2003 been lacking in the technical universities, due to the fact that there were no professors active in the area. It is indicative that a number of leading Finnish construction IT researchers got their Ph.D:s abroad (Kähkönen 1993, Laitinen 1998, Karhu 2002, Kiviniemi 2006) and that two central researchers in VTT:s RTA programme later were recruited to become professors abroad (Bo-Christer Björk, Lauri Koskela).

In parallel with increased attention given to construction sector research by the Academy, the Ministry of Education has also now allocated money for the education of future researchers in construction IT specifically, through its Ph.D school programme. After a start with a school with 6 fully funded positions for Ph.D students the school has expanded through mergers to a much larger school for construction research as a whole (KIRSU 2008).

FIG. 7: Finnish Ph.D. students and faculty visiting the University of Salford for a joint workshop in October 2007

The first Ph.D graduated from the school in 2008 (Finne 2008) and it is hoped that the school will provide a steady supply of highly trained experts for future research, industry development and university teaching.

6. CONCLUSIONS

The priorities set in RATAS still look up-to date but it has taken 25 years to come even part of the way, at least concerning BIM-technology. This can be contrasted to the "official" prediction in the RATAS final report that it would take around 10 years to reach the target state. Although a lot of progress has been made (Kiviniemi et al 2008) we're still not there!

The key learning from this case is that the central issue is to reach a common understanding of main priorities for R&D and standardization among the central stakeholders in the industry. Most of the more detailed recommendations from projects and roadmapping activities like RATAS tend to become obsolete rather quickly, due to the rapid developments of the technology and the marketplace. This has for instance happened to the recommendations for standards for data exchange standards included in the final report. The recommendation about one "portal" for information about buildning materials etc is still valid, but in the Internet age this seems to happen in many industries as a result of market forces and convergence on one dominating service rather than through conscious planning. A good example of this type of market mechanism at work is finding information about houses for sale in a given city or region and how clear winners rapidly emerge. The emphasis on product modeling in RATAS was the most far reaching and the decision to actively contribute to an international standard (IFCs) rather than a national one in hindsight the only feasible one.

Another key learning is that the technical competence for further work and personal networks gained by participants is very important, as can be seen by looking at the later careers of many of the active participants of the original RATAS project.

The central later activity which paved the way was the VERA-programme, which was a much more loosely structured collection of industry near development projects. The VERA programme had in common with the RATAS project that it gathered together in a closely linked network almost all the key competencies in the country, thus also paving the way for a strong Finnish presence on the international scene. Finland has always been one of the leading countries involved in international standardization activities such as IFCs and Finnish software companies are also among world leaders in BIM software.

ACKNOWLEDGEMENTS:

The author was at the time of the start of the RATAS project a researcher at VTT. He was engaged in the RATAS project as secretary of the product modeling group and later become head of a research group focusing on building product modeling, in which subject area he got his doctorate. He was also actively engaged in the RTA programme. He moved to Sweden were he was professor of Information Technology in Construction at the Royal Institute of Technology between 1993-2000 and is since the beginning of this decade employed as professor of Information Systems Science at the HANKEN school of economics in Helsinki, Finland. In this capacity he has participated in the KITARA programme and the KIRSU Ph.D. School.

Looking back at the RATAS project and follow-up activities there are so many individuals whose contribution to RATAS and its follow-ups should be acknowledged that the list would be extremely long. Some of the key individuals can nevertheless be found among the literature references given in this article.

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