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InPro - integrated project within the 6th Framework Programme

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Abstract

In a first part, this paper introduces the research project InPro. InPro addresses the early design phase of a building's life cycle. The structures in the construction industry can be characterised as traditional. After illustrating the current situation and the resulting challenges, objectives and approach of InPro are presented: To design buildings with improved lifecycle performance, the early design phase needs to be transformed. The main result will be the InPro Open Information Environment, an innovative Information and Communications Technology concept connecting all stakeholders of a construction project. This environment will enhance collaboration along the construction value chain, improve lifecycle design and give decision support in the early phases. A European consortium of 19 partners has been established to strive for industrial transformation.

The second part of the paper discusses a comparative analysis of best practices carried out in the InPro scope. Partners from Aircraft Manufacturing, Shipbuilding and Plan Engineering are been invited to participate in this benchmark focused on collaboration and model based working in the early design phase. The paper illustrates approach and first results of this benchmark.

Keywords: InPro, ICT, Early Design, Benchmarking

Industrial Context

The European construction industry has maintained traditional processes and communication structures. The industry is dominated by SMEs. In 2005, 97% of the registered companies in Germany had less than 50 staff (HDB 2005). Projects are carried out by ever changing consortiums. These unsettled surroundings ask for flexible project organisations and communication structures, which can easily be set up with any partner involved. The traditional processes and communication structures have been able to cope with such situations. Nevertheless, the traditional structure is responsible for generating considerable amounts of waste in a building's life cycle. Designers have to rework plans due to miscommunication, the construction site is slowed by events that could have been foreseen in design and avoided, and life cycle costs are higher than estimated.

R&D activities to improve the situation are pursued by major players in the industry. SME resources are often focused on the daily business. Research results can only be deployed industry wide if all partners of a consortium are able and willing to apply the new methods.

Problem

While productivity has gained significantly in production and services industry, construction has not shown a major improvement over the last 20 years. This leeway in productivity is endangering the competitiveness of the industry in a globalised market. It can be assumed that one reason for this situation is that ICT usage in the construction industry has not kept up with the use in the manufacturing industry. Nevertheless, Information and Communication Technology (ICT) is one of the key enablers for productivity growth in modern economies (Reding 2005).

ICT has proved to be a key enabler in product design. Large scale, complex engineering projects as the development of the Airbus A380 Aircraft are only feasible by using simultaneous and concurrent engineering interwoven with suitable 3D design toolkits. Shipbuilding and plant engineering are other examples showing the success of model based working in complex engineering projects.

Yet in the European construction industry, model based working is only used in isolated applications with limited scope. A holistic ICT approach linking all stakeholders of the construction value chain needs to be established.

Learning Objectives:

- The InPro Open Information Environment will improve the early design phase of a building project
- The success factors of an information environment are determined in a benchmark

The InPro Project

To tackle the challenge of improving the tools supporting the building process, five major European construction companies decided to bundle their efforts and initiated the InPro research project. InPro will transform the design phase of building projects. Immediate and efficient collaboration between all stakeholders of the construction value chain up to the client shall be made possible by an innovative approach.

InPro stands for “Information” and “Processes” which links the name to the focus of the research work. The project is funded by the EU framework program for research and development. 20 European partners representing both industry and research are integrated into InPro. The consortium embraces the whole construction value chain from building owners and architects, to construction companies and facility managers. It also includes a number of European research organisations in the field of construction, industrial processes and IT as well as leading software developers. Having started September 1st, 2006, InPro will run for 4 years until August 31st, 2010.

InPro focuses on the early design phase of a building project. Decisions taken during early design strongly determine the building’s performance during the life cycle. Yet, these decisions are often taken with limited transparency towards the consequences of a decision.

The InPro Open Information Environment will be the main achievement of the project. Based on existing as well as innovative Information and Communications Technology (ICT) applications, an advanced system of integrated design and analysis processes and decision-support will radically improve collaboration all actors (Figure 1).

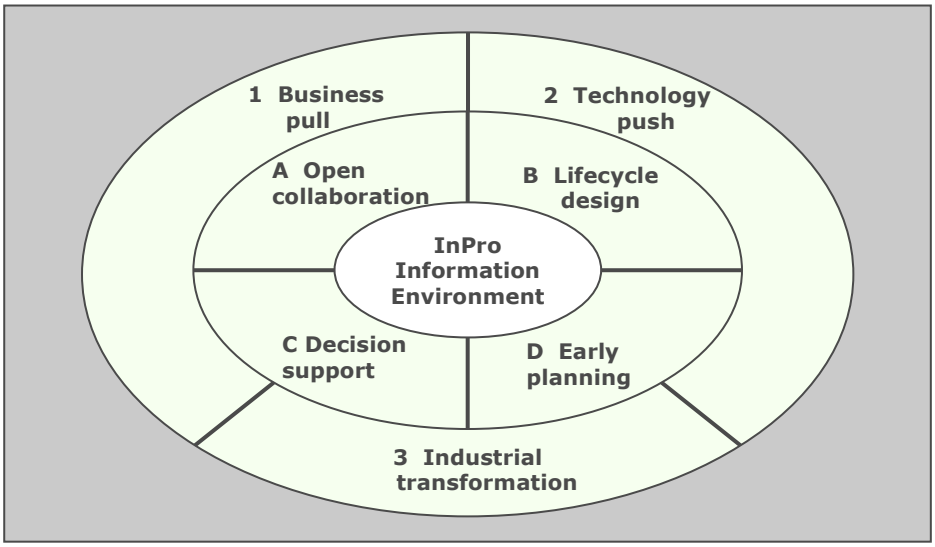

Figure 1: InPro Open Information Environment

The InPro environment will bring improvement to four aspects of the building process:

A) Open collaboration between all stakeholders of the construction value chain
All relevant parties of the construction value chain - from client to architect, engineer, contractor, and facility manager - collaborate openly and flexibly on a common web-based information platform, independent of specific ICT software. Business concepts provide incentives for stakeholders to jointly develop the best design solution by cooperating and complementing each other's competence.

B) Design from a life cycle perspective
Buildings are designed taking into account a life cycle perspective, e.g. the future needs of the user, energy efficiency, use of high-performance materials, efficient design/build/operation, future upgrading and renovation, decommissioning, and much more. Thereby, the building brings added value to all main stakeholders.

C) Smart decision support
Smart and model-based multiple-criteria decision support, makes it possible to prioritise between a great variety of often conflicting decision alternatives, and to make "informed choices" based on explicit knowledge of each decision's consequences on the building's life cycle.

D) Early planning of the realisation and operation processes
Computer-enabled simulations of smart digital prototypes enables the parties of the building value chain to plan and predict the build and operation processes already in the early design phase. This is crucial for the industrialisation of building processes and efficiency of downstream activities.

Putting the outlined benefits into reality will contribute greatly to the overall productivity of the construction value chain, resulting in better products and less resource waste. Consequently, the implementation of the InPro environment will radically transform the early design phase in the European construction industry.

InPro targets the business aspect of the early design phase as well as the technology aspect. The work package reflects this structure of the project (Figure 2):

Work Package 1 (WP1) "Business Concepts" focuses on establishing new forms of collaboration for project partners. Focus areas are analysis existing concepts in other industries, development

of innovative business concepts and meaningful performance indicators for the construction industry, and strategies for industry wide deployment.

WP2 "Early design processes" establishes ways of working that take into account all stakeholders of a construction project in a life cycle perspective. The "Use Case" method is used to detail the InPro scope. Processes for better collaboration and customer focused, sustainable product design are developed. Those two WPs embrace the business view of the project.

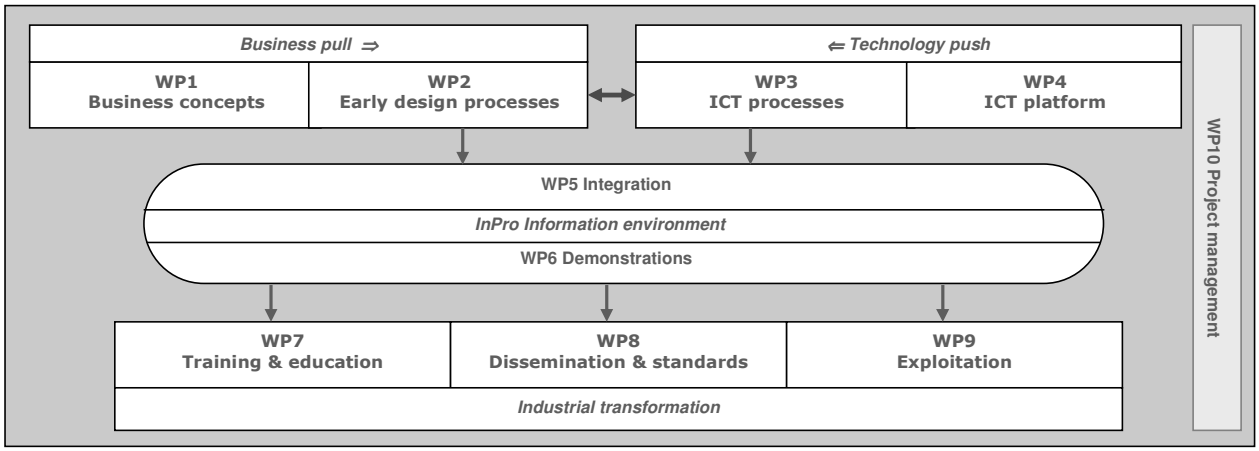

Figure 2: InPro work package structure

The technology side of the project is reflected in the work packages 3 & 4. WP3 "ICT processes" is end user oriented and focuses on data handling and data management applications as well as the integration of different applications into an integrated environment. WP4 "ICT Platform" focuses the "under the hood" part of the InPro Open Information Environment and implements a neutral backbone for applications.

The business and technology view aspects are merged into the InPro Open Information Environment in WP5. The construction industry partners of the consortium will demonstrate the InPro Environment in five real life projects (WP6).

A threefold approach is pursued to ensure an industry wide transformation of the early design phase in the building industry. WP7 focuses on trainings for students, users and managers; WP8 coordinates the press relations and links the project to the national and international standardisation bodies and WP9 develops an exploitation strategy for the InPro results.

All project management activities of the project are pooled in work package 10.

The need for the InPro project has been motivated by outlining the current status of the European Construction industry with a special focus on the ICT aspects. Objectives and structure of InPro have been described. After illustrating the InPro approach, the focus now moves to the business process aspects of InPro.

Comparative Analysis of Best Practice

The comparison with other European industry sectors shows examples of more advanced ICT use in design processes. The head start of the manufacturing industry can teach valuable lessons of do´s and don't´s in taking up new ways of working. A comparative analysis of best practices for early design is a valuable baseline for the elaboration of new business concepts.

To develop viable business concepts, the key success factors for the InPro Open Information environment need to be identified. Analysis of working processes and tools gives information about focus and ambition level of the InPro environment. It is equally important to decide which processes shall be supported, how the processes shall be supported and to what detail level this

support can be beneficial. Benchmarks with companies from other sectors are one of the initial activities of the InPro project, running from September 2006 to March 2007.

Three industry branches are chosen as the most promising partner industries to analyse: Aircraft manufacturing, plant engineering and shipbuilding are approached as benchmarking partners of the InPro project. These industries base their product design process on 3D tools. They face similar challenges in product development like the construction industry: Complex products which are designed in line with customer requests. Limited timeframes for design and realisation necessitating parallel design and manufacturing activities paired with small series or unique part production, limiting the ability to spread the cost of design on multiple units.

In the following, the benchmarking approach and first results are described. The final comparative analysis of best practice is not available at the time of creation of this paper.

Benchmarking

Benchmarking describes the comparison of production process, management practice and products or services. This term is similar to the comparison of effort. Hence, benchmarking is a process which compares certain objects with each other.

The InPro benchmarking is following a five-step approach (Figure 3) according to (Siebert 1998). Definition of scope and objective initiates the benchmark. The processes in focus and parameters to measure the process performance need to be established. Based on these process parameters, questionnaires can be developed to collect the wanted knowledge in a comparable way. The knowledge can come from within an organisation (internal data) and by discussing with external partners.

Figure 3: InPro benchmarking steps

Differences between industries become evident by comparing the results and excellences and gaps can be assessed. Measures for transfer of excellences and closure of gaps can be deducted.

The described methodology has been applied to the InPro project, as described in the following paragraphs:

Process and Parameter Model

The InPro benchmark is focused on early design. The InPro Early design start is defined as the first contact between the client and the participants of the construction process. Early design concludes as soon as all discipline oriented concepts are integrated into a total concept design.

The vision of the InPro Open Information Environment is the guideline for defining the benchmarking focus:

- How can open collaboration, life cycle design, smart decision support and early planning be supported by attractive business concepts and innovative ICT infrastructure?
- How is the integration of business processes and ICT realised in the manufacturing industries?
- Which role do 3D models play in the early design process?

The benchmarking seeks for answers and ideas and discusses their applicability in the construction value chain.

Valid results are depending on comparable data, which has been collected in a process and parameter model applicable for all benchmarking partners. Consequently, early design processes in construction and partner industries need to be mapped to a generic process model. To establish this generic model, the VDI methodology "Systematic approach to the development and design of technical systems and products" (VDI 2221) is used to establish a generic process model for early design phases. Using this generic process model, the company specific early design is analysed to determine benchmarking points of comparable product maturity. A high level process model is created for each benchmarking partner.

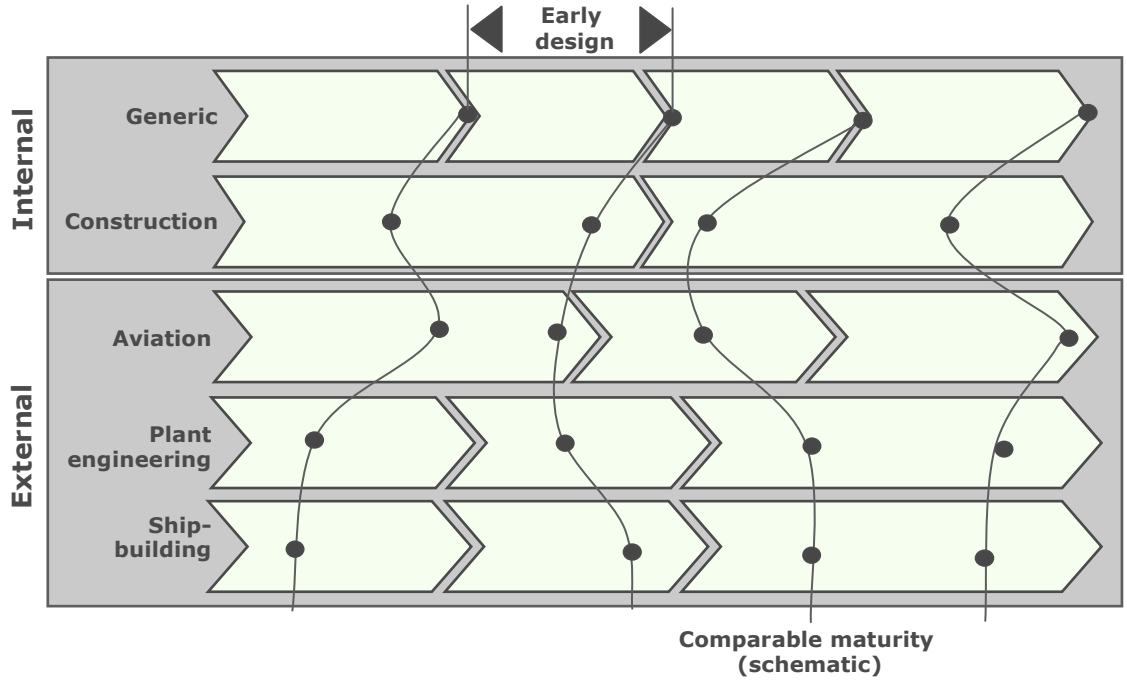

Figure 4: Mapping of early design processes

Parameters are selected to make the process performance measurable. These parameters are selected in respect to the core benchmarking questions and focus on the topics brought up by these.

- Early design processes and scope of early design
- Requirements management
- Project management
- Use of models in the Early design process

Questions dealing with classification of the partners' business environment and the typical client relations in these environments precede the a.m. questions to facilitate classification of the partners.

Questionnaire

The processes in focus are complex product development processes with high numbers of actors and stakeholders. For each situation, different constraints, e.g. special market position of a benchmarking partner, have to be taken into account.

The complex environments can not be captured in a questionnaire only. The closed questions of a questionnaire could not reflect the variety of answers possible. A twofold approach is required to extract the information required. Benchmarking data is gathered by combination of a questionnaire and a benchmarking workshop at each partner. The questionnaire gives an

overview of business structure and model use at the benchmarking partner. The questionnaire is provided to and returned by the benchmarking partners prior to the workshops. Using this information for preparation, the partner workshop preparation can be focused on the most promising subjects.

Data collection

The phase of data collection is performed in two steps. First, a common view of the European construction industry needs to be created. The benchmarking questionnaire was distributed to all InPro project partners of the construction industry and workshops were conducted with each partner. These results are being consolidated to a single view. This view - although not claiming to represent the European construction industry as a whole – is the basis of comparison to benchmark the construction industry with external partners.

For each external partner industry, a high level process model was established by discussion with industry experts. With each external benchmarking partner, process model and questionnaire is reviewed prior to the workshop, either by face-to-face or by telephone meeting.

Each industrial partner is visited for a benchmarking workshop together with representatives of the construction industry partners. At the time of writing, these workshops are ongoing. Final results will be presented during the conference.

Results and Business Impacts

Key Findings

With the data collection ongoing, preliminary conclusions can be drawn:

An information environment has to reflect it's sectors surroundings:
Design processes in the industries discussed are strongly influenced by ways of working in each industry. The prevailing market situation, client relations, product characteristics and contract types determine which information in which quality is available at project start. Quantity and quality of the information available characterise the approach to a project and the linked design process. Each information environment reflects the ways of working in its sector.

The benefit of an information environment needs to be shared between the contributors:
Early design process organisations are furthermore strongly depending on the number of actors involved and their relation. Commercially independent actors lead to a segmented design process with similarly segmented results, while actors who are commercially linked or under the same commercial umbrella seem to be able to handle a more interconnected process. This results in a better-integrated product at an earlier stage of the process. Partnering models need to be found to bring all stakeholders of the construction value chain under one umbrella.

Integrated design is the key to better products:
Life cycle design requires qualified decisions in the early phases of the building design process. Such decisions can be taken if alternatives and their consequences on product are transparent. Bundling the expertise of actors of the key trades already in the early design phase is the key to product design with guaranteed life cycle performance. Applied to the building design process, integrated design asks for integrated project teams, from architect to contractor and facility manager, at the earliest possible stage.

Conclusions

The ambition level of the InPro project is the transformation of the early design phase in the construction industry. The project approach composed of business pull, technology push, implementation and demonstration, and the industrial transformation has been introduced.

Special focus was then laid upon the business pull, where one key task is a comparative analysis of best practices in model-based working. The results of this task will influence the further proceeding of the project by shaping requirements for business concepts and providing input for the ICT development.

Key Lessons Learned:

The InPro project addresses the business and the technology view of the construction value chain. Both views will be integrated into the InPro Open Information Environment, a platform managing all data of a building project.

A comparative benchmarking study analyses the use of 3D models in aviation, plant engineering and shipbuilding. Leading practices and key success factors will be adapted to the construction industry within the InPro project.

References

Reding, V. (2005) Speech ”i2010: The European Commission’s new programme to boost competitiveness in the ICT sector” http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/05/61&format=PDF&aged=1&language=EN&guiLanguage=en (date accessed: 05 February. 2007)

Siebert, G. and Kempf, S. (1998) Benchmarking: Leitfaden für die Praxis, Carl Hanser Verlag München Wien, 3-446-19342-1

VDI 2221 (1993) Systematic approach to the development and design of technical systems and products, Beuth Verlag GmbH

HBV (2005), German construction industry association, annual statistics

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Dipl.-Ing. Johann Jaeger graduated in 2004 from Aachen University of Technology and holds a degree in Mechanical Engineering. Subsequently, he joined "P3 - Ingenieurgesellschaft für Management und Organisation". He is coordinating the of P3 – Digital Services involvement in the InPro project.