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IMPLEMENTING NEW PRODUCT DEVELOPMENT BEST PRACTICES IN HOUSE-BUILDING DEVELOPMENT PROCESSES

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1. Introduction

Developments in the Dutch housing market, like changing consumer demands and regulations, are making the current development and construction processes in the building industry increasingly ineffective. In particular, failure costs in projects are seen as a major problem. Construction companies have realised that there is a need for process innovation in the house-building industry. A possible way to realise process innovation is to look for inspiration in industrial new product development processes.

To that end, Ballast Nedam Bouw, one of the largest construction companies in the Netherlands, wanted to investigate which practices of the industrial product manufacturing industry can advantageously be transferred to the housing development process. A preliminary study into this subject was carried out as a graduation project at the Faculty of Industrial Design Engineering of the Delft University of Technology.

The goal of this project was to identify ideas and practices in NPD that might contribute to the improvement of construction practice in house-building. Important questions were:

- What ideas and practices of NPD processes can be adopted in house-building?
- How do these ideas and practices relate to the near-future housing market?
- What are the consequences of these ideas and practices for the current business processes of construction companies?

Results of the comparison of NPD theory and real world development processes in house-building were already presented at the ICED '05 conference [Soetens, Roozenburg, 2005]. It was concluded that transferring certain practices from NPD could potentially inprove house-building processes. This paper builds on the results of this study, adding concrete options for implementing practices in the housing development process.

2. Methodology

Research into this subject has been two-fold, in the sense that both theoretical data and data about real world practice had to be gathered.

Research was therefore partly conducted at the large Dutch construction company Ballast Nedam Bouw, to be able to compare actual construction practice with NPD-theory. Their experience and development practice were used as a large case study. It was observed that the findings at Ballast Nedam Bouw are highly comparable to the ways of working in other construction companies, and can thus be seen as representative of the house-building industry in the Netherlands in general.

As a first step, the current situation regarding working processes in construction companies and also the main problems in current building practice were researched by means of conducting interviews, studying internal processes, and reading relevant literature. This research was limited to the Dutch situation, so the conclusions cannot automatically be generalised to a broader international situation.
Results from these analyses served as a basis for a comparison of development processes in construction companies with a theoretical view of industrial NPD processes, based on best practices. Generic models on industrial NPD processes were used to find similarities and differences between both industries, and to find alternatives to the weaknesses of the current construction practice.
The comparison has led to a series of recommendations to improve construction processes. These were researched further to find out in what form these recommendations could be implemented.

3. Current practice in construction companies

3.1 Characteristics of development processes in house-building

Extensive research was carried out to obtain a good view of construction processes in house-building projects. Below is a short summary of the most significant characteristics.
Major construction companies carry out both development and building activities in these projects. The construction company coordinates all activities, but a lot of the actual work is outsourced to external partners in design, development and building phases (Figure 1).

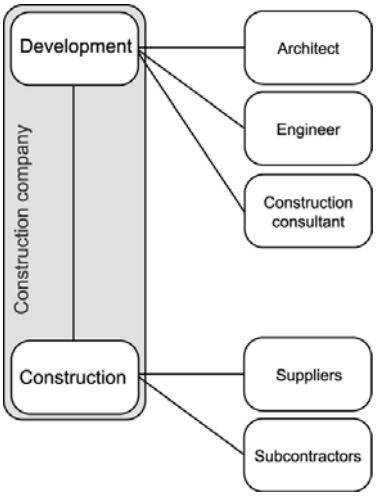

Figure 1. Structure of the construction team

The following main characteristics were found to be specific for these projects:

- Division of development and construction functions: even when the project development is carried out by the construction company itself, development and construction are separate processes, each with its own director.
- Project development is mainly a serial process [Bondt 1993] with design, sales and construction phases respectively. In this process, design decisions concerning the housing are taken over a very long trajectory.
- External parties like suppliers and contractors have very limited influence in the project, although a large amount of the total work is contracted out to them.
- Construction companies are very project focused; they tend to view their production as a series of independent projects [Lichtenberg 2002].
- The need for cost reduction is an important factor in the setup of the current development and construction processes and results in a tendency to start the actual construction (often referred to as the ‘primary process’) as quickly as possible.

3.2 Problems in current house-building projects

In current house-building projects, construction companies have signalled an increasingly higher number of unwanted results. The main issue is the increase of failure costs, which are generally associated with unforeseen changes in the construction during the building phase, a longer than expected building phase and construction errors that have to be corrected afterwards.
However, research shows more problems:

- Projects are delayed and exceed budgets because of legal procedures and issues.
- Construction companies offer buyers more freedom of choice in the configuration of their houses, but this generates problems in their on-site construction planning.
- After the realisation of the housing project, construction companies face buyers with complaints about building quality, construction errors and configuration mistakes.

Although part of these issues is the result of external influences, it can be concluded from this preliminary research that the current construction processes are a major cause for these unwanted results. Studying the current practices the following causes were identified:

1. A lack of preparation in the project
Prior to actual development activities, minimal attention is paid to risk analyses, coordinating the collaboration with external participants in the process or specifying an extensive program of demands for the project.

2. A lack of integration and collaboration in the development phase
The architect, main engineer and construction advisors all have a very limited role in the design. They are contracted by the construction company to do their part of the job, but this is not an integrated effort.

3. A lack of coordination in the total design process
As mentioned before, there is no single person or function that coordinates the design process from first development activities to the building phase, although design decisions are made during all phases of the process. There is a lack of direction from design to production.

4. A lack of process control in the construction phase
In the preparation and execution of the actual construction, planning, purchasing and work preparation, activities are executed parallel and under time pressure. A large part of the work is handed out to subcontractors and suppliers, who are responsible for making their own working drawings based on general documentation. Process control problems are caused by

- wanting to start with the actual construction as soon as possible;
- the lack of a document management system to eliminate errors;
- a lack of attention to construction site logistics.

The identified problems in the current construction practice are concerned with preparation of activities, integration of functions, collaboration of participants and control issues. These issues served as starting points for comparing construction practice in house-building with NPD theory.

4. Comparison of housing development practice in construction companies and NPD-theory

The current practice of construction companies has been compared with modern views on NPD in the manufacturing industry. For the comparison generic models of the product development process have been used, such as concentric [Roozenburg 1995] or concurrent development [Smulders 1992] and stage-gate progression [Cooper 2001], as well as reported best practices in industry, such as Design for X [Ulrich 1995], life cycle analysis and quality control systems.

In this preliminary research it was concluded that the processes in both industries are, on an abstract level, similar with respect to the forming of a project organisation, the consecutive phases in the development process and the definition of phases in the design process.
However, focusing on the actual activities in the various phases of the total development process, a number of key differences with respect to the practices in both industries were identified:

1. Serial versus parallel execution of process activities
In housing development, the preparation to the actual on-site construction (including design detailing) is delayed until a large percentage of the houses in the project are sold. This reduces investments needed in the project, but also causes a delay in the total development time.
In NPD, preparation for production and marketing of a product is started parallel to product design. This approach reduces the total development time of the project, thus shortening the time to market.

2. Different sequences of design, sales and production
In construction practice, first a concept design for the housing is made, which is used to sell the houses. When the project is sold, the design is further detailed and production methods are chosen. This means that in the building phase there are lots of design decisions that still need to be taken. This causes time stress because the contractor wants to deliver as fast as possible.
In NPD processes, the design detailing and production preparation are generally completed before production and sales commence. Depending on the type of product it may be first produced and then sold, or produced on client order.

3. Concentric development versus aspect design
Compared to NPD, in housing development the design of the 'product' is developed differently. First, an architect creates the basic 3D design, which is then elaborated by an engineer and construction advisors to make the design production ready and compliant with all regulations. The design of housing starts as an aspect design, which is then modified and optimised a number of times.
In NPD best practices, different aspects of the new product are considered from the earliest design phases, and gradually detailed during the process. The design evolves in a concentric way from global to detailed. Optimisations are used to improve certain aspects of the design (Design for X methods).

4. Preparation activities in the development process
In NPD theory, preparation activities before the start of the development phase are more thorough than those found in house-building practice. NPD theory suggests forming a business case at the start of a development project, stating business possibilities, forecasts and risk analyses. This then results in a detailed design brief. In house-building projects, only a rough financial feasibility study is done, and a basic program of demands is made. Risk analyses exist in the building industry, but they are not used in housing development.

5. End user configuration options in the development process
In housing development houses are being designed without end user involvement. Designs are based on general insights and the architect's preferences. Buyers are allowed to specify individual preferences after acquiring the premises, in consult with the developer. These preferences are not pre-specified, and have to be individually planned in construction preparation.
In NPD processes of consumer products, it is common to consider target groups and research their needs by market research, either before or during the development process. Their preferences are considered in the development of the product, and possible configuration choices (as in cars) are largely predefined.

6. Management of the total development process
Compared to housing development, in NPD processes the responsibilities for the management of a project are more clearly defined and during the project more control measures are taken to ensure the project will deliver the designated results. It is common to form a project team with a projectleader

who is responsible for the project from beginning to end. To facilitate internal communication, the multidisciplinary project team consists of members from all relevant disciplines.
In house-building several people are in charge of the project during the consecutive development phases. From development to realisation the design of housing is the responsibility of a project developer, a project manager and a project leader. Development and construction are separate processes. Despite internal meetings there is no deliberation about design problems that need to be solved.

7. Supplying and contracting
Both in NPD and house-building businesses, suppliers are contracted to carry out production activities, but their position and responsibilities differ.
In house-building decisions on components to be used and subcontractors to be hired are made in the work preparation phase (i.e. after the design and sales phases). In the development phase, practically no component decisions are made and no suppliers are involved.
In NPD it is common to involve suppliers early in the development process, contracting out the production of certain parts as well as the related development activities. These practices have led to the forming of co-makerships, where suppliers share a responsibility in the development process.

5. Implementing NPD best practices in house-building development processes

5.1 Potential improvements to development processes in house-building

Based on the outcomes of the problem analysis on house-building development and the comparison of the two development processes, it can be concluded that adopting certain ideas from NPD could potentially improve the development processes in the (Dutch) house-building industry.
To significantly reduce costs and improve the quality of housing development processes, a more integral development process is necessary, with more attention to preparation and collaboration in development activities. To realise an integral development and building process, improvements can roughly be divided into three main areas (Figure 2):

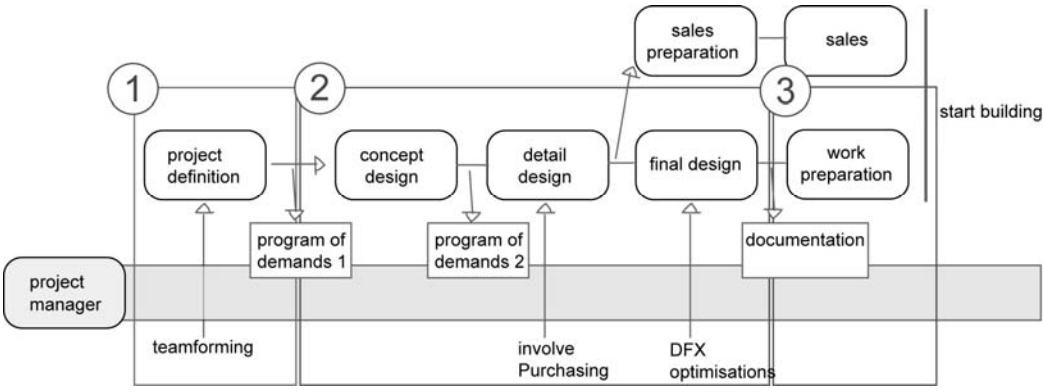

Figure 2. Focus areas for implementing NPD practices in housing development

1. Executing preparation activities in the project definition phase more thoroughly
Before the start of the actual design process, several measures have to be taken taken to ensure the integral execution of the development process, and to reduce the risks and errors associated with the current execution of projects.
This involves carrying out a comprehensive risk analysis to identify potential problems in several areas (regulations concerning the building location, financial pitfalls, collaboration of the involved subcontractors), setting up a thorough program of demands, and identifying possibilities for shared development (co-makerships).

2. Closely managing the development of the design

A development process in which all parties are more closely involved in the main process offers opportunities to reduce design and construction errors and shorten the time to market. Essential in the forming of a multidisciplinary development team is a project manager who oversees the development of the design during the total process. In addition, executing design reviews and involving suppliers in the development phase can improve the efficiency and quality of the design process.

3. Improving the preparation of the actual construction phase

To reduce costs in the actual building phase measures should be taken to speed up the on site construction. Since the actual building activity accounts for 50-60% of the cost of realising new housing, by far the largest share of the total cost of a project, eliminating errors and delays during this phase is essential to substantially reduce failure costs.

On the one hand this can be done by fully detailing the design before commencing the sales phase, including specification of possible buyer options. On the other hand, it is important to complete the building preparation phase before starting the actual construction. This means ensuring that all involved parties know what to do, and that all activities are planned and coordinated.

5.2 Implementing ideas and practices from NPD

In the previous paragraph potential areas for improvement were identified. After a thorough research of the real world housing development process, it can be concluded that several ideas and practices from NPD can be implemented in housing development. In this paragraph the implementation of key issues will be elaborated.

5.2.1 Preparation measures in the project forming phase

First, a more thorough program of demands can be adopted to direct and control the development process. This will serve to:

- Communicate the goals and guidelines of the project to all involved parties;
- better guide the design development by checking the design with the program of demands during the process;
- reduce the number of design changes during the process and improve the quality of the design.

Rosenau opts to formulate the program of demands in two phases [Rosenau 2000], which can also be implemented in housing development. As a first step, results from market research and project analyses can be translated to a first idea of what type of housing has to be developed. The involved architect can assist the project developer to define the functions of the product qualitatively. After the first concept design is created based on these guidelines, the demands can be translated to specifications, to quantitatively define the requirements that the new housing will have to meet.

Next, to achieve better integration of functions and activities within the development team, contracts focused on integral development can be used. For a start, the external members involved in the development can be made joint responsible for the end results through the use of ‘alliance contracts’. Furthermore, with suppliers who are willing to take on part of the development of the new housing project, or even a series of projects, co-makerships can help share costs and speed up the development process. These types of collaboration are currently known as ‘partnering’ in the building industry.

5.2.2 Managing the development of the design

To achieve an integral development process and facilitate communication between all participants, a multidisciplinary development team should be formed. This has to consist of members of all main disciplines, including an architect, an engineer, a constructional advisor and a project developer. The team will share the responsibility for the first concept of the housing, and for overseeing that attention is paid to all aspects of the design during the development process.

The development team should be led by a project manager, who will be responsible for coordinating and directing the development and building process from start to end. While in construction

companies the project developer is responsible for the commercial aspects of the project, the project manager has to ensure the successful execution of the development task. This means:

- The monitoring of progress and checking integration of all aspects in the process;
- The coordination of decision making in the design process;
- The stimulation of communication between the involved departments and contractors.

Next, moving the purchasing function from the construction process to the development phase will make it possible to find design solutions using available knowledge in the supplier market. This approach will improve the integration of third party elements, like installation systems, into the design, and offers the possibility to lay down the complete specifications for the housing earlier in the process.

Finally, cost reductions in the development process can be achieved by introducing design reviews in the final design phase. Design for X-methods as known in NPD can be used to optimize the design on several aspects. The design can be optimized in reference to:

- Ease of production and building logistics;
- Configuration options for individual buyers options;
- Performance requirements as formulated in the program of demands, like ease of disassembly, isolation performance etc.

These reviews can be carried out by introducing the relevant specialists (construction project leader, sales representatives) in the development team at this stage.

5.2.3. Preparation to the construction phase

The best possibilities for immediate cost reduction in housing development are in adopting production practices in NPD. Instead of starting sales when only a concept design has been created, fully detailing the design prior to production will improve the quality and speed of the construction process. This means defining upfront how to build the design, what components will be used, and which options are available to buyers to personalise their new home.

This way work preparation for construction can start parallel to the sales phase, offering more time for planning and optimisation of the on-site construction work.

By standardising buyers' options for personalisation, these individual configurations can be integrated in construction planning. These options can be predefined based on consumer insights and experiences from sales representatives.

Although these measures mean construction companies will have to invest more time and money upfront, it can dramatically reduce both total development time and the number of design and construction errors.

6. Conclusion

The preliminary study showed that development processes in construction companies and industrial product manufacturing companies are comparable, although a number of key differences in current practice were identified. Several key differences offer opportunities for construction companies to improve development processes. Adopting certain NPD practices may potentially improve processes and solve observed problems in house-building development.

Changes to current construction processes may lead to the following improvements:

- The occurrence of design errors will be greatly reduced by using a more integral approach to the design process, including optimisations and design reviewing. This leads to fewer design changes during work preparation and building phases.
- Chances of construction faults and planning errors during the building phase are minimised by paying extra attention to work preparation, thus improving build quality.
- A reduction of development time can be achieved by involving suppliers as early as the design phase and by specifying exact components already during the development phase. Also, executing sales and work preparation activities at the same time and putting more energy into preparation of the building phase will shorten the realisation process.
- As a result, reduction of the overall costs of projects, particularly in the building phase.

Besides cost reduction, adopting certain NPD practices in the development process offers more potential benefits. First, a reduction of design and build errors means the quality of the final product will be improved. Next, a more integral approach to the development process offers possibilities for improving the quality of the design. Multidisciplinary development can lead to better integration of functions and aspects in the housing design, and by involving purchasing in early design phases, product innovation at suppliers can be implemented more easily.
Some of the proposed practices can already be implemented within the current setup of development processes in house-building. However, full implementation of the suggested integral approach does require changes in the current business processes of construction companies.
The project reported here was a preliminary study based on findings in the Dutch situation; further research is required to get a more thorough view on the validity, benefits and consequences of the proposed changes to the development process in construction companies. As mentioned before, these findings cannot be automatically generalised to other countries.
Although this preliminary study did include researching the possibilities for implementing certain practices in the house-building development process, further research will be needed to clarify how construction companies will have to modify their business processes and working methods to accommodate these practices and effectively realise the potential benefits.

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