

DESIGN MANAGEMENT LESSONS LEARNED FROM TWO STUDIES IN NEW PRODUCT DESIGN

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Abstract

This paper addresses a number of issues that were identified during two interview studies carried out at a middle sized industrial company Hägglunds Drives AB (HDAB) in Sweden. HDAB is expert at hardware design and have an excellent reputation for high quality products. The two studies concerned two hardware development projects carried out by HDAB starting in the early 1990: s.

The objectives of the studies were to identify the value judgements used, design criteria, to review the expectations and outcomes and to learn lessons for future work. Additionally, the studies would be able to identify the managerial issues that significantly affected the design activity such as new software, use of design methods, planning and resource allocation. Furthermore, it was possible to identify obstacles to the incorporation of customer requirements.

Interview studies were carried out consisting of 16 taped interviews. The interviews were transcribed and studied to identify the collective opinions of the interviewees. In addition many more informal conversations were carried out with HDAB designers, market and after market representatives, sales representatives and others.

The interviews were analysed using a Person-Product-Process-Press framework as developed in the field of creative problem solving.

Keywords: industrial case study, industrial applications, design projects, introduction of methods, barriers to implementation

1 Objectives

This paper addresses a number of issues that were identified during an interview study carried out at a middle sized industrial company, Hägglunds Drives AB (HDAB) in Sweden. HDAB is expert at hardware design and have an excellent reputation for high quality products. The two studies concerned two hardware development projects carried out by HDAB starting in the early 1990:s. (These will be referred to as project A and project B in the remainder of the article.)

The objectives of the studies were to identify the value judgements used to design the products, to review the expectations and outcomes and to learn lessons for future work.

Furthermore, by studying two projects that had been undertaken by the same company in series, it was possible to identify what had been learned from the first project and incorporated into the second project. Additionally, the studies would be able to identify key the managerial issues that significantly affected the design activity.

2 Method

An interview study was carried out consisting of 16 taped interviews. The interviews were transcribed and studied to identify the collective opinions of the interviewees. A full transcript of each interview was made available to each interviewee and the collated findings were discussed both individually and in groups. In addition many more informal conversations were carried out with HDAB designers, market and after market representatives, sales representatives and others. Naturally these diverse people have in part very different opinions about design criteria and their relative importance.

The data collection and data analysis were carried out using the 4Ps model (Figure 1) developed in the field of creative problem solving [1], [2]. This framework was chosen because it is well established and results can be compared with other studies. The framework has allowed clustering all information in four groups as specified in figure 1: person, process, product and press. The person strand involves the people, their skills, motivation, way they are organised, etc. The process strand includes the way they work, methods and procedures they follow, tools they use, etc. The product strand represents the characteristics of the aimed product. The press strand includes the factors that define the working atmosphere and company culture.

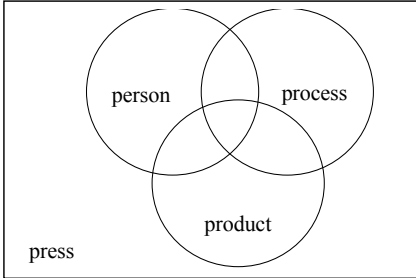


Figure 1. The 4Ps model

3 Results

3.1 Product related criteria

Differences in product related criteria between project A and Project B may be found in Table 1.

Table 1. Criterion differences related to the “Product” variable.

Product	Project A	Project B
Type	innovative	adaptive
Type change	step	incremental
Design criteria	sufficient	expanded

3.2 Design Criteria

During project A product development relied on:

- High quality personnel selection
- Lab tests of critical technical details
- Theoretical motor models
 - L10 service life
 - Efficiency
 - Torque
 - Speed

During project B, in addition to the above they also included:

- Quality Function Deployment [3]
- Modular Function Deployment [4]
- Failure Mode and Effects Analysis [5]
- Field tests

The criteria used for product assessment in project A were:

- Cost
- Efficiency
- Torque
- Speed
- Size

In particular the objective was to design a small coupling of high technical capacity. In project B, the emphasis was on minimising the number of components and inter-usability of parts.

The two development projects were very different in nature. The first project was necessary because HDAB needed to modernise the technology, it dealt with new and innovative technology, the development team was small and the project leadership was well defined. The other project was started for different reasons and involved the same or similar technology, the development team had become larger, the leadership had changed and the timetable had shrunk.

People had in part very different ideas as to what constitutes “good design” just as everybody had differing ideas about good production, marketing and management etc. This was especially apparent in project A since it was a much more open project and its outcome was much less predictable than was the outcome of project B. The differences in that respect between project A and project B are not surprising since according to Lyttkens [6] innovation often involves larger costs of identifying relevant information. Few companies today have a clear idea about the cost of identifying new information and can therefore not measure the productivity of the employees accurately.

3.3 Press related criteria

Differences in press related criteria between project A and Project B may be found in Table 2.

Table 2. Criterion differences related to the “Press” variable.

Press	Project A	Project B
Top leadership	very strong	less defined
Project leadership	strong	varying
Impl. of new tools by	consultant	consultant
Time	appropriate	short
Budget	no constraint	little constraint
Academia contact	good	improved
Consultancy contact	good	improved

3.4 Obstacles to the incorporation of customer requirements

HDAB sell their products to two main types of clients: end users and OEM clients who sell on to end users. After the warranty has ended HDAB sometimes handles the support of the motors for the end users and sometimes that is taken care of by the OEM client. In the case of a sale directly to an end user it is most common that HDAB support the motors after the warranty period has ended. It is often easier to capture customer requirements and opinions about existing motors from the customers/end users who bought the motors directly from HDAB. That is not true to the same extent for reports gathered from OEM clients and in turn their clients, the end users

HDAB use “Non Conformity Reports” (NCR) overseen by one person. Both sales people and customers send NCR’s to him although sales people do it more often. They may report that the error concerns piston when somebody else reports the same error as piston ring trouble. Therefore, the same fault may be reported as two different faults.

There is no way of knowing how many of the smaller errors are fixed in the field without NCR’s ever being sent. One of the interviewees said he feels it is probably close to all of them. In addition, if a second NCR comes from the same person because the suggested solution did not work, then they have no way of linking the two together in a database, the only connector is the personal contact. This is potentially dangerous: The system is built solely on one person without any backup and there is no way of seeing what is being done

about the problem short of talking to that person. Whilst this solution may appear to work rather well it is doubtful if it will work well if the company expands.

The same system of keeping knowledge with certain people is also true in the Marketing Department. HDAB have sales companies (wholly owned by HDAB) in many different countries. The Marketing department meet a lot of these companies and the end users all over the world and do a good job. However HDAB have no system in use today to track the wishes of the customers, the salesmen have to discuss it among themselves to form an opinion about it. A possible tool that would be helpful to base such documentation on is Sounders [7] Customer-Developer Conditions model which highlight the needs of the customer and their level of awareness of their own needs.

3.5 Process related criteria

Differences in process related criteria between project A and Project B may be found in Table 3.

Table 3. Criterion differences related to the “Process” variable.

Process	Project A	Project B
Modelling tools	2D	3D
Information handling tools	folders	PDM system
Engineering Design tools	none	adaptive tools
Decision making tools	few	improved
Planning	good	worsened
Customer contact	somewhat indirect	quite direct
Subcontractor contact	good	improved

3.6 Project management

The first project had a very strong leader in the (now former) president. The authors’ view, based on the interviews with the employees, is that he used situation based leadership that involved a blend of different leadership styles. However his personal style seems to have been based on enthusiasm and quite a bit of authority. This led to some dislike from some employees who felt that their views were not taken into account properly. On the other hand, a firm approach may have been needed to lead the A project due to the open nature of the work.

It became necessary for Hägglunds Drives AB to vary the leadership in the second project. The first manager of project B agreed to start the project and complete the preliminary studies before returning to his principal job. A second manager was appointed, but he left the project. The first manager then agreed to return to finish the project.

3.7 New software

When project A started HDAB used a 2D design program. A new 3D Computer Aided Design (CAD) program and a new Product Data Management (PDM) system were introduced early on in project B (1999). SolidWorks was chosen by Hägglunds Drives to be their CAD software. Hägglunds Drives AB is also using "Smar Team", which is the PDM-system (also sold by the SolidEdge) it handles Word, Excel, and all other such documents. One effective feature of Smar Team used by HDAB engineers is that one may use it to store and organize Auto Cad drawings.

Additionally HDAB use a second CAD system for modelling. The company is engaged in further exercises to ensure that both software systems function well together in a compatible manner.

Therefore, staff of the company has been engaged in a significant programme to learn new software and to integrate different software systems. Project A benefited from a CAD system that was familiar to all. However, in project B, engineers had to learn new systems in addition to creating new products, albeit that the new systems were potentially more powerful.

3.8 Use of design methods

During project A very few (formal) design methods were used. Tools such as pie graphs and histogram were used to plan and manage the number of motors to be produced and sold in different market and different applications. Project A was instigated with a thorough preliminary study and its result was followed up throughout the project.

When deriving the design specification in project A appropriate specialists scored certain functions in the range 1 to 5. The scoring was done in house after discussions with clients. In project B a similar process was used except that it was more developed and structured. In project A HDAB hired consultants to help with the idea generation for new motor concepts. One of the lessons from project A was that more engineering design tools were needed to better judge the worthiness of product concepts and to track the project once started. In project B HDAB hired a consultant to introduce the MFD, QFD and FMEA tools. That HDAB identified this need of new competence especially during the first project was interesting and somewhat surprising. The MFD method was well suited to project B since that project dealt with well known technology, previous motor models were redesigned rather than designed from scratch. One did not use all of the originally intended engineering design tools mainly because it took a lot of time to properly use MFD. Everybody were quite happy to have employed such an engineering design method. All relevant employees now appreciate the good results that appropriate engineering management tools can produce. The result certainly shows in the product itself – the Hägglunds Drives AB CB motor. The two studies showed that HDAB are experts in detail design and somewhat less sure of their own abilities when it comes to the early phases of product development. Therefore if anything, tools to help explore problems as well as tools for developing and selecting concepts might be of interest.

It is also important to understand that HDAB has a very long history in designing hydraulic motors and this knowledge permeates the company so that a design culture exist, albeit not defined in the HDAB product design plan. HDAB is embarking on an ambitious program to further develop project management tools, a proper selection of engineering design tools (More commonly known as engineering design *methods*)

3.9 Planning

Should HDAB grow in any large extent the size of the organisation will demand structured ways to plan and manage their work. Traceability of documentation is required. Edvinsson & Malone [8] identifies that not only is it necessary to document success stories but also to document failed projects since such experience also creates new knowledge and experience for those involved. Formalised methods for identifying critical points in the product development process (in order to check that all preceding decisions have been made before passing a critical point) would be beneficial.

Marketing and planning (both internally and externally) the different stages of product development are important according to the interviewees. Matters relating to planning were mentioned by several people. For example, it is felt that HDAB hurried into production after design and redesign of the piston. Another point was the time required for testing; in order to get statistically safe data from tests in the lab or in the field HDAB need to organise their tests carefully and not be rushed.

In both projects the criteria used were appropriate and sufficient to make a good product. The criteria, in addition to cost and weight, included a group of technical demands on the product. Had less knowledgeable people worked on the product it may have been beneficial to use a systematic method to (better) quantify and determine their relative importance. In both projects determining the relative importance was done by reaching consensus after a number of discussions.

People in both design and marketing departments feel that individuals tend to step into other departmental domains too often. Engineers thought that some product would not sell while sales people decided that a technical solution was wrong. Sounder [9] suggest ways to identify the type and level of problems occurring in the interface between R&D and Marketing divisions and recommend ways for increasing project success rates by improving the conditions at the R&D/Marketing interface. To do this becomes increasingly important for several reasons. Landry, Amara and Lamari [10] have provided strong evidence that “diverse forms of social capital” influence the decision to innovate or not. In addition Landry, Amara and Lamari indicate that social capital as well as the number of different advanced technologies employed by firms for production determines the radicalness of innovation which in turn affect the competitive advantage of the new product.

The customer contact should be managed so that different people from HDAB do not contradict one another. The Marketing department felt that their cooperation with the Design department with regard to the customer contact, while good, could have been better during project A. It is also felt that this cooperation improved during project B. This view is also seconded by the Design department.

3.10 People related criteria

To identify key personnel and keep them working on the most important assignments will probably be critical to the continued growth of Hägglunds Drives AB. HDAB is a small company, one of its strengths is that everybody knows each another. This makes it possible for management to select the right people for the right job. People have often worked their way up through the company ranks giving them thorough knowledge about the company and its practices. All employees have a technical background; they either have an extended high school degree, a Bachelor of Science degree (BSc) or a Master of Science Degree (MSc). It is

seen as a step up (career wise) to be assigned to the sales division. Sales people make more money and the people at the sales department get to travel more than others.

People employed by Hägglunds Drives AB commonly stay on for very long periods of time. To have a loyal work force is beneficial to the company since the knowledge is kept and developed within HDAB. However, there is also a threat; there is little incentive for HDAB to develop systems to keep the competence within the company. Such a system would be of importance in case of an increase in turnover or increased rotation in the workforce.

Comparing project A and project B (Table 4) one notices some people related differences between the two projects.

Table 4. Criterion differences related to the “People” variable.

People	Project A	Project B
Group size	small	double
Control group	very active	less active
Education	varying	varying
Experience	large	improved

3.11 The 4P model

The 4P+N model (which is built on and closely related to the 4P model used in this article) presented by López and Thompson [11] has recently [12] been proven to be a helpful tool by which one may identify and organise changes to a product development process. In this project the 4P model has by the authors been found to be a helpful tool by which to identify and examine criteria in a retrospective study of a product development project.

4 Conclusions

This article has come to be about management related issues in design of a hardware product. Management and management style have a significant effect on project success. Several management related issues were identified as having had significant effect on the outcomes of the projects studied. Management style and the incorporation of new design software have certainly affected the projects. In addition, use of engineering design methods have been identified by Hägglunds Drives AB as being important, especially tools to explore problems and develop and select product concepts.

Comparing projects A and B, it is clear that the project A benefited from continuity of leadership. The changes of leadership in project B meant that objectives were less clear and that they varied according to diverse subjective criteria. It is advantageous to set clear project objectives that are not allied to personal goals.

Whilst all companies must introduce new software to maintain their competitiveness, this process must be carefully managed. In the case of project B, (although the software used was much more powerful than the software used in project A) the engineers had to learn new systems and simultaneously create new products. Such a process is unadvisable.

The lessons learned from project A were that more engineering design methods should be used. HDAB recognised that their expertise in detail design would be advantageously augmented by additional tools. In project A, they used consultants for ideas generation. In project B the company recognised the need for project management tools, OFD and FMEA, and obtained external support in this respect. HDAB did well in realising the need for further expertise and when they selected the proper consultants. Therefore, a major lesson learned was the need to continually develop competence in a wide range of design and design support methods.

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