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LESSONS LEARNED FROM A WANT BASED NPD PROJECT

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1. Background

The small sized enterprise Careva Systems AB is specialised on positioning equipment for safe and comfortable transportation of disabled children in cars and vans. In June 2002 the company concluded that its existing main product line - a harness system supporting body posture for disabled people - was not possible to sell to the large public transport sector (Björk 2003). Dialogues with drivers from this target group in Great Britain revealed the opinion that the existing products were too expensive, difficult to use (fasten), and difficult to store in the vehicles when not used for transports of non-disabled passengers. It was also found that the interviewed drivers and managers wanted a cheap, simple and universal solution to ease problems with transporting disabled passengers. They - and Careva - knew of no other products or solutions that directly solved or could solve the expressed wants although other solutions existed. The expressed customer want – which was not a need in their view - resulted in a desire to create a new and simpler solution than the existing Careva solution, which could not be re-engineered to suit the public transport sector.

2. Paper disposal

This paper first briefly deals with the terms need, want and wish after which the concept of Dynamic Product Development (DPD) is briefly described as DPD played an important role in the project. Thereafter the creation and development of some functional solutions for the public transport sector is described. At the end of the paper some findings and conclusions are drawn. Both authors have from the start until when the paper is written in December 2007 done Insider Action Research (IAR) (Björk & Ottosson 2007) on the NPD project. Author Björk has been project leader all the time while author Ottosson has been responsible for the administration of the project. He was also brought in as "guest" developer from September to December 2007.

3. Theory

3.1 Needs, wants and wishes

Most well-known product development (PD) models – as Integrated Product Development (IPD), Simultaneous Engineering (SE), Concurrent Engineering (CE), and Stage-Gate® - are parallel within each development stage. Often each stage is separated by gates/decision points. Iterations can be done within each stage but not into earlier or later stages. Common for these models is that the PD process starts out with first finding a "customer need" or simply a "need". Next step is to plan the PD project. Then - or in parallel - the project team is set up representing different knowledge areas. According to common definitions, projects shall be completed at a fixed finish *time* (T), at a predetermined *performance* (P) or quality (Q), and at a specified *cost* (C). These three measures form the PCT or QCT project triangle (as Q is a sub-set of P it is better to use P than Q for PD projects).

In most western larger corporations and in PD literature there today exists a view that without an existing customer or market need, no PD project will be successful. The "need" is in general seen as an existing need or problem that can clearly be stated. Historically the engineering design pioneers Olsson and Hubka also included a wish, a dream or a market want under the term "need". However, when a term covers everything it does not support the development of theory and methods. We therefore have found it meaningful to distinguish between a present need, a want and a more distant wish. As we see it, incremental innovations often are based on satisfying a *want*. Radical innovations often are based on satisfying a *wish*. The relevance of using the three terms - and not only a *need* for everything - is that the conditions for *want* and *wish* based PD differ much from *need* based PD for which the well-known PD models initially are designed. Some differences between the three PD driving forces mentioned are shown in table 1.

Table 1. Three types of backgrounds for product development causing different circumstances for PD work (based on Holmdahl 2007)

Driving PD force	Characteristics	PD target	Planning	Stable conditions	Unstable conditions
Need	Knowledge and solutions exist to re-use for an existing need	Fixed	Fulfil plan	Yes	No
Want	Knowledge and solutions are incomplete to solve a new want	Moving	Adopt to the situation	Partly	Partly
Wish	Important knowledge and solutions do not exist	Vision	Create, make and test	No	Yes

For PD projects based on a market *need* the time factor is crucial as the need/problem already is there and that the risk of competitive solutions to occur is great because of that many competitors have or can get the same information. The price is the second most important variable as many similar solutions can appear on the market meaning a price competition. In turn that means a demand for low PD and production costs as well as effective logistics. CAE (Computer Aided Engineering) is key to efficient and effective development using known knowledge and solutions to work further from. To find out market *needs* the most used method seems to be the QFD method (Quality Function Deployment) combined with a representation in the form of a "House of Quality".

For the development of products or other solutions that are based on *a want* the time factor does not have the same importance as for *need* based development. Investigation tools, as QFD and market investigations, seldom can be used as there is no reference for the market to known solutions. To find out *wants* for a near future - as well as to create *wishes* for a more distant future - unstructured interviews and dialogues with people on the market often are used. Other ways of finding *wants* - and *wishes* - are to encourage people to express their views e.g. on web pages, to study trends and research findings, to have creative meetings, etc. The planning of the development is difficult and can only be done for short periods of time. Time-to-Market is not crucial. Also Time-to-Market is totally dependent on how fast efficient and effective solutions are created. The demands on performance are the same or higher as for *need based* development. In the early development stages creativity is utmost important and are other methods than CAE needed when known solutions cannot be used. Iteration backwards without limitations is needed when problems occur – when taken milestones are lost. Especially lead users (von Hippel 2005) can initially in the development process make important contributions.

For products or solutions that are based on a *wish* the time and price factors are less important as few – if any - solutions exist to use for the development. Key people in the development of an early concept are often highly qualified and creative researchers and inventors.

Both for *want* and *wish* based PD, initially the team often has to take decisions based on very little and/or unreliable data. In turn that often results in reaching “dead ends” and a frustrated team that has to go back in what can be described as a PD labyrinth to make a new start. In this situation the leadership is critical for if the project – of psychological reasons -will be successful after the new start.

3.2 DPD

To cope with both increasing complexity and unstable conditions in NPD dynamic methods – such as Dynamic Product Development (DPD) - are being developed. DPD is a user-centred philosophy which relies on a learning strategy where knowledge is gained through exploration of multiple possibilities. Typical for DPD is an iterative refinement of the developed product coupled with detailed short range and rough long range planning. In the turmoil of unstable conditions, DPD proposes a number of rules of thumb that, being taken together, form a structure that help team members to develop products at high speed making them “right” at delivery time. To cope with complexity and unstable situations DPD recommends that the project leader is mentally and physically in the centre of the development in order to gain immediate feedback from the development activities and to take counter measures when necessary. A new organization form called “Planetary Organisation” is designed to support this view.

To quickly find useful abstract solutions on difficult needs, wants, and wishes DPD recommends to use BAD (Brain Aided Design) supported by known creative methods and dialogues (Ottosson 2004). To concretisize and quickly evaluate the solutions PAD (Pencil Aided Design) and MAD (Model Aided Design) are then used. Frequent tests on the models - made in as soft material as possible – is recommended and the more MAD & test sequences per time unit the faster functional solutions will be the result (Schrage 2000). First when – and normally after many tests - a functional solution has been found, it is time to use CAD (Computer Aided Design).

The DPD concept defines three product values:

- Functional product values (values corresponding to effectiveness and efficiency in solutions)
- Perceptional/sensorial product values (values responding to inputs to our five senses)
- Image values (trademarks etc corresponding to social and economical interests)

Before the functional values have been satisfied with useful solutions, in principle it is a waste of time and money to work on the perceptual/sensorial values and even more so on the image values. Further, successively only one main and 2-3 secondary demands shall be worked on simultaneously. When they have been solved new main and secondary demands should be worked on until a large number of demands have been satisfied. Thus a large number of demands to work on simultaneously is not recommended according to DPD. If a problem can be divided in parts the same principle is due for each sub-problem.

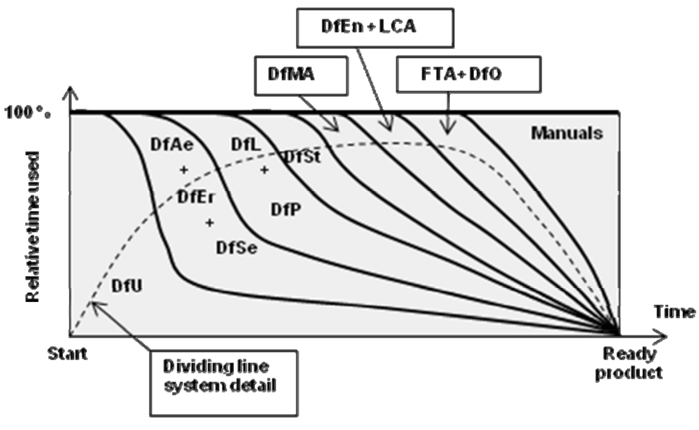


Figure 1. The order in which a new technical product is preferably developed (Ottosson 2006)

A principal example of the order in which the different Design for X (DfX) topics are worked on in DPD is represented in figure 1. In the picture there is a dashed line. Above this line system design takes place while detail design is done under the dashed line. As seen in the figure, DPD focuses initially on usability in solutions (DfU – Design for Usability). In turn that requires - for optimal solutions - cooperation with representatives from the potential user groups. Thereby, the problem of the designers unknowingly incorporating un-necessary complexity into devices, interfaces and instructions automatically is reduced. Further, that means reduced risks of imbalances between product demands and the mental and physical resources of the users. Thus, the idea is that the PD process already from the start of the project should incorporate user requirements, user goals and user tasks into the design of a product. A benefit from this is that early in the design process needed changes can be made at a low cost.

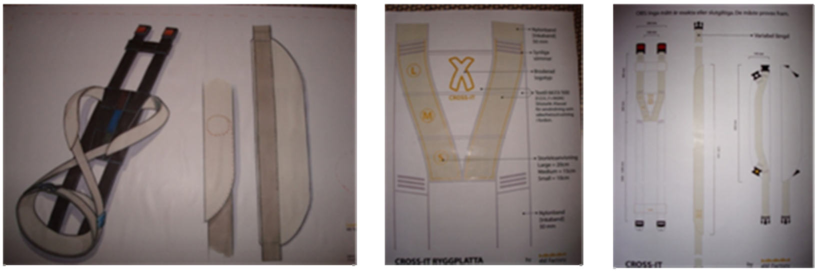
4. The want based project

The customer *want* – expressed as "we want a more universal solution of your individualized solution" – initiated a decision to try to develop a new product for the public transport sector. As DPD suggests, a number of BAD –PAD – MAD attempts were then done using parts of existing products and soft loose material as paper, plastics, textiles, rubber tubes, etc to test the different ideas that were generated. On the 23rd of January 2003 these attempts had led to the principal solution shown on the left sketch in figure 2 (Björk 2003, p105). The first model is shown in the second picture of figure 2. In June 2003 the situation was as is shown in the middle picture of figure 2. In September 2003 the lower body fixation had got a new solution (see the third picture in figure 2). After a number of modelling attempts and consecutive tests a functional solution had been reached that led to patent investigations. A patent attorney also got the commission to work out a patent application. On the 15th of October 2003 a Swedish patent application was filed. However, as the work on the patent application together with documentation was money consuming the PD work had to be put on hld.

Figure 2. The PAD and MAD of the NPD project until December 2004 (Björk 2003 p 105)

When the work was taken up again, early in 2005 it was found that the solutions shown in figure 2 did not function well in tests on disabled users. The problems were e.g. lack of effectiveness in posture and lack of fitness and efficiency. The first "dead-end" in performance, according to the labyrinth metaphor, was a reality and further development funding was difficult to bear for the small enterprise as well as the motivation to continue the PD went down to low levels.

However, in 2005 the Swedish government had announced the year to be an industrial design year and encouraged companies to apply for support for industrial designers to participate in different PD projects. Careva applied for such a grant. With 100 % support from SVID (The Swedish Association for Industrial Designers) the first industrial designer was engaged to find new solutions especially on the upper body positioning. The existing upper body positioning solution in the left picture of figure 2 was nicely drawn as is shown in the left picture of figure 3. Drawings with refinements of the initial solution shown in figure 2 were produced (see the right picture of figure 3). The important contribution from this work was a symbol for the new product line (see the middle picture of figure 3). To continue the project more money was needed. Therefore a syndicate of five companies in Sweden and Norway was formed under the leadership of Careva. A budget for the years 2006 -2009 was agreed upon by the parties in the syndicate after which a supporting contribution was applied for from Nutek - the Swedish Agency for Economic and Regional Growth. On the 6th of 2005 Nutek decided to support the four year project with 44 % of the project costs.



October 2005

Figure 3. Examples of the result of the first industrial designers work

The solutions proposed by the first industrial designer (see figure 3) were produced as the first step after the new funding. Initial tests showed that a step forward had been reached. However, the tests showed also that the function was not good enough what regarded the upper body positioning solution. There showed also to be different problems with textiles chosen. The second industrial designer, who also was a material expert on textiles, was therefore brought in. The result was new pictures and valuable suggestions on high friction material for the seat plate. Some of the sketches are shown in figure 4. As seen no new functional solutions were proposed except for the horizontal fixation in the first picture, which unfortunately does not function for car seats as they are conical.

Figure 4. Pictures (December 2006) by the second industrial designer on the total system

As the upper body positioning still needed a new solution a third industrial designer was consulted. This designer proposed a new solution as is shown in figure 5. To test the solution the designer proposed the production of a rather expensive plastic tool. However, the principal solution was not convincing and the needed investment in tools lead to that the solutions never have been materialized.
As the project in September 2007 despite large costs had not reached useful solutions a review found out that the basic crossing principle shown in figure 2 still was the best principle but that the locking of the chest belts was problematic. Therefore a standare solution with a four way locking device was searched for – without success. As author Björk was heavily engaged in the upgrading of the standard

products of Careva, author Ottosson was asked to take over the development until January 2008 using the DPD principles again to get useful solutions and to catch up somewhat with time.

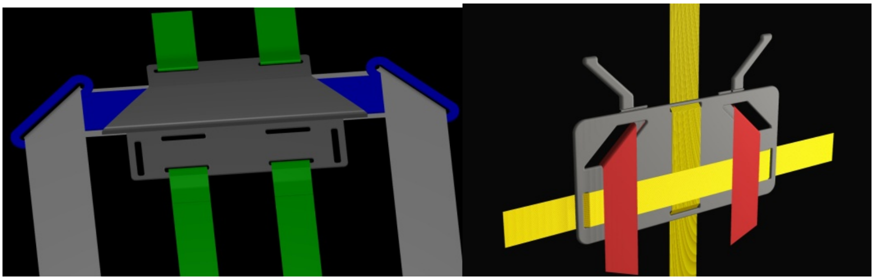


Figure 5. Examples of input from the third industrial designer what regards the upper body positioning (May 2007)

After a brain storming meeting in September 2007 with authors Björk, Ottosson, and a locking expert, a two piece hinge was designed and materialized in a simple model with tape as hinge (see the left part of figure 6). As author Ottosson was convinced that this was a good solution a CAD drawing was done which in turn was transformed to a code for water injection cutting (the second left model in the left figure 6). The material used was 3 mm ABS as this kind of material is frequently used in cars. In practical tests however the hinge had a tendency to tilt and "cut" into the stomach of the user. A solution of this problem showed to be to make one piece (the third left model in the left figure 6). Different variants of this solution were tested as is seen in the figure. Also a pure belt combination (the right part of the left figure 6) was tested. In parallel the upper fixation solution was developed so that the crossing belts could come from behind the seat instead of from the front of the seat. Some of the development steps of the fixation plate solutions are shown in the right figure 6. As seen the plate was reduced in steps to fit the testing vehicles (Saab 9-5 and Saab 9-3) often used as taxis in Sweden. However in a test in a Volvo V70 it showed that the width of the ABS plate had to be larger to fit that car. Now also the plate was - as a cheap option - taken away attaching the crossing belts to the belts that are fixed to the back rest of the chair.

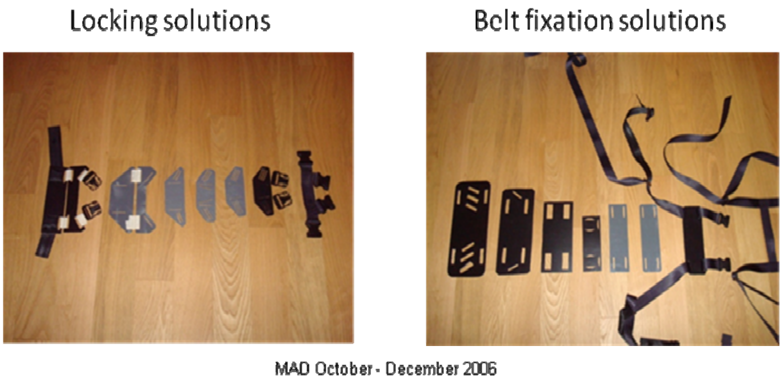


Figure 6. Some of all the tested simple models that were used on the original seat of the car (see the right picture of figure 7)

The situation at the tests in the Saab 9-5 car in December 2007 is shown in figure 7. At this stage an important detail had been added as the right picture in figure shows; the up and down adjustment of the crossing belts. The possibilities to use the fastening solution around the backrests of ten different car marks were also done by visiting two car dealers.

Figure 7. The fixation of the belts in the test Saab 9-5 car

Tests were then done on different users without any disabilities. Two examples are shown in figure 8.

Figure 8. Two test persons of the set up in figure 7. The boy is sitting in a Volvo child seat

The functional solution shown in figure 8 fulfils the demands on "normal" users. Next step is to make tests on disabled children with different handicaps. Successively and based on these tests refinement of details will be done until the final versions of the product exists. In parallel, adaptations and re-engineering of the solutions will be done for other public transport segments than taxis (e.g. buses, air planes, ferries, etc.).
The simplified performance-time curve for the NPD project from its start to the situation as shown in figure 8 is shown in figure 9.

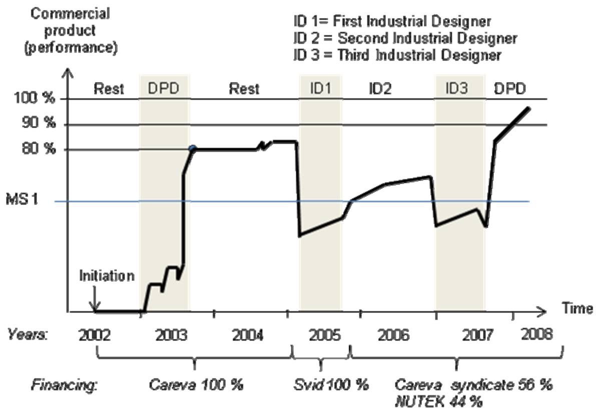


Figure 9. The performance-time curve for the want based NPD project from 2002 until 2007

5. Some findings

- As creative solutions were needed the project was impossible to plan both what regards development time and cost. An effect of this was a long unwanted stop/rest for the project from 2003 to 2005 because of money shortage.

- The tools and methods that traditional PD methods recommend and use showed not to give wanted results in this project. However, with the use of the DPD principles, and especially BAD-PAD-MAD, the difficulties were overcome.
- The nice S-shaped curves often used in PD theory did not show up in this case and e.g. the milestone at the 50 % performance level (MS 1) in figure 9 was "taken" three times and "lost" twice before a stable situation was reached late 2007.
- For the want based project still the market exist although the development time has been long.

6. Conclusions

In this want based project the traditional PD methods and tools used by the three industrial designers did not produce acceptable results why the principles of DPD had to be used to get the project back on the tracks again. The view that traditional "need" based methods can be used for all types of development situations was therefore not supported by in this project. The view that different circumstances exist for a need and a want calling for different PD approaches was supported in this project. No contradictions showed up against the distinctions used in table 1.
There seems to be no real investigations verifying S-curves. This investigation points at that the firm belief in S-curves in theoretical, educational and practical work situations should be questioned.

Acknowledgements

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