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STAGE-GATE™ VS. DPD IN SOFTWARE DEVELOPMENT

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Abstract

Product Development is complex as it is time dependent and many agents participate during the development process. When comparing the efficiency of development processes - measured e.g. in development time, cost and user satisfaction – the internal factors that should be considered are *management principles, physical environment, tools & methods, financial resources, organisation & work*, and the *people* doing the work.

To deepen the knowledge of product development mechanical field, two software development cases (web portals) have been studied. Case 1 was performed in 2003 in Gothenburg, Sweden according to Stage-Gate™ principles. Case 2 was also performed in Gothenburg during January and February of 2004 according to dynamic product development (DPD) principles. Both cases solved the same problem. Case 2 had more functionality than Case 1.

For Case 1 *Time to Sales* was 30 weeks compared to 3 weeks for Case 2. For Case 1 *Time to Ready Products* was 30 weeks while for Case 2 it was 10 weeks. The programming time was 400 - 500 hours in the first case while it was 250 hours in the second case. Thus DPD showed to be as advantageous for software development as it has been shown to be for the development of mechanical products, mecatronic products, and assistive products e.g. for disabled people.

A side conclusion from the investigations is that the traditional outsider researcher position using interviews gave only rough information of Case 1 while IAR gave detailed information and understanding of Case 2.

1 Introduction

Generally speaking, when comparing the efficiency of development processes - measured e.g. in development time, costs and user satisfaction – some important internal factors to consider are *management principles, physical environment, tools & methods, financial resources, organisation & work*, and the *people* doing the work (see figure 1). In this paper methods and the Shadowed internal factors shown in the figure will be treated for two successful software development processes to develop web portals (Case 1 and Case 2) as the other factors were quite similar for the both cases. The way of performing research on complex processes will also be touched upon.

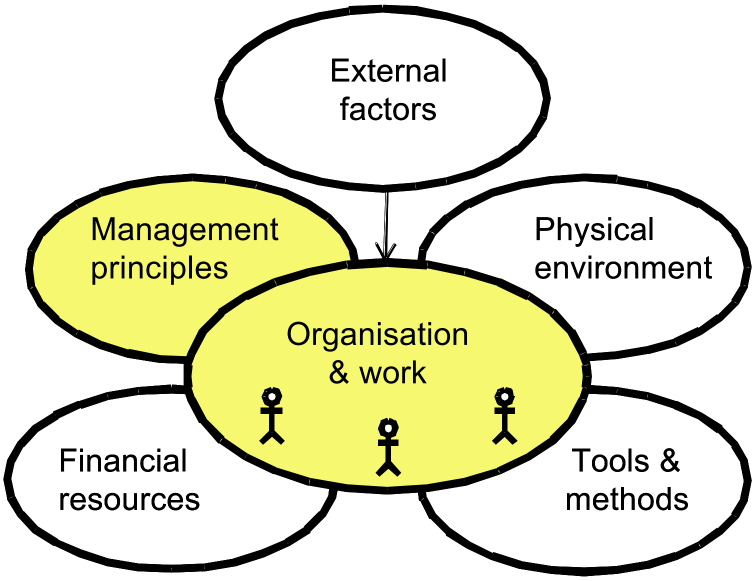

Figure 1. The efficiency of a development process is dependent on many internal and external factors [OTT-04]. The Shadowed parts will be treated in the paper.

In Case 1 Stage-Gate™ methodology was used and information on the development process was collected through interviews after the development process had ended. In Case 2 the methods of Dynamic Product Development – DPD - were used and Insider Action Research (IAR) as observer was used during the ten weeks the development lasted.

What characterises software products in general is that their commercial life time – the Product Life Cycle (PLC) - is short (often less than two years) and that the development time before Ready Products/launch can be in the range of 50 – 100 % of the PLC according to the author's experiences from industrial work. When such relations reflect reality *Time to Marketing, Time to Sales* and *Time to Ready Products* – often together called *Time to Market* - of ready products becomes extremely important for each company's possibilities to make a profit on the product. Studying development of software products can also be of interest for the development of other types of products with shorter PLC's e.g. as more and more products inherit software and as PLC gets shorter and shorter for all types of products.

There are two principally different views on product development. Philosophically they build on Classical Newtonian mechanics – as Stage-Gate™ ([COO-94], [COO-02]) and Integrated Product Development (IPD) [ANH-87] – and Quantum mechanics for dynamic product development (DPD) [OTT-04c]. Stage-Gate™ processes are today used in many larger companies in the western world although they name them individually as e.g. PROPS® for Ericsson. As the Stage-Gate™ processes in practical use often become static and bureaucratic, development turns in such cases out to be slow and costly. A growing interest therefore is at hand for dynamic principles.

There are also two principally different views on how to do research on development processes. They also build on the Newtonian mechanics view with research done from an outsider position (classical research) and Quantum mechanics with research done from an insider position (action research). When the researcher is present in a process most of the time

– in general more than 80 % - it is called Insider Action Research – IAR [OTB-02]. IAR can be done as an observer, team member and/or project leader [BJÖ-03].

2 Research

The research behind this paper was structured in such a way that the author performed IAR as observer on development Case 2 while the development took place in the Spring of 2004. After having got a deep insight into that Case he, in March 2004, interviewed the project leader of Case 1 on how that project went.

During the development of Case 2 a number of dialogues were had with Anders Meiton, who was the initiative taker and customer (through his one-man company InnovationsExpo AB) of both the products. Mr Meiton is also the Maketeer and salesman of the products. In Case 1 Mr Meitons position was that of an outsider, while in Case 2 he had access in the everyday development and could any time test the programming results.

3 Dynamic Product Development - DPD

To be able to deal with complex situations Dynamic Product Development (DPD) has been continually developed since 1994 (e.g. [OTT-96], [OTT-02], [BJÖ-03]). DPD builds on the view that it is rather a waste of time to plan in detail more than for one week, give or take a few days. Instead a clear vision, rough long-term plans, and detailed short-term plans are used. According to DPD, complex situations are difficult to foresee and simulate, which is why real tests are always needed to make good products. Recent information also tells that the more tests done per time unit, the more successful the company [SCH-00].

DPD has shown to shorten the development time of new mechanical products ([OTT-96], [OTT-04], [AGO-04]). In the development of assistive products e.g. for disabled people, the use of DPD development principles has also shown to produce good, usable commodities [BJÖ-03]. The same was the case for the development of an e-learning portal using the principles of DPD [OTT-03].

According to DPD, tests should be carried out as soon as enough good solutions exist, which is called the Pareto principle or the 80/20 principle [KOC-98]. It is especially important during the innovative development stage, according to DPD to repetitively test and adjust. Figures 2 & 3 show some characteristics of DPD.

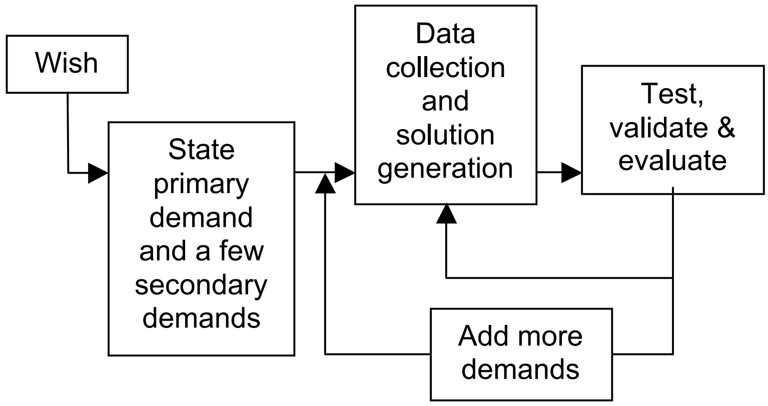

Figure 2. Performing DPD means to state the primary demand and to give the few most important secondary demands for which solutions are created and tested. When acceptable solutions are found more demands are added for which adjustments of the solutions are done and tested, etc.

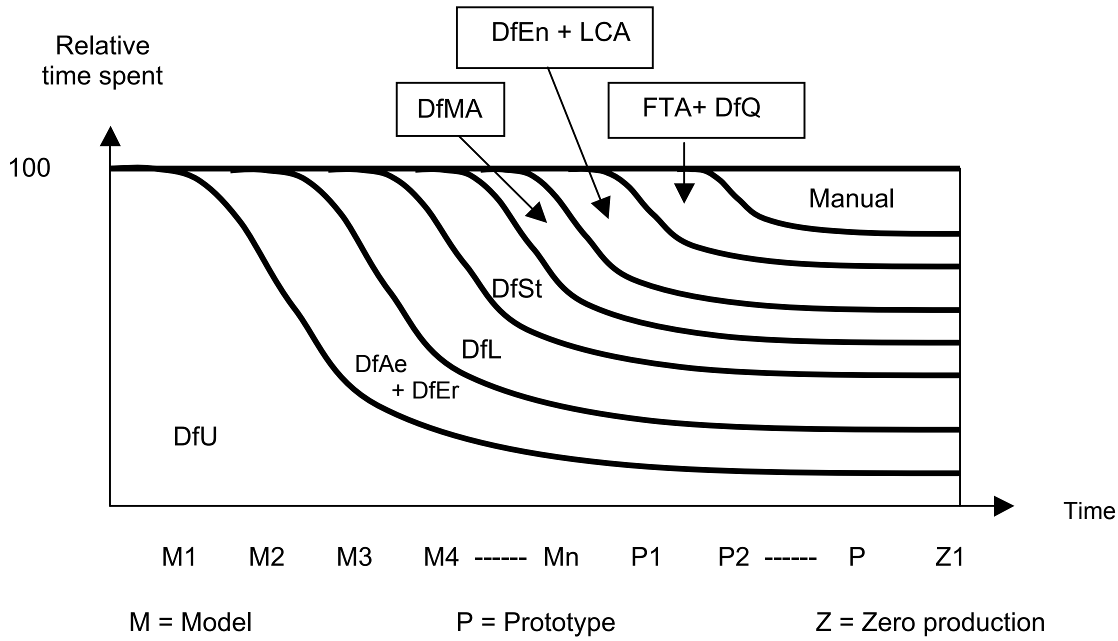

Figure 3. Using DPD from the beginning until production starts means adding demands and solving & testing them iteratively [AGO-04]. M1 in the figure means the first model. DfX stands for 'Design for X' where X is exchanged with other letters as; U = Usability, Ae = Aesthetics, Er = Ergonomy, L = Logistics, St = Stress, MA = Manufacture and assembly, En = Environment, and Q = Quality. LCA stands for Life Cycle Analyses and FTA for Failure Tree Analyses. Depending on the product to be developed more DfXs can be added to the process.

Performing innovative development of hardware products means to repeatedly think on an abstract, concrete, totality and detail level. In our research we have found three manual tools to be especially important, which we call Brain Aided Design – BAD, sketching, which we call Pencil Aided Design – PAD, and making simple models, which we call Model Aided Design – MAD [OTT-98]. When performing parametric design computers are convenient to use, which is called to make Computer Aided Design – CAD. Figure 4 shows when the different methods are used for mechanical engineering depending on the completion level of the development.

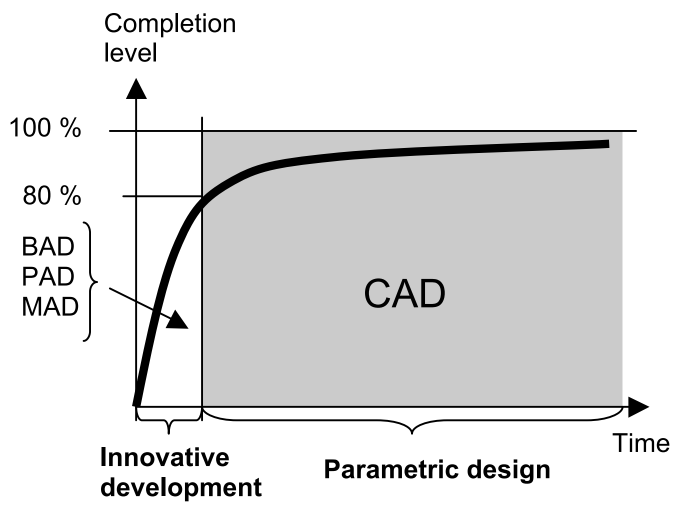

Figure 4. When new solutions are needed, it is important to start out with BAD (Brain Aided Design), PAD (Pencil Aided Design) and MAD (Model Aided Design) before benchmarking and CAD are used [OTT-03].

In the industrial world it is a common opinion that it is waste of time to “re-invent the wheel” why one should start with benchmarking existing solutions when a new product is to be developed. This leads to detail adjustments and few innovative ideas, which is why one must often discard the solutions after some time and start to be creative, forgetting the work we have done so far. Therefore one should start to find one's own solutions first, which is accomplished by using Brain Aided Design (BAD), Pencil Aided Design (PAD) and Model Aided Design (MAD). For the design of larger objects, Virtual Reality (VR) is often useful as an extended MAD-tool [OTT-02]. BAD can be seen as finding solutions on an abstract level. PAD is done to find more concrete solutions. MAD/VR is used to find whole solutions. Figure 5 shows in principle the DPD way of working in the start of a new Case and when problems occur later in the development work.

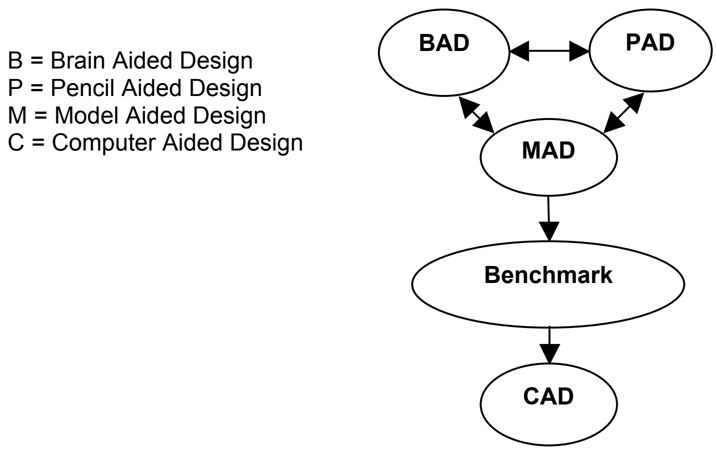

Figure 5. When new solutions are needed, it is important to start out with different non-computerised tools before benchmarking and CAD are used [OTT-04].

Investigations in Germany [PRLH-01] have also revealed that development engineers performing CAD-supported parametric design often stop using CAD when problems occur and/or when new ideas are needed, and turn to at least BAD and PAD before they can go back to CAD.

Relative time used when performing development according to DPD can be as is seen in figure 6. Note that the concept is developed all the time and that time to marketing and sales is endeavoured to be as short as possible, which is especially important when PLC is short.

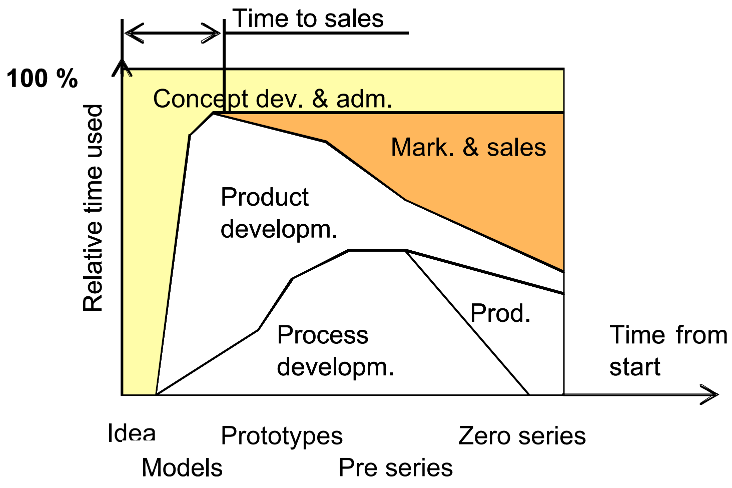

Figure 6. Performing DPD means performing many parallel activities. In this case Time to Sales and Time to Marketing are the same. Prod. in the figure stands for production.

4 Case 1

The development of Case 1 started 12 months before the start of Case 2. After and during the development of Case 2, many dialogues were held especially between the author and the customer Anders Meiton, who was also the customer of Case 1. In Case 1 Mr Meiton took part at the gates and had no insider information of the development process as the company did not, according to him, want him to interfere with the development people between the gates. Mr Meiton´s impression of the development process of Case 1 is shown in figure 7.

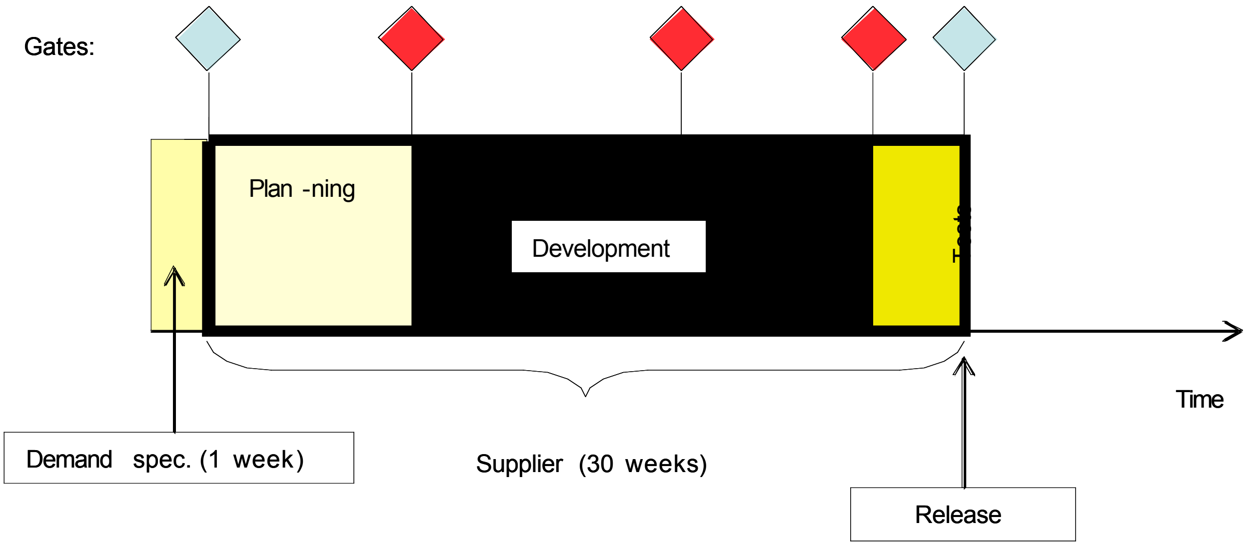

Figure 7. Activities in the first case

To control the impressions of Mr Meiton with the project leader of Case1, the author on the 8th of March 2004 performed an unstructured interview with the project leader of Case 1. The interview lasted one hour (08.00-09.00) and was held at the office of the first supplier, which was the contractor of the work.

The dialogue revealed that the company had, as a principle, to clearly separate the customer and the development people in order not to create unclear situations. To minimize problematic situations a lot of work, according to the project leader, has to be done on preparing a demand list and concept before the start of development. That in turn means that a decided concept shall not be changed during the development process.

Mr Meiton had estimated that the development time at first supplier was 450-600 hours. The project leader said that the first supplier had invoiced for 9 weeks work and 40 hours per week, which means 360 hours.

At the first supplier a skilled programmer with a Master of Science degree had been used. As he had other things to do while the development project took place, his work had been spread over 30 weeks. During the job Mr Meiton could log in and check the work proceedings.

Mr Meiton said that, in his opinion the database development had preceded the development of the Graphical User Interface (GUI) and that the time they could spend on developing it at the end of the Case was not enough. This was not the view of the project leader of Case 1.

After these controlling questions on the view of Mr Meiton the project leader of Case 1 did not want to talk further about Case 1 as he said that he was disappointed that the first supplier did not get the opportunity to develop Case 2. His view was that the reason for change of supplier was that the first supplier did not want to work in ASP (Microsoft) as they preferred the open source PHP. In his opinion, reusing the code from Case 1 should have saved 150 hours and two weeks to Time to Ready Products compared to what now had been the case for Case 2.

5 Case 2

The work started on the 9th of January when the second supplier got the order from InnovationsExpo AB to develop the product “Think if ....”. The team at the second supplier consisted of the project leader, one senior programmer without academic education, one graphical designer without academic education, and one junior programmer without academic education. The project leader spent 2-3 hours per week on the project, mainly leading the weekly project meetings at which Mr Meiton also took part. The senior programmer worked full time on the programming work. The other two programmers worked between 30 – 50 % on the project. Careful time reporting was done as the customer InnovationsExpo paid on an hourly basis and the time limit for the project was agreed at 300 hours. The author was present about 80 % in the project room and took part in all the weekly meetings held with the customer representative Mr Anders Meiton.

During the initial concept phase BAD-PAD-MAD was used, after which the concept was developed all the time the project lasted with frequent feedback from Mr Meiton. A strong user focus, meaning the administrator and the users/visitors of/at the portal, was of prime importance in the project work. The project leader and the team members were well accustomed with the principles of DPD. The senior programmer in particular had used the principles of DPD in the development of the e-learning portal e-Professor [OTT-03].

The release of the ready product was on the 1st of March, which means 9 weeks after the project started. Three weeks after start the customer could begin to present the product to potential customers. Due to detailed time reports of time spent by the project leader and the programmers, and estimations done on the marketing time spent by Mr Meiton, figure 8 could be drawn of how the work was done from start until Ready Products of the product.

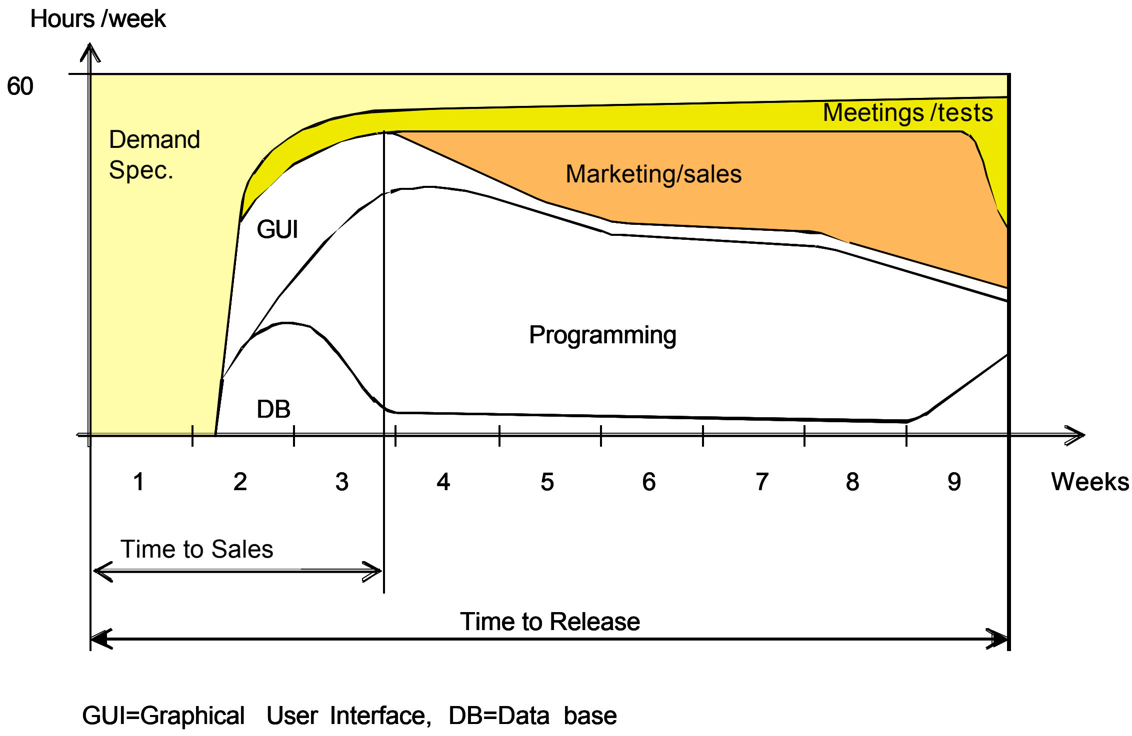

Figure 8. Representation of how time was spent in Case 2.

6 Comparisons of the two cases

In both cases equal tools were used. The localities (physical environment) were surprisingly equal for both projects. The financial resources were equal as the customer paid roughly the same hourly rates. Therefore the differences were on management principles, organisation & work, development methods, and people involved in the development.

Due to the dialogues and the reconstructing interview of Case 1 and to the observation studies of Case 2, it is clear that *Time to Marketing, Time to Sales* and *Time to Ready Products* were considerably shorter for Case 2 (see figure 9). However the total programming time was only about 20 % longer for Case 1.

For Case 1 one programmer was used while three programmers were used for Case 2. For Case 2 the programmers' work concentrated only on that Case while the programmer in Case 1 had other work to do in parallel. This explains the big time difference with regards Time to Ready Products between the two cases. It may also explain the difference in programming time between the two cases.

For Case 2 three programmers with different specialities worked in parallel, which meant that Time to Sales could be reduced to three weeks. This was possible because one of the programmers, from the beginning, spent 30 % of his time developing the GUI. For Case 1 the one programmer gave the customer the impression that the work on the GUI was done late in the Case.

For Case 1 the customer was called in for meetings three times during the development process as the requirement of the supplier was to develop the product according to agreed specifications without interference from the customer. However Mr Meiton could test the code, which he experienced as difficult and reactive. At the gates he found it difficult to critizise the result as the supplier gave him a feeling they were very proud of what they had achieved. For Case 2 the customer's involvement was less restrictive, which meant that he could influence the work all the time and not only at discrete points.

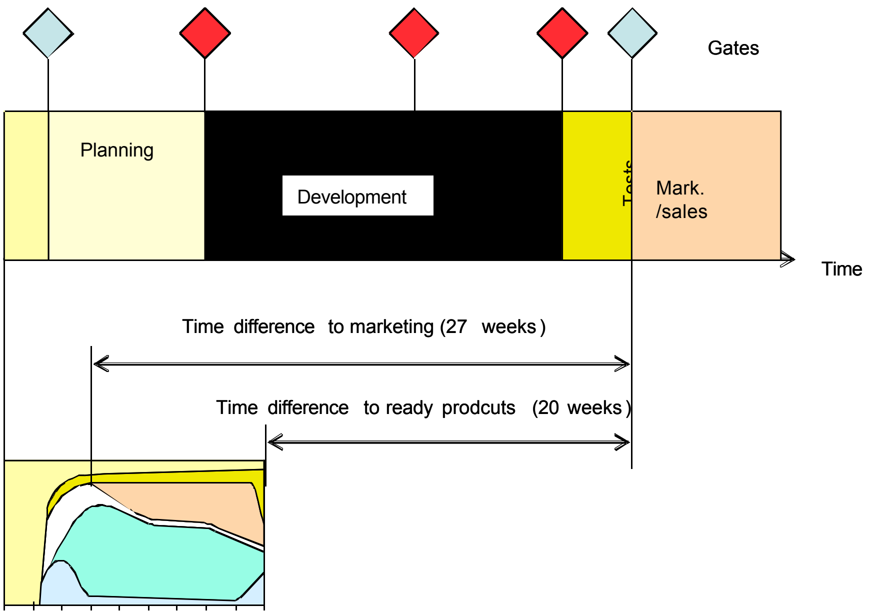

Figure 9. Two important time differences between the investigated Cases.

7 Conclusions

Both Cases have resulted in commercial products that meet specifications. However Time to Sales is especially important when PLCs are short. Good products that come late to sales have, in reality, little chance of becoming profitable products.

In the first case *Time to Sales* was 30 weeks compared to 3 weeks for the second case. In the first case *Time to Ready Products* was 30 weeks while for the second case it was 10 weeks. The programming time was 400 - 500 hours in the first case while it was 250 hours in the second case. Thus did DPD show to be also advantageous for the software development process compared to Stage-Gate™.

The investigations also showed that the traditional outsider researcher position using interviews gave only rough information of Case 1 while IAR gave detailed information and understanding of Case 2.

To be able to reduce *Time to Sales* it was shown in the compared cases that concentration on one case at a time is beneficial, especially, as DPD suggests, that it is important from the start to have a user friendly interface focus.

To be able to deliver an optimal product measured in terms of customer satisfaction, the compared cases have indicated that a continuous development of the concept is beneficial. Few gates, which Stage-Gate™ suggests, have as DPD suggests, for the most part and that even in positive cases, been successfully exchanged for weekly meetings and dialogues that deal with problems and questions as fast as they arise.

Getting the customer involved in the development process, as was done in Case 2, proved to be advantageous in many different ways. E.g. as it was difficult in advance to foresee everything, involvement meant that small and large changes could be easily made, especially early on in the process. With time the swings became smaller and smaller. As the customer was involved in the development every day, testing the work done and communicating with the programmers, he got a deep understanding of the product, which could be important when the time to sell it arrived.

References

[ANH-87] Andreasen, M.M. & Hein, L.: "Integrated Product Development", Springer Verlag, Berlin, 1987

[AGO-04] Axeborn, M., Gould, A. & Ottosson, S.: *Dynamic product development of rain protection for vans,* Journal of Engineering Design, Vol. 15, No. 3, pp. 229-248, 2004

[BJÖ-03] Björk, E. (2003): *A contribution to Insider Action Research Applied on Development of Assistive Products,* PhD thesis, Otto-von-Guericke University, Magdeburg, Germany, 2003

[COO-94] Cooper, R.G.: *Perspective: third-generation new product processes,* Journal of Product Innovation Management, Vol 11, pp. 3-14, 1994

[COO-02] Cooper, R.G.: Winning at New Products – Accelerating the Process from Idea to Launch, Perseus Publishing, Cambridge, Massachusetts, 2002

[KOC-98] Koch, R.: *The 80/20 Principle – The sectret to success by achieving more with less,* Currency Doubleday, New York, 1998

[OTT-96] Ottosson, S.: *Dynamic Product Development - Findings from Participating Action Research in a Fast New Product Development Process,* Journal of Engineering Design, Vol. 7, No 2, pp. 151 – 169, 1996

[OTT-98] Ottosson, S.: *Qualified Product Concept Design needs a Proper Combination of PAD-MAD before PDM,* Journal of Engineering Design, Vol. 9 No.2, pp. 107-119, 1998

[OTT-99] Ottosson, S.: *Dynamic Product Development (in Swedish)*, Tervix AB, Floda, Sweden, 1999

[OTT-02] Ottosson, S.: *Virtual Reality in the Product Development Process*, Journal of Engineering Design, Vol 13, No 2, pp. 159 -172, 2002

[OTB-02] Ottosson, S. & Björk, E.: *Research on Dynamic Systems – Some Considerations*, article in press in Technovation - the International Journal of Technological Innovation and Entrepreneurship, 2002

[OTT-03] Ottosson, S.: *Dynamic Product Development of a New Intranet Platform,* Technovation - the International Journal of Technological Innovation and Entrepreneurship, Vol. 23, pp. 669-678, 2003

[OTT-03b] Ottosson, S.: *Collaborative Product Development*, Human behavior in design, Springer Verlag, Germany, 2003

[OTT-04] Ottosson, S.: When time matters, Keynote speech at TMCE2004, Lausanne, April, 2004

[OTT-04b] Ottosson, S.: *Verification of Product Development Methods,* TMCE2004, Lausanne, April, 2004

[OTT-04c] Ottosson, S.: *Dynamic Product Development – DPD*, Technovation - the International Journal of Technological Innovation and Entrepreneurship, Vol. 24, pp. 179-186

[PRLH-01] Pache, M., Römer, A., Lindeman, U. and Hacker, W.: *Sketching Behaviour and Creativity in Conceptual Engineering Design,* International Conference on Engineering Design ICED01, Glasgow, August 21-23, pp. 461 – 468, 2001

[SCH-00] Schrage, M.: *Serious Play – How the world's best companies simulate to innovate,* Harvard Business School Press, Boston, USA, 2000

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