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Management of Design Complexity

THE DEVELOPMENT AND RESEARCH OF DPD – A HISTORICAL REVIEW

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Abstract: *To reduce the risks of failure when new products are to be developed - e.g. to insure that companies stay profitable when product life cycles decrease - short Time to Market for new products is of the utmost importance. Other influencing factors that contribute to the reduction of failure risks are cost efficient development, the development of user friendly solutions with good "soft" values, low logistic and production costs, and high commitment of the developers but to mention a few.*
Our ambition to reduce risks for failure when developing new products was and is our driving force for developing DPD (Dynamic Product Development), which has been going on since 1993. The development builds on industrial experiments which began in 1978. In our work we have considered new and old theories, tools, and methods to find good practises for practitioners. The DPD method differs considerably from IPD (Integrated Product Development), CE (Concurrent Engineering), SE (Simultaneous Engineering) and so called Stage-Gate™ principles with regards philosophy and how to perform the development especially in its early phases.
In the development and research of the DPD method we have seen that the above mentioned failure risks can be reduced when using DPD principles. We have also indications that DPD improves customer and user satisfaction, that it seems to improve working conditions for the product developers and eventually also that it reduces the risk of burn out for the developers. DPD has been used with good results in industrial cases and is seen with an increasing interest by large companies in Sweden.
The paper describes the background of the development and research of the DPD method, and gives some central guidelines. It also demonstrates some of the difficulties there could be in breaking with existing paradigms.

1. INTRODUCTION

People in general want to reduce risks more than they want to try new opportunities [37]. This is often the reason why profitable companies are not particularly eager to invest in innovative activities until they need to bring forward new products. However as product life cycles decrease due e.g. to intensified international competition, companies which use development methods that lead to shorter Time to Marketing, Time to Sales, and Time to Ready Products (together called Time to Market) will reduce the risk of not becoming profitable in the long term. Wheelright & Clark [35] claimed e.g. that a delay in market introduction of 6 months for companies developing "compact stereos" meant that the whole possible profit disappeared. Launching 6 months earlier meant an accumulated profit three times higher during the life cycle of the product.

Only 20 - 30 years ago the development of new products was rather simple as focus could be on technical matters (engineering design). Today the complexity level is much higher as the *functional values* of a new product is only one – but very important – success factor. Today, soft values, such as *sensual values* and *image values,* are often more important when it comes to making a profit on a new product [16]. In the political debate and also in the academic debate much interest is put on industrial design, which helps to satisfy two senses (sight and sensation) but in general not the remaining three senses (taste, hearing, smell).

Due to the changed circumstances for making profitable new products it is not enough today to supply the developers with modern computer-based tools for success, on which presently it is quite popular to focus. Neither does giving check lists to follow help much. Many examples point to the fact that more important than supplying tools, checklists and detailed administrative forms, is nice premises and financial resources, the use of proper management principles, the careful selection of developers, and the formation of efficient teams. Figure 1 shows some important factors influencing the product development process. Most of the factors in the figure are of a direct or indirect social matter. Therefore, if the researchers are to be able to find or develop useful development methods and guidelines, they have to use research methods that differ from dealing mainly with non-social factors such as technology.

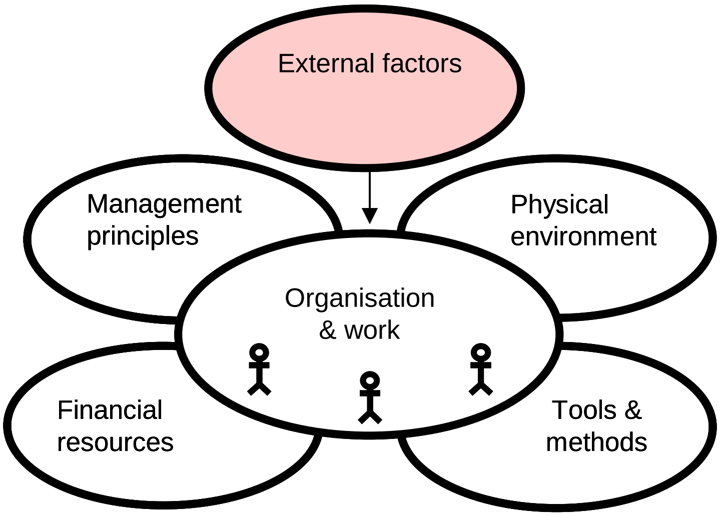

Fig. 1: *Product and process development processes are dependent on many factors that in turn are time dependent making them truly complex. Some important factors are shown in the figure [16]*

In modern society circumstances often change suddenly and with little or no warning. Dealing with partly chaotic systems, which product development endeavours are, calls for dynamic actions, fast adaptation to new situations and taking advantages of the changes. Thus, to be successful, dynamic principles become increasingly necessary, which means that the traditional serial, parallel and semi-parallel performances (see figure 2) should be exchanged for dynamic performances. Doing research on chaotic systems also calls for research methods other than those used for stable mechanical systems [3].

This paper describes the background of the development and research of the DPD method as well as some central guidelines. It also shows some problems that could arise in order to break with accepted paradigms if local management is weak.

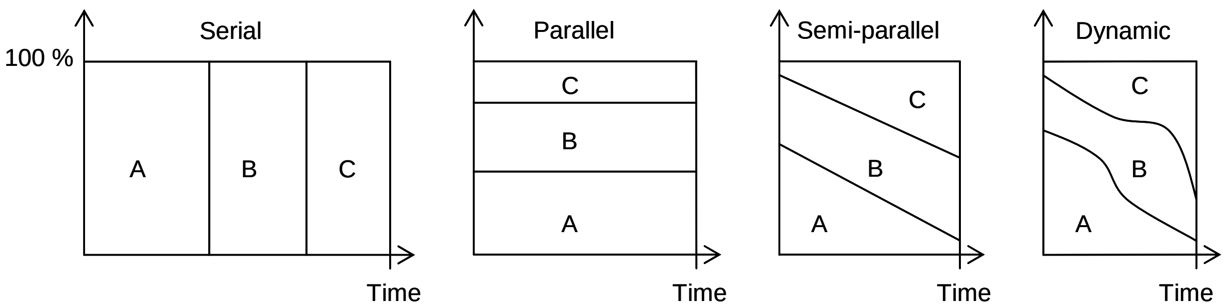

Fig. 2: *Four ways of performing a development mission for which three main activities A, B, and C are needed. (The vertical axes show normalised time used for the three activities A, B and C)*

2. THE RESEARCH

As product development is complex and contains chaotic influences, the development and research on DPD has mainly been based on what the right branch in figure 3 shows.

Prior to the development and research of DPD industrial tests of a new development approach had been going on since 1978 (see figure 4). The research on DPD then started at Halmstad University in 1994 although the term "Dynamic Product Development – DPD" was not "invented" until 1997. The research principle used has been a mix of Insider Action Research (IAR) and reconstructions of industrial projects and other experiences. Comparisons of DPD and IPD (Integrated Product Development) have been done on students carrying out product development projects.

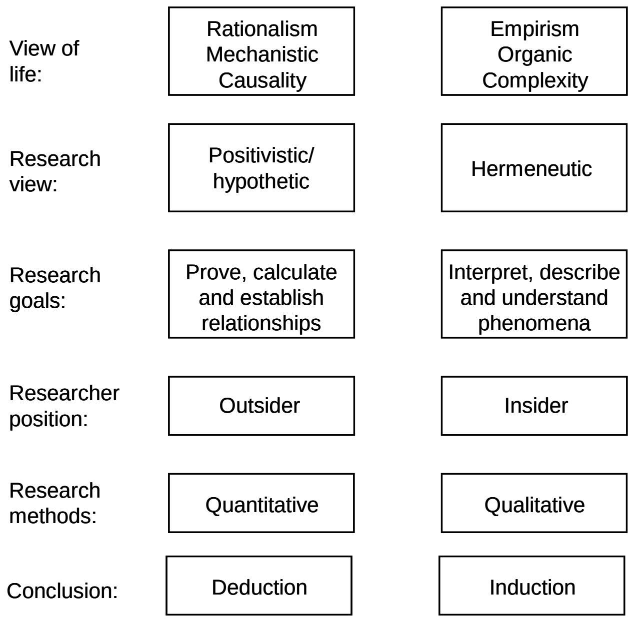

Fig. 3: *The research of DPD has mainly been based on the right branch in the figure*

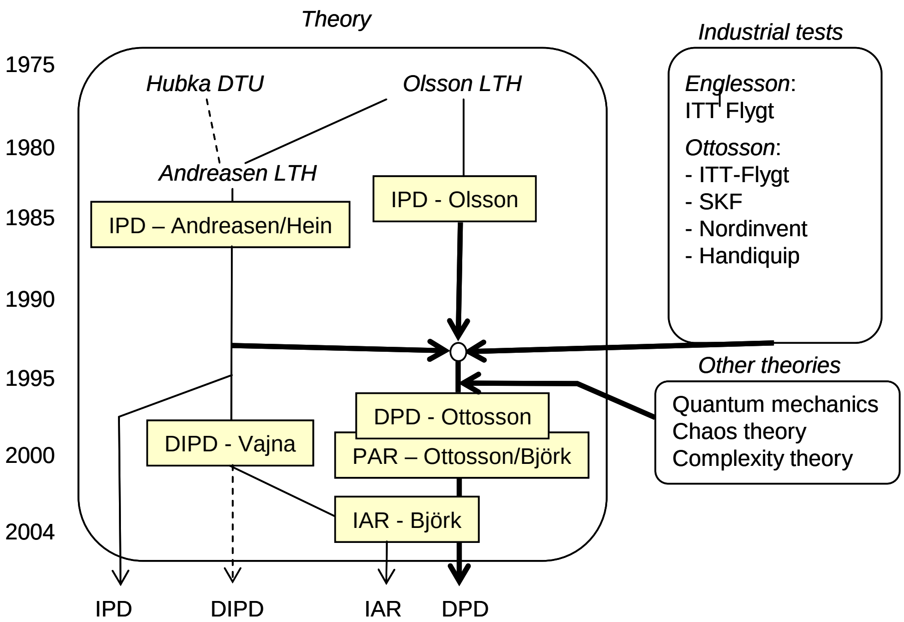

Fig. 4: *The development of DPD and IAR [16]. (DIPD =Dynamic IPD. PAR=Participation Action Research)*

During the period 1994 – 2004 14 articles in well-known scientific journals such as Technovation and The Journal of Engineering Design were presented on DPD topics. 56 papers were presented at different conferences such as ICED and TMCE. Four posters were also presented at these conferences. One Lic. of Eng. thesis [5] and one PhD thesis [4] have been produced dealing with DPD and IAR (Insider Action Research).

Built on the development and research on DPD three books in Swedish have been published amounting in total to about 900 C5-pages [28, 29, 30]. The author has been supervisor for about 200 third or fourth year students in new product development projects. Other teachers in Sweden have guided maybe another 500 students in the practical use of DPD.

A handful of successful industrial projects have been developed in Sweden for which the principles of DPD have been used. A large number of seminars and speeches have been given for management teams and developers in industry.

Gradually the DPD method has grown built on the observations from the different activities mentioned as well as from tests on students performing work according to dynamic ideas and theories. For every principle forming DPD we can give different examples of its usefulness compared to other theories or methods. There is a lot of documentation stored in notebooks, computer files, etc. There are also three granted patents and one filed patent application from the work as well as successful companies that have grown up based on the use of dynamic principles. Thus high demands on validity, reliability, credibility and usability should be satisfied for the research done [3].

To make DPD useful we have, in our work, considered new and old theories, new and old tools, new and old methods to find good practises for practitioners. In that work historical investigations have been done and dialogues have been held with an uncountable number of product developers, marketers and project leaders. Most of the dialogues have been held in unplanned meetings e.g. during conferences, meetings, travels in trains and airplanes, etc.

2.1 Industrial tests 1978 - 1993

1978 Mr Bertil Englesson, who was technical director of ITT Flygt AB in Stockholm, Sweden, was concerned that the Product Board of the company only accepted the redesign of existing products and not the development of innovations. His view was that the Product Board always stopped product development ideas if market investigations did not show large market possibilities. According to him it was not possible to make market investigations on products that did not exist on the market.

He therefore decided to form a "guerrilla group" which should turn around the development process and find a customer or a user to whom they could sell a new product idea. Next step was to develop the product. When the product was well functioning, a market investigation would be done after which the Product Board should be approached. The author was at that time Laboratory Manager at ITT Flygt and became partly involved in the "guerrilla activities" as laboratory tests had to be done on the solutions. The "guerrilla" approach proved to be successful when it came to fast development of functional models and prototypes and getting the new products through the Product Board. That in spite of the fact that the Product Board did not like the way Mr Englesson had managed to push the new ideas through the Product Board.

1979 the author was appointed manager of SKF New Products in Gothenburg. He brought with him the ideas Mr Bertil Englesson had used at ITT Flygt. The first new product line to be developed at SKF based on the Englesson principles was a conveyor system called FlexLink. When top management of SKF realised that we had started that business without market investigations, they ordered one to be done. Unfortunately that investigation showed a market only of about 6 MEUR and an annual market growth of about 3 % [12]. [The demand on us to be allowed to start a new business unit was a market of about 12 MEUR and an annual market growth of 10 %!] 2003 FlexLink Systems AB's turnover was about 135 MEUR (www.flexlink.com)!

Building on the experiences from ITT Flygt and SKF New Products a product line of lifts/elevators and other products for disabled people was developed successfully [34] in the small company Handiquip AB, which the author had bought in 1983. In 1993 that company was sold to an American company and the author became professor in product development at Halmstad University in Sweden.

2.2 Development and research of DPD 1993 - 1998

At Halmstad University the development method taught and used in the student product development projects was, in 1993, the Integrated Product Development (IPD) method proposed in 1985 by professor Freddy Olsson [14]. The time it took for the students to develop new products in their projects using that method was, according to the author's experience, unacceptably long for at least SMEs (Small and Medium sized Enterprises). Therefore 10 of the student groups (two students per group) were, in 1994/1995 taught to develop their products in accordance with what the author had found useful in his industrial work. The remaining 20 student groups performed development according to the IPD principles under the supervision of two other teachers.

It turned out that functional models were ready 3 – 4 months after start for the 10 groups working according to the new principles. For the other 20 groups it took 8 – 9 months to arrive at functional models. In 1996 it was decided to only use the new way of working in the student projects. These positive experiences led to the author being asked to form a new research centre in product development (Centre for Product Development Research - CPDR) at Halmstad University. Our initial intention for the work in CPDR was to develop "version 2.0" of the IPD principles according to Olsson [14] and the related IPD principles of Andreasen & Hein [1], because the integration of people and knowledge was also an important element for our new way of working.

However the differences in our work philosophy became so large compared to the IPD models that we decided to call our method Dynamic Product Development (DPD). At that time also the first edition of two books in Innovation Management and Product Development [31, 32] were completed and used in the education programme at Halmstad University.

In 1997 we had achieved what we regarded as good results in the student development projects at Halmstad University (a large number of national prizes were e.g. awarded them), we had managed to build up an active CPDR with 5 PhD students, and we had started to get international acceptance through many accepted articles and conference papers. Many national magazines, newspapers, and TV channels visited us. The media coverage caused a large interest among students who came to our course (two students applied per place of the 80 offered 1997).

As a consequence of the positive experiences of the student's work and the international recognition of our research, Halmstad University got, from the Swedish authorities and after careful investigations of our activities and plans - the rights to extend the bachelor education to a master education in innovation management. To give us the rights to examine PhDs, one professor chair in product development and innovation management was also given to Halmstad University. However, this professor chair should have Chalmers University of Technology as the responsible university for setting the examination. The author was asked by the rector (vice chancellor) of Halmstad University to apply for the new professor chair, which he unfortunately did and which showed to have some negative consequences for himself, for the university and for the PhD students at CPDR.

What happened was that Chalmers TU changed the writing of the professor chair program. They proposed the appointment of the three peers being Swedish professors respectively in machine design, stress and strain of materials, and integrated product development. The three peers represented the quantitative research view (left column in figure 2). They belonged to the national Endrea research program in Sweden (www.endrea.com), which had refused Halmstad University to take part in their activities as only the technical universities and institutes of technology at large universities in Sweden were considered qualified for that body.

The outcome of the subjective evaluation of the four applicants done by the three peers was that the applicant from Chalmers TU (CTH) was placed first of the four applicants in the ranking of the peers. The second in rank was the applicant from Mälardalens University (MDH). Third in the rank was the author. The fourth applicant was not regarded competent for the position. The appendix shows a summary of public information about the applicants [9, 13, 15].

Due to the outcome of the appointment process and to the fact that Halmstad University – which, in 1998 had got a new rector - accepted the course of the process, the author decided to leave Halmstad University in late 1998 to return to an industrial position. The applicant from Chalmers TU (Applicant # 1 in the Appendix) was appointed to be professor in product development and innovation management but never came to Halmstad. Instead he became professor in project management at Chalmers TU. The second applicant was, due to the positive peer evaluation, promoted to the position of professor at his home university, Mälardalen University.

2.3 Development and research of DPD and IAR from 1999

Back in industry being responsible for industrial research of Virutal Reality systems (Prosolvia AB) and product & process development of mechanical products and IT products (Frontec AB & Tervix AB) the author continued to develop different pieces of the dynamic principles getting feed-back by making tests and observations. He also acted as supervisor for Mrs Evastina Björk from CPDR at Halmstad University until 2003 when she graduated to be PhD [5].

The development has mainly been to fine tune the methods in general and to test the methods in particular on the development of assistive products [5] and on software development [19]. The principles of DPD have been presented in Technovation [18, 20] and in a key-note speech at the conference TMCE 2004 in Lausanne [16]. Larger industries and organisations in Sweden have started investigations and work to implement DPD principles in their guide lines to be better at developing new products and to decrease Time to Market. Examples of such companies are EKA Chemicals, Ericsson, MalacoLeaf and SCA.

In 1999 the author was offered the opportunity to be professor (20 %) for three years in Innovation management at Linköping University in Sweden, which he accepted. He held courses in product development and project management coupled with a number of final years MSc examination projects. In 2002 and 2003 he also worked part time (50 - 75 %) at Trollhättan-Uddevalla University as teacher in product development and as tutor for final year BSc examination projects. Some papers and articles have resulted from these two academic positions [e.g. 2, 17].

In 1999 the author published three books in Swedish on Dynamic business development (Innovation Management, Project Management and Product Development) [27, 28, and 29]. These books build further on the books that had been used in Halmstad. In 2003 these same books were used at ten universities in Sweden.

From 1999 the author and Mrs Evastina Björk from CPDR at Halmstad University have also continued to further develop the research method Action Research for complex systems. We did this because we had found from our experiences that participation in real projects was extremely important to be able to understand the complex patterns of business development, and that guide lines for such research were largely missing. Only performing IAR can reveal activity peaks that occur unevenly distributed in time (see figure 5). Closer cooperation with prof. Sandor Vajna in Germany was established as he and his research group were working with what they call "Dynamic IPD". Late 2003 Mrs Evastina Björk defended her PhD thesis at the faculty where Dr.Ing. Vajna has his professor chair.

The author's joint experiences led, in 1999, to a first paper on what we called Participation Action Research [24] and later Insider Action Research (IAR) not to confuse it with Participatory Action Research. The author also found philosophical connections between quantum physics and action research. The discovery of these connections was a fundamental step, as the traditional research methods, having objectivity and repeatability as fundamental corner stones, have Classical (Newtonian) mechanics as their philosophical mind set. The first paper on that was published in 2001 [26] and was followed up with two articles in Technovation [23, 25].

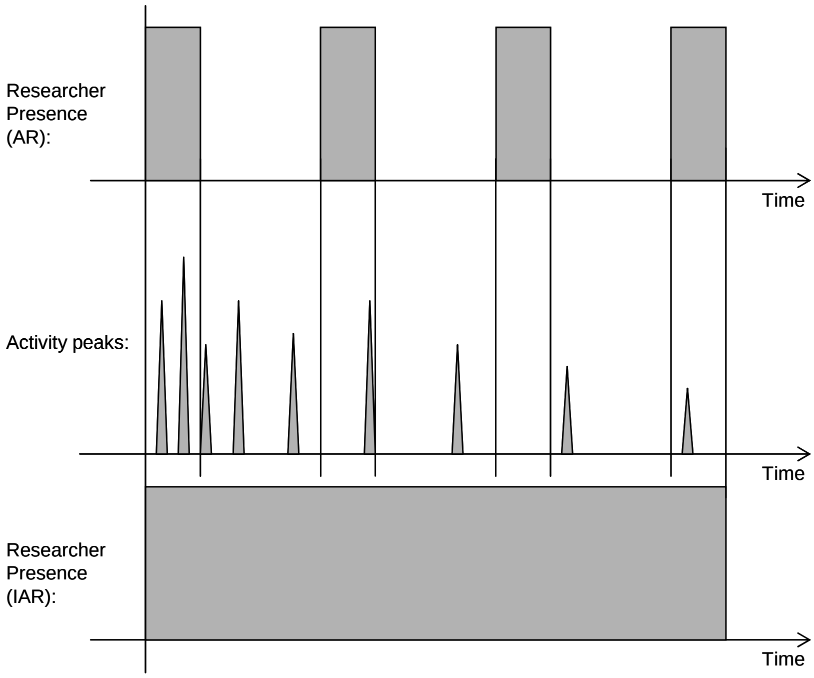

Fig. 5: *Activity peaks of different magnitudes occur unevenly distributed, which is why in reality the researcher needs to be present most of the time to get a good understanding of the development process [4]*

3. HOW WE CAME ABOUT SOME OF THE PRINCIPLES OF DPD

The recommendation on how to develop products and businesses according to DPD is described in books and articles [e,g, 4, 18, 20, 27, 28, 29]. Here, therefore, only some examples will be given on central DPD principles and briefly how we have come about them.

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 [22].

As explained we have in our work, which is important to underline, considered new as well as old theories, tools, and methods to find good practises for practitioners. Thus we have not been limited in any way in our work to "compose useful recipes" with a mix of old and new principles. Some critics, using the mechanistic/reductionistic view [e.g. 15], have argued that DPD contains old knowledge, which is right and in accordance with our aim to take care of existing knowledge and to mix it with new ideas to form the DPD method.

Quite often practitioners and managers, after having reflected on the holistic DPD method, have said that it "puts words" on what they have seen to work well in practise. They have also said that they had understood why that way of working functions.

In our development of DPD we have got indications that it improves customer and user satisfaction [e.g. 19], that it seems to improve working conditions for the product developers and, eventually, that it also reduces the risk of burn out for the developers. Our explanations for these indications are that the DPD method means for everyone participating; more frequent feed-back than for other methods, being exposed to more information, less formality, less hierarchy, and better opportunities to influence the work.

3.1 The development of technical concepts

In psychology it is claimed that a man simultaneously can deal only with 4 +/- 3 pieces of information. To be efficient one should therefore limit the number of problems to deal with at the same time. Thus, if before one starts to develop a new product one makes a list of e.g. 100 demands, that will take some time to sort out and it will be difficult to decide what to concentrate on. However we have all been taught to find out "all" demands to start with and not to forget something that is important. "Make it right from the start" is another sign of that thinking.

When a new product is to be developed where similar products exist, users can be asked their opinions about the existing products in order to get ideas on what to do better for the new product. This kind of work can also be started with "reversed engineering" or the use of existing CAD-files. Thus what can be called re-engineering is what is to be done and, e.g. House of Quality/QFD can be used to sort out what is most important to start to work on.

When a new product is to be developed where similar products do not exist, House of quality/QFD can not be used [33] and one can only find out how many potential users and customers there can be or how many existing applications there are that can benefit from the new product. If e.g. a new solution can take away problems in the paper manufacturing process one can calculate possible gains of stop time, wasted paper, repair time, machine wear out, etc. Finding out how many machines exist in the world makes it possible to find out a theoretical market size for the new solution. But is it not enough to conclude that there is a big market that should benefit from a new solution? If rough calculations in that case show that the customers will gain by using the new solution there should be a market possibility for the product.

Having got the practical experiences from the start of new product businesses in ITT Flygt, SKF FlexLink System and Handiquip AB it seemed logical to use the principle of rough planning instead of careful planning before an innovation project starts. Having seen the same things when students do their work we concluded that it is an inefficient principle to start to collect "all" demands before development work can start. We therefore came to the conclusion that the start can take place when a primary demand and 2 – 3 secondary demands exist. When these demands have been satisfied another 2 – 4 new demands are added and so on (see figure 6). This way of working has shown to shorten Time to Marketing, Time to Sale, and Time to Ready Product considerably compared to the other way of working. We have also seen that to start with a "Wish" (Think if ….) is more creative than starting with a problem or a need.

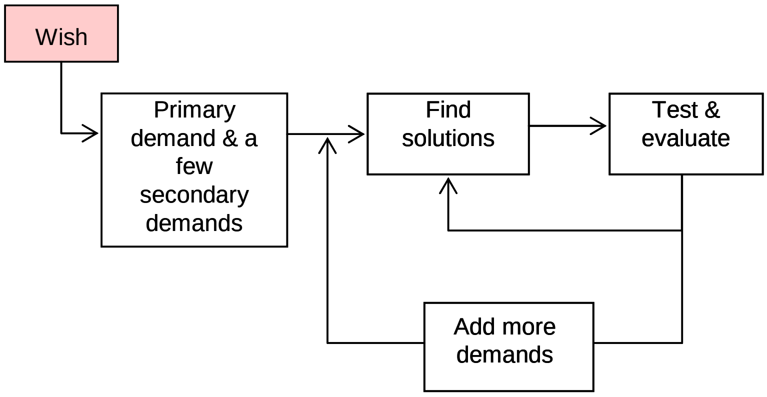

Fig. 6: *The DPD way of reducing Time to Marketing and Time to Ready Products [17]*

3.2 The creative process

To "find solutions" in figure 6 creativity is needed for each new demand that is added and to solve problems when they occur in the development process. To reach and to verify a creative solution (see figure 7) can take a long time. For the "preparation" and the "incubation" - time to speed up and to get "illumination" - we have, in our different studies seen that dialogues, e.g. around the coffee table, and brainstorming sessions are supportive to give inputs for the work of the sub-conscious minds of everybody taking part in the dialogues.

To individually and together with others get principal technical solutions, we have also found that the use of BAD-PAD-MAD (Brain Aided Design, Pencil Aided Design, Model Aided Design) should be done before Benchmarking and CAD (Computer Aided Design) (see figure 8). Otherwise we have seen that creativity gets blocked for some time until one throws the old ideas overboard and starts to think in an abstract way.

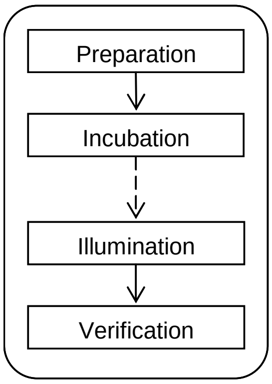

Fig. 7: *The creative process [after 11]*

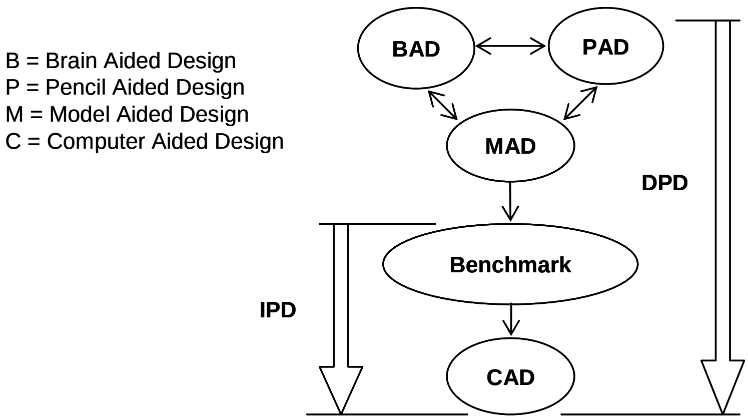

Fig. 8: *Going from an abstract to a detail level is best accomplished by using traditional tools as well as computer based tools [18]*

BAD means to perform thinking on an abstract level (see figure 9). PAD means making the ideas more concrete with the help e.g. of a pen and a piece of paper. Moving a pen and studying many sketches show to improve creativity. Making models helps to get a feeling for the total solution. The models should be made in simple/soft materials that are easy to change. Other ways to make MAD is e.g. to use Techno Lego® pieces. The last step, when a solution has been found, is to use the computer for finishing the product on a detail level and to control design functions e.g. for moving parts. The time BAD-PAD-MAD is used is short compared to the CAD work which is seen in figure 9.

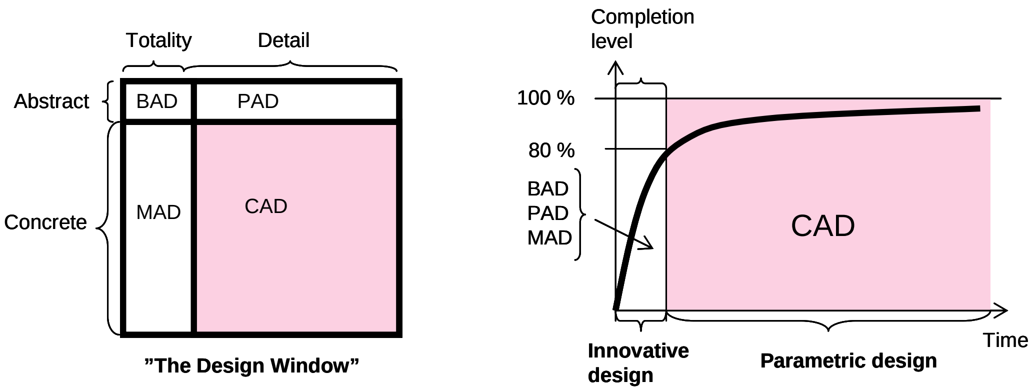

Fig. 9: *When a new product is to be developed (innovative development) abstract thinking on a totality level should generally precede abstract thinking on a detail level and concrete thinking on a totality level. When working on the concrete and detail level in general CAD is to be recommended [2]*

3.3 Development in which order?

Many discussions have been had regarding which order different things should be done in product development. We have seen that a user focus is extremely important during the whole development process for the people involved in the technical development. For the people involved in the marketing- and sales process the customers are the most important. Thus we have found it important to clearly distinguish between users and customers. We also distinguish between primary users and secondary users.

In the technical development, *functional values* must be satisfied after which *sensual values* – what we experience with all our five senses - are satisfied. The third value – *the image value* - is something that is developed mostly by the people responsible for marketing and sales.

When developing a new product our experiences are that the order shown in figure 10 in general is to to be recommended.

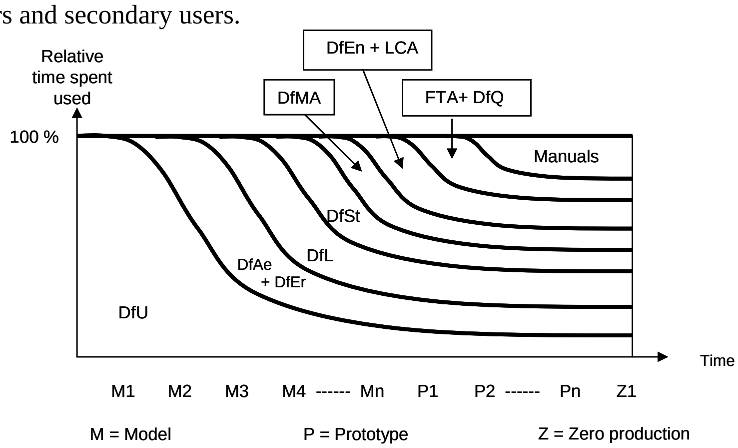

Fig. 10: *When performing DPD DfU (Design for Usability) has to be done first followed by DfAe and DfEr (Design for Aesthetics and Ergonomics). Next in turn could be Design for Logistics (DfL), Design for Stress (DfSt), Design for Manufacture & Assembly (DfMA), Design for Environment (DfEn)/Life Cycle analyses (LCA, Design for Quality (DfQ) and Failure Tree Analyses (FTA) [2]*

3.4 Organisation and premises

According to our observations, experiences and tests we have seen that it is of great importance that the project leader of a development project is at the centre of all the development activities using all her/his senses to get fast information (c.f. figure 5).

If the project leader acts in a hierarchical way he/she controls information given to the other team members. Having most information is the traditional way of having most power and a possibility to control people, especially when the project leader does not know or rely on the team members. If however a work has to be done quickly and with a great deal of responsibility that way of maintaining one's own power does not work well. That as well as lacking information means that the team members have to wait to get proper information at different points during their daily work. Being cut off from information also means that they do not engage themselves in the same way they would were they to have a surplus of information. In really bad situations they simply do what they have been told to do without question regardless of how stupid it is.

To get people to work efficiently the information flow must be frequent and as unlimited as possible. Being in the centre of the organisation – being an insider - the project leader can, according to our experiences, more carefully guide the work to a successful result than what is possible having the outsider position typical for the Line organisation [30].

By opening up the information flow in the traditional hierarchical organisation a Planetary organisation is formed as seen in figure 16. What has shown to be valuable is, if the project leader, being in the centre of the planetary system, also makes use of senior people acting as "comets", which means that they can move freely in the team helping to speed up the pace when problems occur. [30].

To be efficient ideally the teams/sub-teams should, according to our experiences, not have more than 6 members localized together [11]. If the team members are engaged simultaneously in another project that means lost efficiency while closing down work in one project to start up work in another. Every time a shift is made from one project to another, closing down and starting up costs time and money (c.f. figure 14).

Recent research [37, p 83] shows that employees working for efficient entities are healthier and less stressed than those working in entities that don't operate very well, and that this is true even within the same company. Organisations and businesses where a high level of job satisfaction reigns also display superior quality in their products and services. Negative stress also increases the risk of employee burn-out. The objective of the Planet organization is to increase operational efficiency, which we have found it to do in laboratory tests [30], as well as in industrial environments.

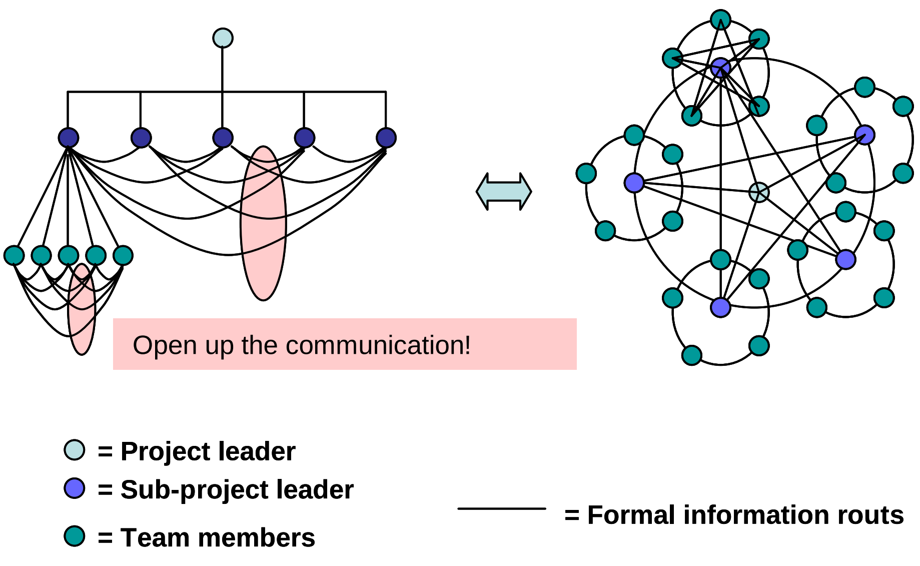

Fig. 11: *Transformation from a Line to a Planetary organisation [16]*

In one case the dynamic principles were used for the transformation of a consultancy firm – Frontec Research and Technology AB – from a company making severe losses to a profitable firm. The financial result of the transformation process is publicly documented in the financial reports to the Swedish authorities (www.prv.se). In this case the company, with 125 employees, was transformed in less than three months from making monthly losses in the region of 100.000 € to a profitable enterprise. The dynamic principles were of the utmost importance in achieving this result, in combination with the Planetary organisation principle and some other principles of DPD not treated here.

3.5 Physical environment

Through a series of unplanned circumstances at Halmstad University we noticed that creativity was heavily reduced when localities were changed. Thus when the students one year made their project work in an open space they applied for 18 patents [6]. When the students the following year were moved to rooms alongside a corridor they did not manage to make any patent applications at all [6]. A conclusion therefore is that localities can support or hinder creativity and the efficiency of a development project. Our research on that topic however has to be extended. Also work done 30 – 40 years ago has to be investigated to find out if we can use earlier and forgotten information.

3.6 Financial resources

Another experience gained over the years is that a lot of money given to a development project can be counter- productive for development. Lean resources force the product developers to find simple and cheap solutions meaning that Time to Marketing, Time to Sales, and Time to Ready Products can be shortened.

It seems that companies/individuals that want to finance their start and expansion through venture capital for new product ideas must spend time to make business plans according to figure 12. When they get venture capital they often focus on technical development, meaning that the important Time to Sales is not paramount. The whole IT-business build up at the end of the 1990's showed to be a veritable failure because of this way of working.

The important topic on how to finance innovation activities has to be investigated further.

3.7 The development of a business concept

The traditional way of developing a business concept [e.g. 7] is shown in figure 12.

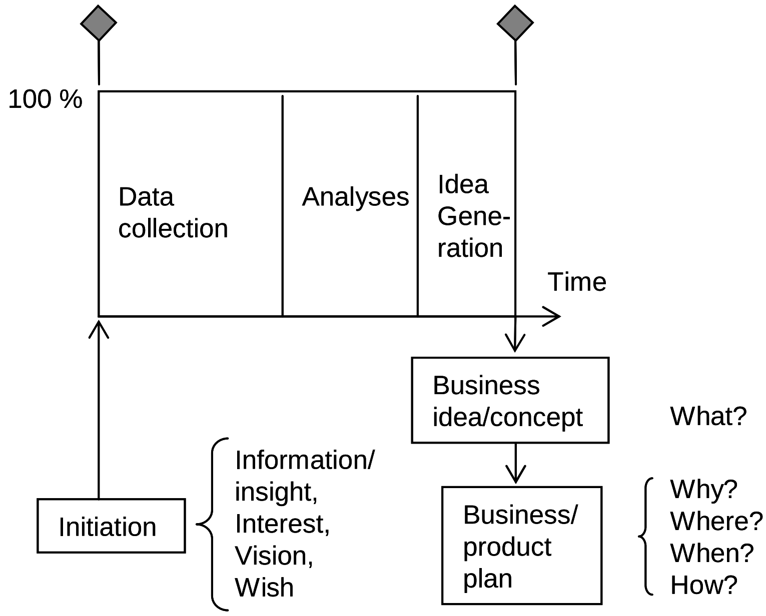

Fig. 12: *The traditional way of developing a product concept [28]. The small grey squares on top symbolise "Gates" or stop lights*

During the development of DPD we have seen that this way of working is extremely inefficient and we can give many examples of that from real life. In one case (Prosolvia AB) e.g. the creation of a new business plan took 9 weeks to finish using the principles shown in figure 10. The theoretical business plan showed in reality to be impossible to carry through as irrational factors in reality showed to be difficult to circumvent.

Due to dynamic principles (see figure 2) data collection, analyses, idea generation and tests are done step by step using the Pareto rule (the 80/20 rule) [e.g. 36] meaning that the business idea grows with every new test so that a working business plan is created (see figure 13). In one similar case (Frontec Research & Technology AB) as the mentioned for Prosolvia case, a tested and functional business plan was developed in 4 weeks.

(Interesting to note is that one nowadays in the Stage-Gate™ model also proclaim constant iterations: rapid-prototype-and-test with customers throughout the development process [8, p 257])

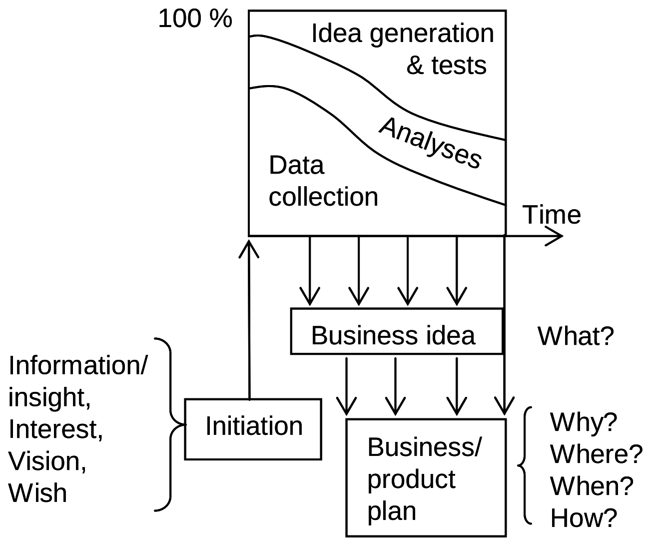

Fig. 13: The DPD way of developing a product concept [28]

3.8 From a wish to a ready product

According to traditional thinking, management needs gates and milestones to control a development process [e.g. 7, 8]. The gates are often shown as stop lights and in some cases – as e.g. for Volvo AB – gate watchers insure that stops are made at the gates [18]. In larger Swedish industries at present (Spring 2004) a clear scepticism towards the static Stage-Gate™-thinking is noted. Mr Tommy Öhlin (2004-06-03), who is manager at EKA Chemicals which in turn is a subsidiary of Akzo Nobel, put it in this way: "Stage-Gate™ is only for weak managers".

We have found the stops due to the Stage-Gate™ thinking to be costly, measured both in time and money. That even if unsharp gates – so called fuzzy gates ("Gates that are conditional or "fuzzy gates" – take place with incomplete information, conditional on some future event or information" [8, p148]) – are accepted. Therefore we do not in DPD use gates in predefined time slots but rather use deliberations when needed combined with revisions e.g. when certain development steps have been reached. The revisions can be seen as roundabouts instead of stop lights (see figure 12).

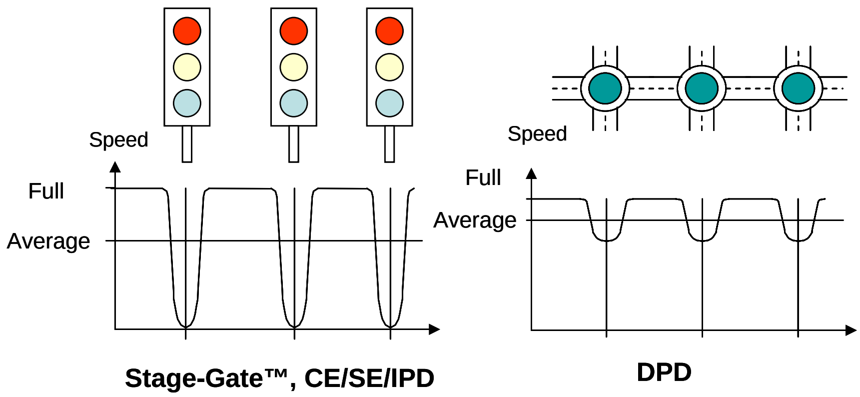

Fig. 12: *The two principal views on how to guide a development project [18]*

When the business concept is ready in the traditional model (see fig. 12) the concept shall not be changed until the product is finished. This is a view we have found to be very costly. In DPD we therefore let the concept be developed until the whole development process has ended (see figure 15).

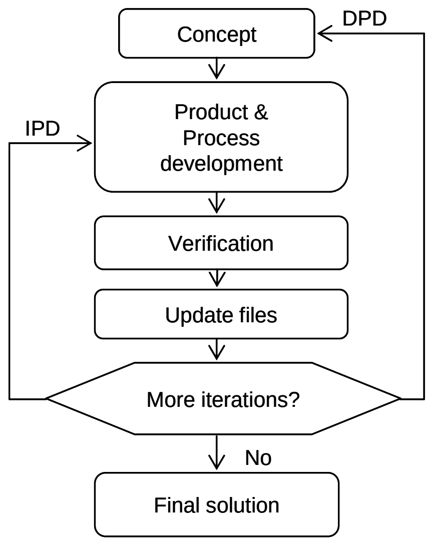

Fig. 15: *It is important due to DPD to develop the concept all the way until the development is finished [18]*

An overall view of the IPD process and the DPD process is seen in figure 16. In the figure it is shown that the concept in DPD is the last thing to finish. The dynamic way of working (c.f. figure 2) is demonstrated both for the concept development and the actual product development for DPD. As seen the few gates for IPD is broken up in a number of interactions for DPD.
Gates mean an outsider situation for the board members and the gates are inefficient stop-lights. For DPD we have an insider situation and an efficient roundabout situation. When using a Planetary organisation the risk for unwanted risk situations is decreased considerably compared to when line or matrix organisations are used.

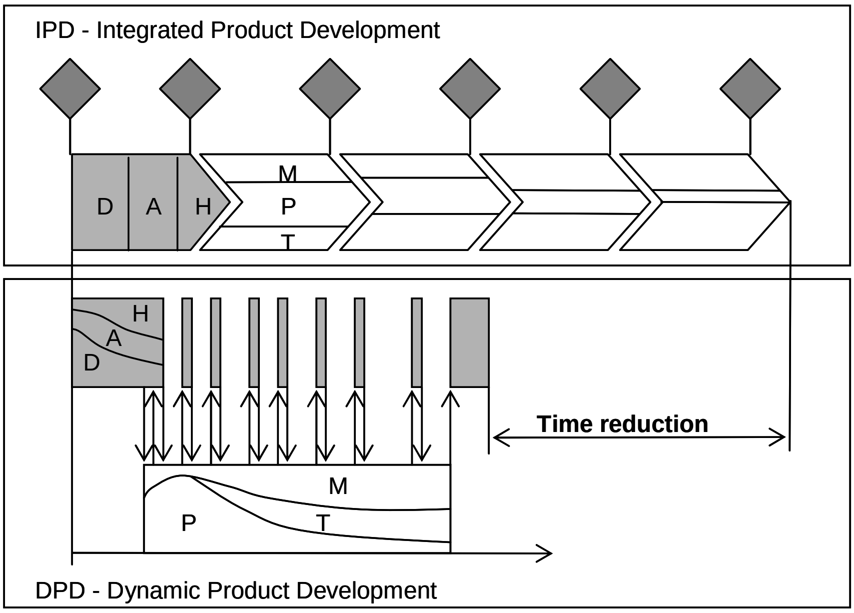

Fig. 16: *The overall view of the classical development methods compared to the DPD model [18]. The figure shows that the concept (grey) is developed once and for all in IPD and in parallel with the product development for DPD (D=Data collection, A=Analyses, H=Handling plans, P=Product development, T=Production development, M=Market development).*

3.9 There is nothing new under the sun

Just to give one example of our historical investigations, the story of Mr Johan Viktor Granath can be told. Mr Granath was what we today would call project manager for bridge projects. Around 1900 he and his teams build two railway bridges and one road bridge in the middle of Sweden over the river Dalälven, which is about 150 m wide and 10 m deep where the bridges were erected.

What is astonishing is that Mr Granath planned and built the bridges in only about four months. One of the railway bridges (see figure 17) is still used every day. Our comparative studies show that today, the building time alone with modern theories and equipment for similar bridges, takes 14 months.

Interviews with those who knew people who worked in the building projects and archive studies show that Mr Granath in fact worked according to the modern dynamic principles that we, step by step, have found to work so well for development projects. Interesting to note is that the academic society denigrated the way Mr Granath worked as they claimed that the quality would be inferior, which is why his findings were forgotten until we in our research found his inspiring examples.

Fig. 17: *The railway bridge still in use at Nås over the river Dalälven in Sweden planned and built 10 Dec. 1905 - 10 March 1906 under the leadership of Mr Johan Viktor Granath [10]*

4. CONCLUSIONS

From industrial tests as well as tests on students a large number of successful achievements have been reached when the DPD method has been used. We have also seen that using the DPD method in industrial projects means that a high level of customer and user satisfaction can be achieved. In 2004 some larger companies in Sweden have started to incorporate dynamic principles into their guide lines.

Time to Marketing, Time to Sale, and Time to Ready Product can never be compared directly as two development projects must have different developers etc. In two projects however we have managed to get relatively equal situations to be able to make reasonable comparisons between the development methods used. In the first case, to develop a wheelchair lift for curved stairways, the Time to Marketing was 2 months when using the dynamic principles and more than 6 years when other principles were used [34]. In the second case, which was the development of a web portal (soft-ware), Time to Marketing and Time to Sale was, when using dynamic principles, 3 weeks while it was 30 weeks for the compared project. In that case Time to Ready Products was 9 weeks when using DPD principles and 30 weeks for the compared project [19].

The use of static methods such as Stage-Gate™ means risking failure in many dimensions when new products are to be developed and only by using a dynamic performance this risk can be reduced. The more innovative the products the more dynamic the performance has to be to reduce the risk for failure.

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APPENDIX

Evaluation of applicants to the professor chair in Product Development (PD) and Innovation Management (IM) at Halmstad University

Applicant # 1 in the table below was regarded by all three peers as being competent to be professor in PD & IM. His scientific production was regarded to be of good quality and he had relevant industrial experiences. He had shown to be a good teacher. To complement his lack of theoretical/scientific and practical knowledge in PD & IM, one of the peers [13] commented that someone else must have that knowledge at the university if technical knowledge was needed. Applicant #1 was proposed to be professor in PD & IM.

Applicant # 2 in the table below was regarded by the peers as being competent to be professor in PD & IM although his scientific merit was limited to his PhD thesis. However his patent with others was regarded as meriting. His industrial experiences were regarded to be important for the chair. Applicant # 2 was placed as reserve to be professor in PD & IM.

Applicant # 3 (the author) was regarded by two of the peers to be competent to be professor in PD & IM. They regarded the article and paper production to be of high quality although they built on empirical research and therefore were of less scientific value. No comments were made on the author's patents. His industrial experiences were regarded to be of less value than for applicants # 1 and # 2. His PhD background in applied physics was not considered to be valuable. His abilities as teacher were regarded by two of the peers to be equal with those of applicants # 1 and # 2. The third peer disqualified the author and his work in most respects [15].

Applicant # 4 in the table below was regarded by the peers as not competent to be professor in PD & IM.

Summary of public information about the applicants

Applic.	Education	Teacher exp.	Scientific papers	Industrial exp.
# 1, born 1951 in Sweden	MSc – Psychology PhD - Psychology	1974-1988 GU (psychology) 1988-1997 GU (1/2) + CTH (organistation)	0 own + 4 shared articles 5 + 27 papers	3 months PD in one large organisation (Telia)
# 2, born 1944 in Sweden	MSc – Mech. Eng. PhD – Mech. Eng. (maschine elements)	1972-1980 LuTU (eng. design) 1993-1997 MDH (PD)	No articles & papers 1 patent	13 years PD in one large company (ASEA/ABB)
# 3, born 1947 in Sweden	Eng. - Mech. Eng. MSc - Appl. Physics PhD - Appl. Physics MBA	1993-1997 HH (PD & IM)	7 + 1 articles 26 + 7 papers 3 patents	15 years PD & IM in large and small companies (ITT Flygt, SKF, Nordinvent, Handiquip)
# 4, born 1950 in Turkey	PhD – Mech. Eng. (production systems) MBA	1980 – 1984 KTH (production)	4+1 articles 5+0 papers	3 years PD & IM in one large company (Ericsson)

(CTH= Chalmers TU, GU=Göteborg University, LuTU=Luleå TU, HH=Halmstad University, KTH= Royal Institute of Technology, MDH=Mälardalen University)