Dynamic Product Development
DPD

version 1.0

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Introduction

In contrast to other methods that prescribe a procession of actions, Dynamic Product Development (DPD) is more of a strategy or doctrine, where the situation at hand prescribes the actions taken. Therefore in DPD there can be no great scheme that declares what to do and in what order. As a consequence of its strategy of opportunistic and continuous adaptation to ever changing circumstance, DPD is like flowing water.

The DPD strategy comes natural in a culture of *maneuver thinking*. It can be said that DPD is born out of such a culture and even that DPD is the application of maneuver thinking to product development. There is no periodic upper/middle level structure of gates as in stage-and-gate methods, but contrary to other methods, there are low-level rules of thumb or tactics, that in the complex system, that is a product development project, create a midlevel control of the project through emergence[1].

DPD was developed by Dr Stig Ottosson and is described in textbooks and papers (Ottosson 1996, 1998, 1999A, B, C, 2001, 2004A, B, C, D, 2005, 2006, and Holmdahl 2003, 2007). In a recent report, DPD was found to be the best method for SMEs (Elfving 2004). DPD has not yet gained widespread popularity because, maybe, it was so recently introduced, but also, perhaps, because of the lack of strict distancing control instruments as in Stage-Gate™. Controlling a DPD project is equivalent to being fully informed of actions and that means responsibility and nowhere to hide.

In DPD, contrary to other methods, the concept is developed continuously in parallel with product and production process development. For this to work a clear and living vision of the desired result of the work is communicated and encompassed by all involved. In order to achieve agile adjustment to changing conditions (unstable conditions), project planning consists of a coarse long-range plan and a finer plan for the near future, with weekly follow-up reports.

DPD use empowered collocated cross-functional project teams. Team size is continuously adjusted to the need of the work at hand. Such expandable structures where members may move in and out of the team can be very successful (Ancona et al 2002). Teams should have a clear user focus in their work. Products are developed with, rather than for, the user, which has important positive effects (Rowland 2004).

[1] Emergence is a term from complexity theory for (often surprising) effects on a higher level from actions on a lower level. Example, electrochemical activities in our brains give rise to consciousness.

Description of DPD

It is noteworthy from a theoretical point of view that in DPD one at every step **makes full use of the latest gained knowledge** through continuous adaptation, use of the Pareto principle, shift between tasks, etc, which makes DPD an efficient new product development method. This also means that DPD can be said to rely on learning not planning (Cunha and Cunha 2002).

If DPD should be characterized by three words, they could be:

- Vision
- Tempo
- Self-organization

Vision. In especially new product development (wish/want projects) one aims at a moving, or emerging target, since the target may evolve as a result of development work (this is unstable conditions). When the project is guided by a vision instead of detailed plans and specifications and there is an empowered project team, then one gains flexibility/agility and the advantage that fleeting opportunities can be profited on. Further, unpredicted outcomes (the complexity of a PD project) and problems can be handled, because the vision helps align activities so that a minimum of nonproductive work is performed. Vision clarity is positively associated with success in evolutionary and radical product development (Lynn and Akgün 2001).

In recent research (Holmdahl 2007) an additional benefit from guiding with a vision was found to be the ease with which the direction of a project could be changed, we find that:

- It is easier to change direction of a project guided by a vision than a traditionally guided project, because it is much, much, easier to move a vision slightly, than to rewrite specifications and plans.

Tempo. In DPD all activities are directed towards the most important activities for realizing the vision. The pace can be high since unnecessary (non-value adding) activities are avoided. It has been found in new product development that emphasis on speed cause development personnel to make more careful decisions, and to more effectively implement new technologies and techniques (Swink 2003). We find that:

- Tempo yields a beneficial byproduct namely that thoughts, mental models, problems, caveats, etc, are kept current.

Self-organization. With an empowered team, it is possible to rely on self-organization when all team members are fully aware of the goal of the project. Self-organization results in every team member's judgment being put to use.

A common objection is "if everyone can do as they please, then they will run every which way" and all command and control is made impossible. However, in the experience of this author, the empowered team is guided by the vision and therefore utilizes their power to fulfill the vision. We find that:

- If by chance anyone should take off in the wrong direction, then it is easy for the project leader to correct that person, much easier and more efficient than continuously ordering every team member about, as in traditional methods.

Flexible taking-advantage-of-opportunities, where team members' judgment supersedes the project plan, are only possible if team members are fully informed and aware of the overall goal, objectives, and deliverables of the project. The project leader must therefore allow and encourage initiatives from team members. Mistakes and errors should be tolerated if they are the result of meaningful risk taking.

It should be noted that in DPD, in order for self-organization to work, we stress perseverance, stamina, a structured approach to work, and discipline.

Product development control structures

The project leader actually hands on control the project. To control a project is about leading people. Leading "…involves the ability to 'get things done.' It requires an understanding of both the formal and informal structures of all the organizations involved…." according to the Project Management Institute (PMBOK 2000, p 25), however that is also practically all they say about leading.

Other project management or product development sources may occasionally cover the subject in general terms over a couple of pages (e.g. Smith and Reinertsen 1995, Forsberg et al 2000). There may be plans with tasks ordered in sequence and diagrams with blocks and arrows, gates and milestones, but no explanation of how a project leader, hands-on, actually leads a project. It is like teaching a student pilot everything about a helicopter, except how to fly. This could be a reflection of the common "detached and from above" attitude found in PD research.

In general management literature there are many sources ranging from theoretical (e.g. Jaques and Clement 1994) to more hands-on books of "management tricks" (e.g Blanchard and Johnson 1984), and of course the military excel on this subject, e.g. dedicating more than 200 pages to direct leadership[2] alone (Larssson and Kallenberg 2003).

The general management literature, although helpful, has a somewhat limited value since there are differences between the jobs of being a line-manager and that of being a project leader. For example, a line manager has the right to hire and fire, and the power to determine a subordinate's salary and other benefits, none of which a project leader/manager normally has. Furthermore, often there is a struggle between project leader and line manager for subordinates' attention, because in a matrix organization a subordinate may have to serve two or more masters.

A literature search by the author, for "control of projects" (several differently worded search strings) yielded practically nil. This was unexpected, since from the experience of the author, one of the first things a project leader asks himself is "what tools are available to me for leading this team?", or differently put "how do I affect the team to go in the desired direction, how do I spot and stop social freeloading, how do I change the course they are on, etc?"

A project leader often reports to a sponsor or sponsor group that have at their disposal instruments for controlling a project. These can be said to map a control structure:

- The sponsor controls the project specification (the project contract, contract book (Ulrich and Eppinger 1995)) that may contain:
  - A mission statement, the main goal and purpose of the project
  - What specific objectives to achieve
  - Action plan and timeline
  - Team staffing and project organization
  - Resources (budget), contact persons, partners
  - Reporting: to whom, what, when, and how.
- Sponsor meetings, where the sponsor controls the agenda and generally sets priorities, as well as controls eventual additional funding, and sets the "rules of the game".

Likewise, the project leader/manager can "set the rules" and decide about reporting and meeting structure for his project team. These subjects seem not to be treated in the literature, except for DPD, for which weekly reporting is a requisite activity (e.g. Ottosson 1999B).

This may seem remarkable as it is in the experience of the author that when his projects have acquired regular attention of the company board of directors, the projects have been technically and commercially successful. From this, we infer that: PD projects can benefit from the attention of top-level management, and there should be companywide procedures in place to handle the PD project and integrate its result with line organization activities.

[2] Direct leadership is when leader and subordinate are in each other's immediate proximity.

DPD control structure

We have a progression from abstract and generic to concrete and special that looks like this (Richards 2004):

Culture ➔ Strategy ➔ Plans (tactics) ➔ Work (techniques are applied)

Culture determines what strategies are possible or acceptable. Then plans are born out of accepted strategy. Plans are transformed into work. It follows that our culture, our outlook, our view of the world is important for the way we perform product development, because it constitutes an important part of our PD control system.

In this way a DPD project is controlled from above through a progression of culture, strategy, and plans, figure 1.

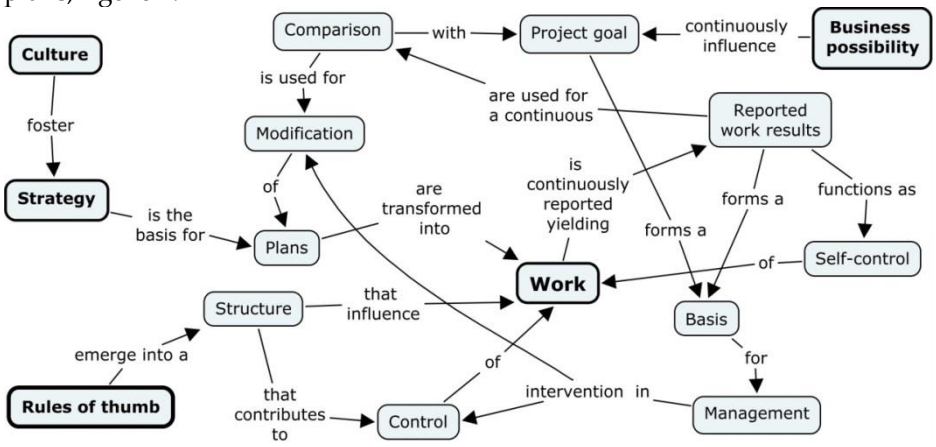


Figure 1. Principal control loops of a DPD project

The DPD rules of thumb result in an emergent structure that influence work and thereby functions as a control of work from below. (Example: the 80% rule is often perceived as "just do 80% right the first time", leading to an iterative attitude to PD and engineering design that markedly affects the way people work). This contributes to the control of work, together with guidance from plans and traditional management interventions.

The main control loop is work – reported work results – comparison – modification – plans – work, but also work – reported work results – self-control – work, which builds on the internal motivation of the individual and is a very powerful control mechanism (Hackman 2002, p 95). Additional control loops are work – reported work results – management – modification – plans – work, and work – reported work results – management – control – work. It is the experience of the author that this very strong and efficient control structure, which seems to be unique to DPD, contributes to the effectiveness and efficiency of DPD.

It is worthy of note that the business possibility may *continuously* influence (if one so pleases) the project goal (moving target, unstable conditions). Work is *continuously* (daily or weekly) reported (scrums[3], email, dedicated website, etc) so "reported work results" is always kept up-to-date, allowing for an almost real-time control of the project. A shift in business possibilities therefore very quickly affects work, especially since team members are empowered to use their judgment.

Let us conclude with an analogy. If you let go of the control stick of older fighter aircrafts, they will fly straight ahead, if you trimmed the rudders correctly. Such aircrafts are stable, which means that we must force them to turn.

[3] A scrum is a short (10-15 minutes), daily meeting where teammates report progress and problems.

That is not the case with modern fighters such as the JAS Gripen. They are instable, which means that in every moment they contain all possible maneuvers and therefore must be controlled by computers to fly straight ahead. This also means that instable aircrafts maneuver more swiftly, are more agile, than stable aircrafts.

We see that for a system to be really flexible, or agile, and be "light at the helm", it must be driven to instability, which leads us to the following conclusion: The more agile a system is, the more comprehensive governance of it must be.

This is precisely the case with DPD. Without the fine-meshed control, DPD would fall back to the lack of performance of traditional, static product development methods.

There is a theorem from numerical analysis, which says that in order to prevent oscillations in the solution, solution frequency must be more than twice the maximum frequency of the problem. In our case it means that governance must be sufficiently comprehensive and sufficiently "quick". This becomes increasingly important the faster conditions change.

New product development will always experience unstable conditions and therefore require tight, high frequency control. Alternatively, for a PD system like DPD to become potent, it requires tight control. This is the idea behind the DPD control system.

DPD process

It is not entirely correct to talk about a DPD-process since in DPD we let the need at hand decide what path to follow and what procedures to use in every single moment. Thus, there is in DPD no real, predetermined process map as in the static methods. Although patterns may be discernable in retrospect.

However if we should talk of a DPD process, it differs from other methods in its stress of performing fact collection, analysis, generation of solutions, test, etc, in parallel, which can be seen as a hyper iterative approach.

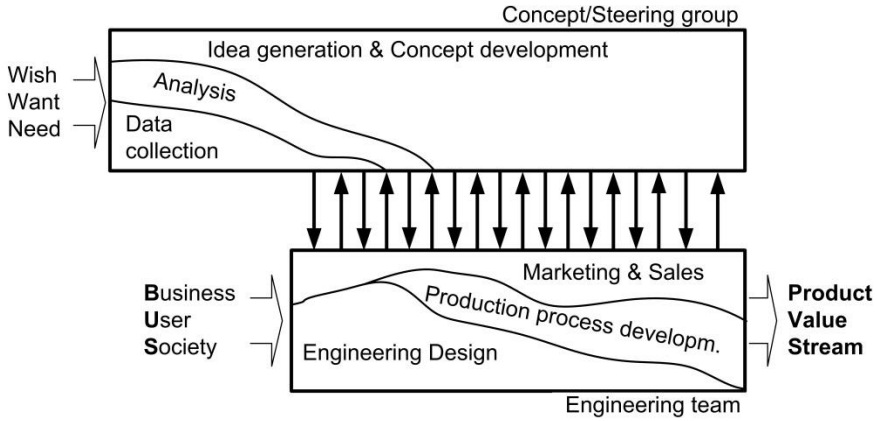


Figure 2. DPD process

Thereafter, during detail design an iterative approach is also applied making use of 80%-solutions in the first iteration. Further, as primary demands are fulfilled additional demands are added.

All through the project, activities are governed by the original concept development group. Thereby special finesses in the design of the product are not lost in later activities due to ignorance.

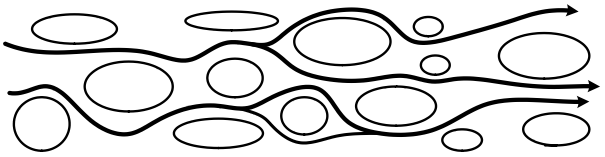
DPD rules of thumb

Contrary to other methods, DPD achieves through a low-level prescription of simple rules of thumb a higher-level effect, so called emergence. In the following are given a subset of the DPD rules of thumb.

Concentrate on the main problem.

Identify the main problem, the big hindrance and attack it. When the main problems have been solved, it is often easy to solve the lesser problems. *If the main problems cannot be solved then effort should not be wasted on the lesser problems, but terminate or redirect the project.*

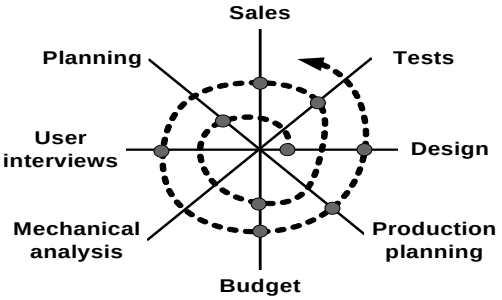
Like flowing water.



This is a principle in the form of a metaphor. Pass by lesser problems like water flows around smaller obstacles, without solving them just yet, or setting them aside and solving them separately from the main work, perhaps by aid of a special task force. The important characteristic is the flexibility of flowing water and its momentum. If the obstacle is massive, water accumulates and eventually finds a weak point and breaks through. In the same way larger, perhaps critical problems are attacked and resolutely solved with the combined force of team members and project resources.

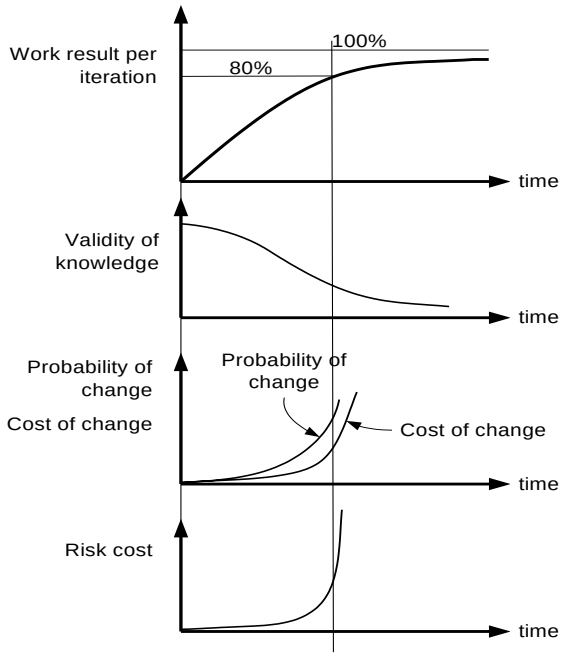
Switch between tasks.

Creative capability benefits from switching between different problems or work-tasks (Wiseman 2009). Tempo, initiative and money is lost if people spend their time waiting (see e.g. Highsmith 2004, chapter 2). If you for some reason cannot continue with what is at hand, then shift over to what is the next most important thing to do until you are able to go back and continue with the first work-task. It has been found that the more experienced and skilled the designers are, the more they iterate between activities (Adams et al 2003).



The 80/20 rule, or the Pareto principle

Initially the work result grows almost linearly with time. As we get closer to work finished, efficiency diminishes, there is a knee on the curve beyond which there is an asymptotic movement towards 100% finished. Work should make a halt at the knee, at approximately 80% of work finished, for the following reasons.



The value of knowledge often decays with time. The knowledge we start with is less valid the longer we keep on without replenishing with new knowledge (verify results, coalesce with the rest of the team, etc).

Therefore the probability, or risk, that we will have to go back and redo earlier work increase progressively the further we go. Furthermore, the cost of design changes increase the longer we continue. Now risk cost is normally defined as probability of change multiplied by cost of change. Therefore, risk cost increases very steeply beyond the knee of the curve.

It is good practice to stop at roughly 80% finished and then shift to other tasks and in this way

verify what one has produced and replenish ones knowledge. A break is also good for ones creativity. During the break, we get new impressions while at the same time the preconscious mind works with the problem.

Continuously develop in parallel the product concept and goals

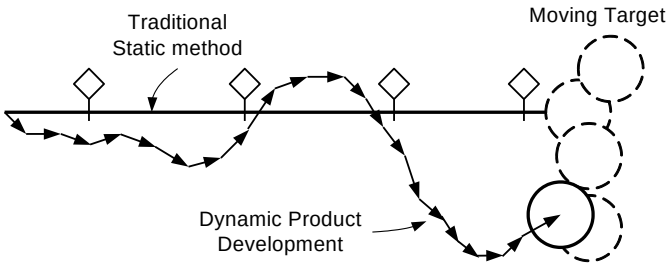
During work, you gain more and more knowledge of the product and its user. This is adaptation to changing circumstance, which results in better products more in tune with user requirements. The concept is "owned" by the Concept Group, which is also the steering group of the project. The Concept Group members are present in the team for the whole length of the project, thereby forming an important project core that carries the team's history and identity (Ancona et al 2002). The concept group develops the first concept and leads the subsequent development of the concept.

Simultaneously gather facts - analyze - create solutions - test.

The analysis and creation of solutions will yield new questions, which will lead to new inquiries, which will influence analysis and solutions, etc. Therefore, they must all be done simultaneously for maximum efficiency.

Make many small, and few large decisions.

This is the gateless method or the method of "every minute is a gate". There is no need to follow a special order when solving problems, except that one should always start at the abstract level and then work downwards to the concrete level.



User vs. customer.

Contrary to other methods that emphasize customers or the mindset that product development serves a number of stakeholders where the customer is one, DPD has a clear user focus. When designing, always have the user in mind! It is far better to design with, than for someone (Rowland 2004). Sometimes the customer and the user is the same person, but often they are not.

There is more to this: by thinking in user terms, you will pay more attention to user values. To understand the user even better you should become the user. Talk to users, study users, and try to understand how it is to use the product while being very small, very large, light, heavy, etc. This calls for empathic abilities.

Design and verify concurrently.

Not many years ago engineering design of the part/system/total architecture, was followed by the building of prototypes. The prototypes were then tested and test results were analyzed. Often there was no time for redesign in case of failure during test, so the design engineer designed the parts sturdy enough to pass the test. This, of course, was a waste of raw material and money. This is case A in figure 4.

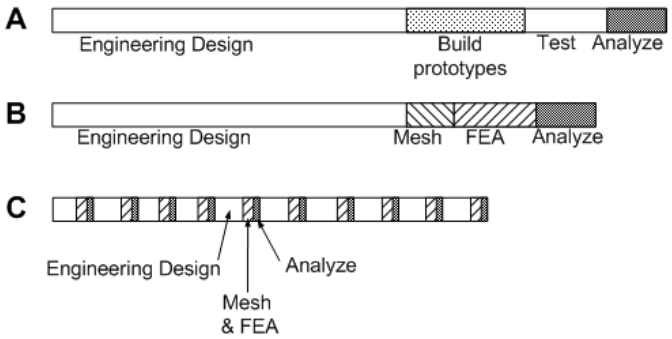


Figure 3. Comparison between different development strategies in foremost the automotive industry, A: old-fashioned, B: contemporary, and C: modern (Holmdahl 2003)

When CAD was introduced, CAD drawings and later CAD models were used for making test specimens. After some time it was realized that, the models could be meshed and used for FEA-purposes making the physical testing obsolete4. This is case B.

Unfortunately, case B has the same drawback as case A - the waste of raw material and money. The reason for this is simple: in both cases, physical tests and FEA are used at the end of the process to verify the design, not allowing any iterative design loops for reason of time shortage. Findings from FEA were not fed into the design process.

The method of DPD, case C, consists of short iterative design-FEA-analyze steps. By using modern software that works in the background of the program and automatically creates the mesh, the engineer can test and modify the design many times during a single day.

By starting out with a coarse FEA-model and making it finer and more precise as the design itself is developed, it is possible in most cases to have the design verified the very instant that it is changed or a feature added. With this method, there is no need for a special validation activity after design is finished, because the design is already optimized as regards strength, noise and vibration, fluid dynamics, etc.

The method of case C allows for quick iterations. This is fortunate because the second time around, the designer will perform faster and better than the first time. For each iteration, the designer gets to know the product and its characteristics better.

It is interesting to see that one author (Ullman 1997, p15-16) acknowledge this by writing: "…after completing a project, most designers want a chance to start all over in order to do the project properly … ". However, Ullman refrains from drawing the correct conclusion, namely that the design method should be of an iterative nature, to allow the design engineers to "do the project all over" many times.

There is an additional meaning to the idea of starting with a coarse concept and then refine it in subsequent steps, sometimes iteratively, and that is - you develop the concept continuously from start of project until finished product. This runs contrary to the established paradigm in engineering design, but is never the less a more efficient strategy for developing products that fit the market situation at product launch. The mindset should be characterized by a preparedness for continues concept development.

Reinvent the wheel

This is a catchy phrase to remind the developer to be creative first, before looking at what others have done. Because if developers start by inspecting others' solutions, they will be so influenced by what they see that for a long time their own creative ability is seriously hampered.

[4] This has not completely happened, and will never happen as long as legislation in many countries demands physical tests, such as crash tests of automobiles.

BAD - PAD – MAD

Brain Aided Design – BAD. Start by thinking! A large part of concept development and engineering design is the joggling of objects in the mind. Design engineers visualize the design and try out different solutions in their mind. It is therefore important to train this ability, and to learn to create the right circumstances, necessary for the ability to function at optimal level.

Pencil Aided Design – PAD. Pencil and paper are the most important tools for concept development and for solving problems in engineering design (Salter and Gann 2003). By drawing on paper there is created a direct link between the thoughts in the brain and the visual impression from the picture being drawn.

Kinesthesia, muscle memory and hand-eye coordination, is at work here. The movement of the hand is important for the brain-activity in finding solutions, especially so for creativity problems. Many pictures are created that are simultaneously viewed and processed by the mind. The paper acts both as memory and as test bed for the seeking of solutions.

The action is from the abstract towards increasingly detailed solutions. At a suitable level the pen and paper sketching is stopped and the work is continued with a CAD system.

Model Aided Design – MAD. It is often useful to build and test some simple models to verify the function of concepts or to increase ones understanding of the concept. Favored materials are model clay, plastic foam, LEGO bits, balsa wood, and cardboard.

As with PAD, models have merits that computers lack. The tactile feedback and the visual impressions, and the possibility to mimic the real thing differ from when using computers only. With models, the impressions are remembered differently and more vividly.

The forte of using computer software for trying out mechanisms is the possibility to get exact data of displacements, forces, velocities, and accelerations.

In DPD there comes a creative phase of BAD-PAD-MAD before comparing ideas with others' solutions (figure 5), while in Concurrent Engineering (CE), Simultaneous Engineering (SE), and Integrated Product Development (IPD) concept development starts with benchmarking others' solutions.

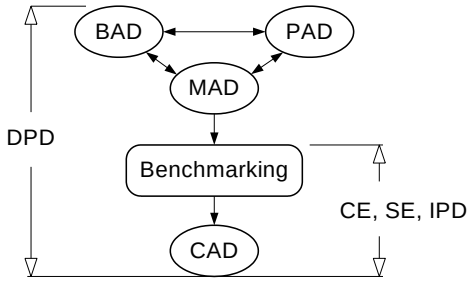


Figure 4. Comparison of DPD with CE, SE, and IPD (Ottosson 2004)

Writing on the wall.

The timeline should be plotted out in as large a format as possible and then hung on the wall next to where the team is located. Then it is always visible and serves as a constant reminder (Smith and Reinertsen 1995).

Changes to the time plan can be written directly on the plot, making them very visible to the team. Further, important information such as descriptions of the user of the product, pictures of its use, and pictures showing the styling and environment where the product will be used is hung on the wall.

Drawings such as assemblies, sections, and mating surfaces are all plotted and hung on the wall together with conflict areas, unsolved problems, sketches, alternative concepts, etc, so that whenever team members lean back or raise their eyes they fall on the wall and the brain is filled with visual information that feeds the creative process of the subconscious mind.

This method is extremely powerful, according to the experience of the author, but it seems almost impossible to convince people to use it. Not until they have actually tried, can one convince them.

Planning

In an orderly world that is linear and proportional and where perfect knowledge is available, precise planning is possible, but in a complex world where order is circumstantial, any reliance on plans is rather futile.

Therefore, plans will not hold together, because the past, which plans are based on, is not an accurate compass for the future, but also because change is so pervasive that the environment can undergo profound alterations while the formal planning process is underway. The value of plans is in the planning, which can create preparedness for future actions, because (Cunha and Cuhna 2002):

1. During planning, management's discussion on possible future scenarios creates a "memory of the future" so that when circumstances unfold they are met with prepared actions (Bunker and Alban 1997).
2. A shared knowledge of plans may be used as a coordination mechanism for individual improvisation.
3. Plans can be conceived as actions unfold, making economizing with scarce resources easier.
4. The planning process can yield organizational learning, shared mental models, in fact a metalanguage.

Separation between the observers and the planners (e.g. between first line operators in contact with customers/users and senior management) is a source of information filtering and delay, which can be dangerous in a fast paced environment (Cunha and Cuhna 2002). The solution is to merger action with planning, resulting in a bottom-up design more efficient than any top-down design (Wesensten et al 2005, Lewis 1994) and the basis for maneuver thinking.

The application of this idea to new product development could be thought of as reliance on self-organization (bottom-up) and a probe-sense-respond mode of operation, which could also be described as quick iterations, or a process of evolve and adapt, and iterate (Highsmith 2004).

We must let go of the idea of the plan as a timetable, but utilize the other aspects of planning. Then to succeed, planners do not need to "know" the future. Because systems guided by rules for making rules are much more flexible than formal systems. Furthermore, if by a lively preparatory communication the organization's members have acquired a shared understanding of proper actions and shared mental models, then they can effectively think in one another's brains (Artigiani 2005).

Therefore, it is best to create a coarse long-range plan and to make a rolling detailed short-range plan. The closer in time, the more detailed is the plan. This is akin to rolling forecasting in which data used for prediction is updated with the most current observations (Hong and Richardson 2005, p175).

At the end of every week, each team member briefly reports that week's work results and time, money, and other resources spent, together with a plan for the coming week.

Organization

Two aspects of the organization of product development are especially stressed in DPD. They are collocation of the project team, and the use of so-called planetary organizations instead of the common hierarchy.

Colocation

The importance of colocation cannot be overstressed. Projects failing to yield expected benefits can be ascribed to this fact. In addition, the physical layout of the building is important (Haynes and Price 2004, Olson 2002, Stallworth and Kleiner 1996). *We shape our buildings, and afterwards our buildings shape us* (Upitis 2004). For practical examples of benefits from collocation, see for example Bunting (2005).

Teamwork depends on constant communication: "In collocated teams, team members frequently report that some of the best discussions occur spontaneously, based on frequent interactions with collocated workers" (Malhotra et al 2001). Through all channels: 1/ hearing the tone of voice, words used, 2/ seeing the body language, clothes used, skin hue, 3/ scent: humans pick up and are affected by pheromones, 4/ tactile information, etc.

Humans have a bandwidth of approximately 10 Mbit/s when meeting face to face. All of this, except less than about 20 bit/s, is subconscious communication (Norrestranders 1999).

Collocation of the team yields the following benefits:

1. The team stays focused. No stealing of team members' attention from other groups,
2. Short communication routes,
3. Easy to have impromptu meetings,
4. Facilitates overhearing, yielding efficient spreading of information:
    a. If for instance the project leader talks over the phone with the client, then the team, by hearing the conversation is informed.
    b. This also makes possible spontaneous problem solving which can happen when one team member hears others talk of a problem to which he happens to have a solution.

When collocating the team, **the product, or a model, mock up, etc, of the product to be developed should be placed in the center of the group**. This has many advantages,

1. Works as a reminder of the reason for the team's existence. Helps focus attention to the product.
2. Is a good visualization aid for talks and discussions between team members themselves and between team members and visitors to the team.
3. Shows the status of the project if the most resent version is displayed.

Collocation of team members mean that they all sit in the same room. There should be no obstacles between them visually blocking communication.

In the close vicinity of the open room, there should be small rooms available that can be used by the team, because from time to time there is need for secluded meetings. The project leader might want to talk to a team member, or meet with a sponsor. There is also need for team members to meet for problem solving without being interrupted, and there is need for private conversations and telephone calls.

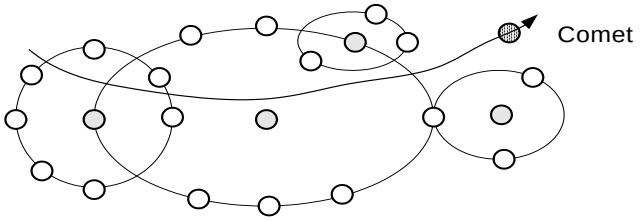
It is convenient to have large white-boards on the walls and video projectors for projecting for instance CAD models on the white-board. Then the team can draw alternative concept solutions on the white-board on top of the projected image. There are numerous smart aids to project work. One's fantasy is really the limit.

Collocation also means that the project leader must never "hide" in his room isolated from the team. The place of the project leader is in the center of the team.

Planetary organization

In DPD a special form of organizing is used (Ottosson 1999D), called planetary organization, figure 6. Around a central sun there are planets. These planets can be suns with their own planetary systems. Each planet reports inwards to their respective sun, just as in any hierarchical organization. However, here each planet also sends information circumferentially to every other planet with the same sun. It is

the obligation of each planet to keep "sister planets" informed of their actions. This facilitates a fast and high information flow.



In order to increase information flow further, there is a special role called a comet. The comet that should be an experienced, skilled, and mature person, has a special supportive function in a planet organization. The comet moves freely about, giving support where needed, and facilitates extra information flow between planet systems. A comet reports to the central sun. In a corporation, that sun would be the managing director or president.

Somewhat similar, but not so advanced models can be found elsewhere (e.g. Highsmith 2004 p240, Jaques and Clement 1994 p262).

Maneuver thinking

In military affairs, it was found that a culture of maneuver thinking resulted in the most effective and efficient strategy (Richards 2004, Smedberg 1994). It was the military answer to the uncertainty and lack of trustworthy information in military operations of war.

To give an understanding and "feel" for the attitude of maneuver thinking, the following description of one of the basic principles of maneuver warfare, *Auftragstaktik*[5], is given (Claesson 2001):

Auftragstaktik found its definite form between the world wars. It is based on the following fairly simple hypothesis:

- As no plan, and thus no orders, remain valid after contact with the enemy, and
- as the very nature of combat is confusion and uncertainty, one must
- develop a system of command that allows rapid changing of plans at every level to seize the fleeting opportunities that combat confusion offers, which thus means that:
  - + command initiative must be devolved to the lowest tactical levels, and
  - + no formal orders can be given other than by commanders who are in physical contact with troops at the point of contact[6]; while, at the same time,
  - + all commanders, down to section level, must react to developing combat situations in accordance with the tactical and operational INTENT, as opposed to precise orders, expressed by higher commanders two links up the chain-of-command so that
  - + all are functioning, one might say, in harmony. And, finally,
  - + this "harmony" is dependent on a common mobile military culture, or philosophy, that is enshrined in the army's doctrine and ingrained in the minds of all soldiers through a system of war maneuvers, Kriegspiele – staffrides and promotion values rigorously applied by the General Staff.

This special method for planning and giving orders allows for large freedom as to the realization of orders. For instance were subordinate commanders invited to seize initiative and develop measures to be used if a tactical opportunity should arise.

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[5] "Auftragstaktik" as a term and method was first developed in the German army in the 1800s (Larsson and Kallenberg 2003).

[6] Or as Sun Tzu wrote ca 490BC: "… in the field a commander need not always follow orders from the court …" (Tzu 1991).

Such opportunities can be utilized directly without order from higher command. It was assumed that by encouraging initiatives from subordinates one would gain a greater flexibility.

Auftragstaktik relies on and thrives in a culture of initiatives at all levels, self-organization, tolerance of failure, intuitive communication, and almost thinking in one another's brains. It relies on empowering professionals at the lowest possible levels, which is the most effective guarantor for excellence (Kolenda 2003).

By making good use of the ideas and philosophy behind *Auftragstaktik* in product development, it seems plausible that *speed and flexibility will increase*, which will *yield higher quality and higher performance products.*

For this tactic to work everyone must know the overall goal and have an ability to change between different kinds of work and adapt to changing circumstance. The ability to achieve "fast transients" is a core capability according to Boyd (Richards 2004).

The advantages and efficiency of maneuver thinking has been reported in the PD literature. Wesensten et al (2005) point out that abilities that facilitate *Auftragstaktik* are situational awareness, adaptability, mental agility, judgment, initiative, anticipation, planning, course-of-action determination.

Other basic concepts of maneuver thinking are (Richards 2004):

1. *Einheit:* Mutual trust and cohesion based on shared experience and shared mental models are the basis for leading by mission statements and commanders intent. In New Product Development (NPD) literature, we find that interpersonal trust is important for new product success (Akgün et al 2005) and for business success in general (Englehardt and Simmons 2002, Pech 2001).
2. *Fingerspitzengefühl:* Intuitive skills based on extensive experience and deep knowledge that make spontaneous improvisation possible.
3. *Schwerpunkt:* The effective focus of our activities that all subordinate units shall support. It is important to be able to quickly shift focus.

There are examples of spectacular success in new product development that seem to be a result of team design (brilliant individuals) and what could be called a maneuver culture (Sawy and Majchrzak 2004, Markus et al 2002). There is an emphasis on speed, the importance of time, or tempo in maneuver thinking that was brought into strategy theory by Musashi in 1643 (Musashi 2001) and which has been found in NPD to cause development personnel to make more careful decisions, and to more effectively implement new technologies and techniques (Swink 2003).

As a result of initiatives at all levels there naturally emerges, from a culture of maneuver thinking, a strategy of multiple thrust, which is in harmony with newer theories of business strategy that stress the importance of keeping a portfolio of options in progress (Englehardt and Simmons 2002).

Pech and Durden (2004) compare maneuver with attrition as bases for a business strategy and advance maneuver thinking as preferred strategic approach. In Pech and Slade (2003), there is an emphasis on action through maneuver, speed, and external focus. They distinguish between decision models R and P, figure 5.

R stands for reactive and relies on tradition, historical analyses, and the "luxury" of careful planning and lengthy response and reaction times in order to attempt to shape the firms future. This is serial information processing and predicable decision making based on "if - then" calculus (Pech and Slade 2003). In such an environment, management may appear to have isolated themselves behind layers of non-porous decision filters. However, no amount of advice will help an organization to improve itself if such improvement methods expose or attack senior decision makers' greed, ignorance, or foolishness (Pech and Durden 2004).

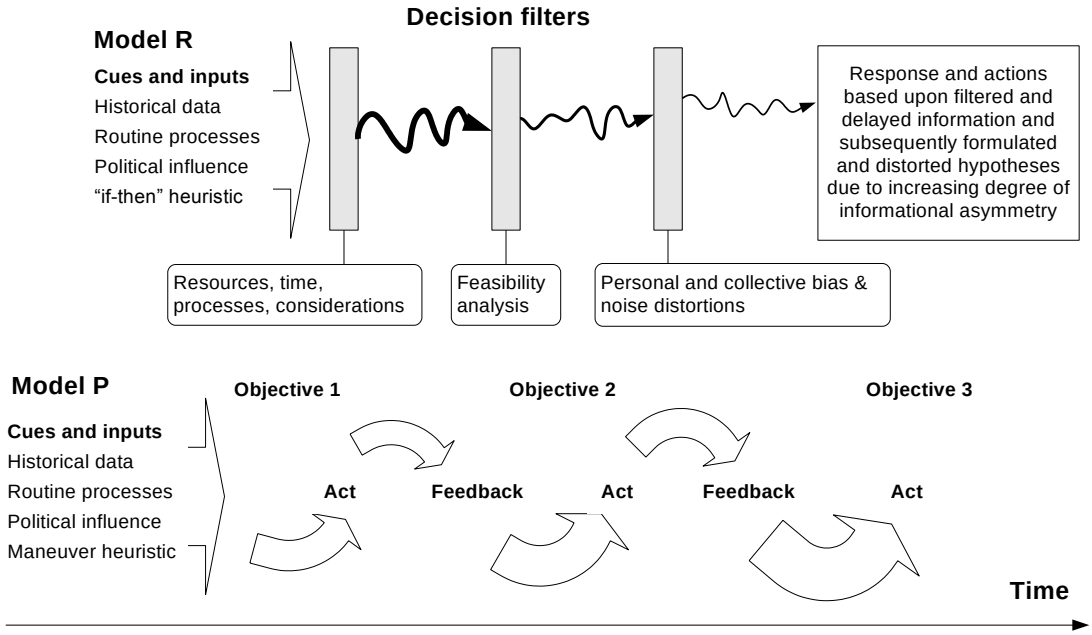

Figure 5. A comparison between models R (reactive) and P (proactive) (Pech and Slade 2003)

P stands for the preferred proactive maneuver model that relies on speed and the development and attainment of rolling objectives in order to influence and shape the future. Model P describes parallel information processing as new objectives and downstream responses to actions are processed simultaneously and in parallel rather than in a serial manner (Pech and Slade 2003).

Based on maneuver thinking Pech (2001) describes characteristics of an innovative organization, table 1, which is profitable for PD and used in DPD.

Table 1. A pathway to a more innovative organization based on maneuver thinking (Pech 2001)

Element	**Characteristics**
Organization structure	Small semi-autonomous units.
Employees	Well-educated and highly trained.
Culture	Open culture espousing loyalty, trust, helpfulness, an action and performance-orientation, team oriented but supportive of creative and independent thinkers, encouraging of on-going learning. An atmosphere of copetition - co-operation and competition.
Management	Supportive, guiding, facilitative, high standards, high achievement, participative and tolerant of failure.
Leadership	Dynamic, motivational, communicative, influencing.
Promotion	Based on performance and ability.
Remuneration	Innovative and based on group and individual performance.
Focus	Innovation, markets and customers, external environment.
Rules and policies	Minimal and flexible for the long-term health and prosperity of the organization.
Strategies	Flexible and two pronged. Focus on growth and market dominance by providing customer satisfaction through quality and innovation, and second, outmaneuvering the competition by getting inside their decision cycle, identifying and isolating their weaknesses, and innovating at a pace beyond the coping capacity of the competition.
Tactics	Numerous, creative, unique, unexpected, a mix of both spontaneous and well planned.
Decision making	Decentralized, well conceived. Uses competitive intelligence gathering and analysis to aid decision-making.
Learning	Continual, encouraging discovery and exploration, and on-going learning

A command and control approach often creates a dangerous illusion of direct cause and effect (Maguire 1999). Ordering people about is not in line with either findings from complexity-based organizational science or maneuver thinking. Instead ''complex leadership'' involves creating the conditions that enable productive, but largely unspecified, future states. Leaders cannot control the future because in complex systems such as organizations, unpredictable (and sometimes unexplainable) internal dynamics will determine future conditions. Rather, complex leaders need to influence networks (Marion and Uhl-Bien 2001).

Leadership thus becomes a question of inspiring, guiding, and supporting committed subordinates and encouraging them to perform freely within set limits (US Marine Corps Doctrinal Publication 6, p83).

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