Product Development

The content of the Product Development tabs

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A Meta View of Product Development

Definition

> *Product development is the collective activities, or system, that a company uses to convert its technology and ideas into a stream of products that meet the needs of customers and the strategic goals of the company. - Michael N Kennedy*

A company is often organized in functional departments: sales/market, production, finance, etc. We must on the one hand *carefully distinguish between functional departments, which are the hierarchical structures people belong to and report within and on the other hand the processes that those people partake in* since a process may cut across several departments.

The product development process involves several functional departments: leading, production, sales/market, and not least: engineering design, where responsibility for product development is often located. It is therefore common practice to manage projects by a project leader from the design department, which is often called product development department.

Product development is different from sales, purchase or production because it involves and transcends so many different departments and such a large part of the company. Which is quite natural since product development is about what the company´s business will be in the near future. But it also differs from the rest in other ways.

Product development is a learning process. This may sound banal, but it's about perspective, how you see it, a paradigm. I will try to explain.

Anyone who has ever developed new products from the very first ideas all the way into production has experienced how one "gets to know" the product, how one discovers the products characteristics during product development, for that is how it's felt.

You create concept solutions, mathematical models and prototypes. By using and testing them, you get to know them. This is a learning process, a building up of knowledge. You learn how to design a product with certain characteristics; the design is modified, followed by a new accumulation of knowledge. Each step, each activity, is experimentation with possibilities, an exploration of unknown territory, you draw the map as you go, you learn.

The more variants you develop and get familiar with, the better you will become at creating the product finally chosen, since you have learnt how to design to obtain the wanted characteristics. You have become expert at designing variants of a product not yet in production.

Product development is an intense learning process from zero - to how to design and produce precisely the right product in the best way possible.

The understanding that product development is a learning process leads to a novel view of product development and how it should be organized.

It also explains why people that have no experience of their own from product development become so nervous and insecure when you hint at the fact of how it is done (and that it is the necessary way, if the results are to be any good). They want to be reassured and have guaranties, as if

it was possible to develop a new product in a straight line from start to finish, as if you were already familiar with the territory that nobody has ever visited.

So, what skill do we have?
We, who have managed new product development projects, can say that we have never done anything that we've done before. This is what I mean: we have time after time run through a learning process that has been by and large the same, but the object of the process has varied. We are good at a certain type of learning.

By knowledge buildup and learning process I do not mean attending class, take a course, or study textbooks. What I mean is exploration that yields knowledge in the sense of *potential for meaningful action*. By aid of scientific method this becomes research. Take note that a group has learnt first when it has changed.

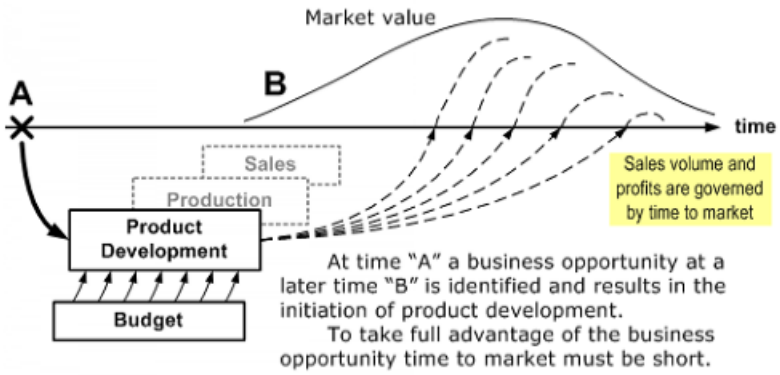
Understand me right. Surely you can say that learning, adjustment and change is important to every part of the company, but the goals of the activities are not learning. The objective of the non-product development processes and departments are to repeatedly produce as error free work results as possible.

In the production department, when the best production method for a specific product has been found there must be no changes. Learning stops and is exchanged for a meticulous repetition. Every day is exactly like the previous.

Product developers on the other hand, explore consciously the world in their work and two days are never alike, but for the fact that the developers explore, make use of their findings, and adjust to them - they ***partake of a learning process***.

Business Possibility/Opportunity

Product development is never done for its own sake, but is always done as part of a business of some kind, whether it is a question of *market pull* or *technology push*.



The figure shows the principal requisites for product development

At time A there is identified, or prognosticated, a business opportunity at time B. The market value varies over time (the solid curve) for the product that was identified at A to have a market potential at B. There are several possibilities.

A < B, as in the figure. This case requires looking into the future, to predict/guess what the market will look like. We have an uncertainty that must be handled by **flexibility and adjustment** (reorientation) to shifting circumstances. There is uncertainty about market potential, if the product can be technically realized at the right cost, about end price to customer, etc. All this taken together makes it impossible to plan the project work in any detail since we here enter unknown territory.

A = B. Now we are in a hurry if we want to capitalize on the opportunity.

A > B. Market has been there for some time and one or several actors are active on the market.

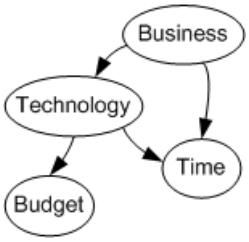
In all three cases **time is important**. We must have the right **tempo!** The product must be made available to the market at the right time with as much as possible of the qualities that **users** value and appreciate.

Often the products success depends completely on company "*time to market*" ability. As hinted by the broken curves in the figure, both sales volume and profit is strongly reduced by delayed market introduction.

Project triangle

Since product development often is performed in projects it is customary in textbooks to introduce a model called the project triangle that can look like the figure to the right. There is always time in one corner; budget in another and in the third there may stand quality, function or result. Then it is stressed that one cannot have it all; one or two corners will have to be scarified more or less.

After the previous discussion of product development and its prerequisites, I hope that you see how *poorly the project triangle metaphor performs*. A more truthful picture of reality is shown in the figure that shows how business opportunity drives the process.



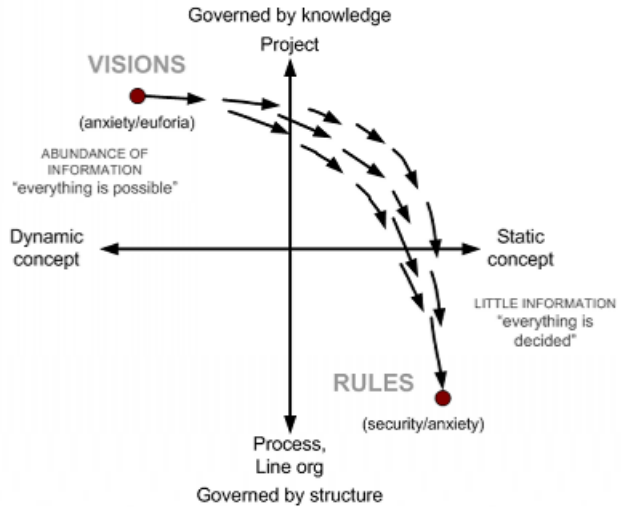
Business puts demands on time (time to market, competitors activities, etc), and technology must deliver a product with the functions required by the business opportunity.

Technology in its turn makes demands on time, since it takes time to develop a product and the budget must suffice for the technical development that the business requires.

Limitations in time and budget balances and decides how technology and business develops.

Product Development Process

The figure to the right illustrates the principles of product development and especially new product development.



We start off in the upper left corner. Initially "everything is possible", there is no frozen design. Information is very large and the task can be both complicated and complex.

Since product development is very much a *learning process* and we don't know from the outset what ways we will later come to choose and what solutions and problems will be discovered, it is impossible to make detailed plans from the start or a detailed organization of work. *Product development is a process where you draw the map as you go.*

From these reasons **the development of new products must take place in projects** to be efficient. Only the project form possesses the necessary flexibility and allow for the unconventional methods that might be necessary.

Many companies struggle with product development in the line organization, or have their developers participate in several projects simultaneously - both equally problematic.

Dynamic concepts are made static by finding solutions and deciding how functions shall be realized. It is like making a sculpture out of a block of marble, which in itself contains an unlimited

number of possibilities. You remove marble, thereby reducing the number of possibilities by every chip until eventually the desired statue have been created. This is from an information technology point of view equivalent to substantially reduce information.

We understand that as we move nearer to the finished product a number of risks have disappeared - it is becoming ever more probable that we shall succeed. The closer we get to the finish, the more uncertainty is reduced in the project.

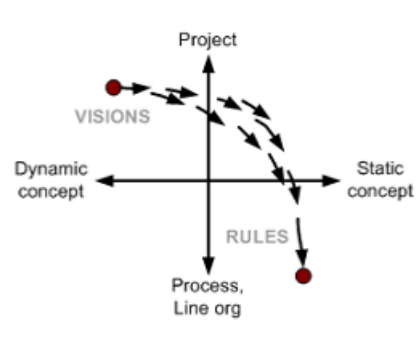
The goal is to determine in minute detail what the new product shall look like (geometry, material, tolerances, surface treatment, color, scent, etc), manufacturing, logistics and the design of package material, as well as manuals and sales promotions, etc.

When this unique description is in place and implemented in the company processes, in the line organization, then product development is finished in the way that now production and sales of the new product take over and drive the product business. Especially the production process is very static where every produced detail must be identical to every other detail of the same sort.

Concepts are now static and the line organization, so governed by structure, by rules and regulations, has taken over the product from the visions- and knowledge governed project.

All humans differ. Some of us are happy in the free environment at the beginning of a development project, while others become anxious faced with all uncertainty. They crave rigid rules and routines and find security in the rules and structure of the line organization, where instead the project minded and entrepreneurial personalities feel anxiety or become bored.

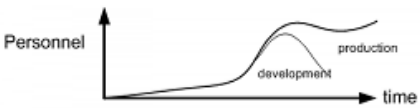
We have in product development to opposites. And this is unfortunate. There are group psychologists that say that *anxiety reduction is the single most important factor for understanding human behavior*. *Unfortunately the very group norms that are anxiety reducing may also be detrimental to efficiency and work performance, and vice versa*.



We start from the previous description of the product development process**.**

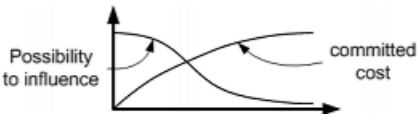
Number of personnel is small in the beginning, but very special.

Those that take part should be creative, knowledgeable, and comfortable with the great uncertainty and the large changes in the beginning. As the concept is made more static and lands in the production- and product improving processes of the line organization there is a demand for more people than at the start. The demand on them is also different.



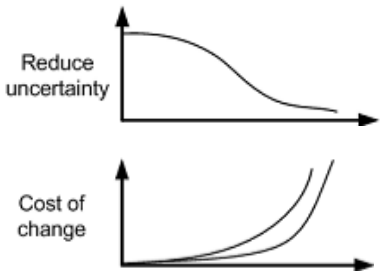
Since few are involved at the beginning and the work (simulations, modeling, etc) involves computers and simple mock ups, cost is low although the people involved are very qualified.

It is good practice to let the concept developing people from the beginning of the project stay on in leading positions during the rest of the project. Thereby guarantying that finesses of concept solutions are not meddled with and lost and that the necessary adjustments that always have to be done are of the highest class.



The possibility to influence the product is large in the beginning. It is now decided what methods and solutions will be used. In the beginning everything is possible. When the number of personnel starts to increase closer to the end of the project about 70% or more of the cost is already committed due to concepts chosen.

Skilled purchasers can later, as the product is in production, only marginally influence costs. It is thus very important that the right persons are engaged from the start so that the right decisions are made.



From an **information theoretical** point of view new product development can be seen as a **reduction of uncertainty**. From a multitude of possibilities, we shall choose one. This can be seen as a reduction of information. This is a view that is helpful in risk management.

The cost for changing the product is small in the beginning but large nearer the end. The exact form of the curve is unknown and besides, it naturally varies from product to product.

It is clear, however, that the connection is nonlinear and strongly progressive. Yet again a reason for handling the project with great care already from the outset

Product Development Strategies

Within product development there are two views: the presently dominant static, and the new dynamic as represented by for instance DPD, Dynamic Product Development. Presented as opposites we get two cases.

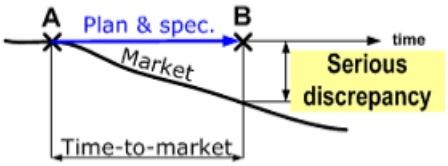
Static view Govern with structure	❑ Rigid forms ❑ Central governing ❑ Linear thinking ❑ Absolute planning (perceived ability to see into the future) ❑ Scientific Management, machine metaphor ❑ **Follow the plan**
Dynamic view Govern with visions & knowledge	❑ Flexible, formless ❑ Decentralized, personal responsibility ❑ Nonlinear, complexity based thinking ❑ Self-organizing ❑ Non plannable except coarsely or for near future only ❑ Flexible adjustment to change (Boyd-loop) for to **reach the goal, make real the vision**

Product development prerequisites

The world around us changes faster than before. Market dynamics increase, fashion changes faster, trends come and go, and product life span decreases. Time-to-market is critical - a little to late and your product flops.

New technology is constantly developed that can make the old one - just old. New legislation changes conditions for design, production, sales, service and destruction/recycling of products.

Static methods fail

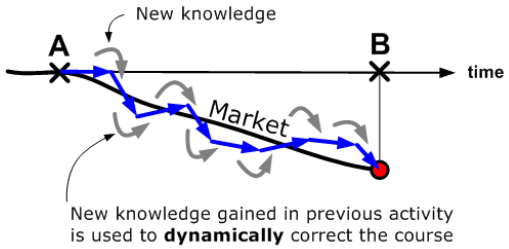


If you, in a milieu as described above, start product development with a detailed specification and a detailed timeline and see product development as a question of delivering according to specification and to follow the plan, then there will be severe problems to your business. Matters will be even worse if you opt for a serial/sequential

development strategy (javelin method) with different phases run through sequentially. If you then slow down the project by using gates, catastrophe is lurking.

Dynamic methods work

Since the world is changing we cannot know beforehand exactly what the product should look like that will best fit the market at a future time of sales. Therefore we must develop with a continuous, flexible and agile adjustment to shifting circumstances. This must be the characteristic of the system/process itself. The organization must quickly react to new impulses and newly gained knowledge.



Only competently managed self-organizing organizations driven to *the edge of chaos* possess these qualifications. Methods with this philosophy are *agile programming, maneuver warfare, extreme programming,* and *dynamic product development*

Product development outer conditions	❑ High rate of change and accelerating ❑ Market is dynamic, occasionally almost chaotic, but more and more integrated and networked ❑ New technology emerges constantly ❑ New laws and regulations ❑ Price cuts
Dynamic strategy	❑ Flexible and agile adjustment to observed conditions ❑ Allows for almost instantaneous change of directions ❑ High tempo ❑ Efficient use of resources ❑ **Utilize newly gained knowledge** ❑ Observe users and market concurrently while continuously estimate if/how observations influence the project and the guiding vision ❑ **Outwards looking tactics & norms** ❑ Information flows quickly through the project and is always available. Through collocation and close contacts management is continuously informed with enough detail

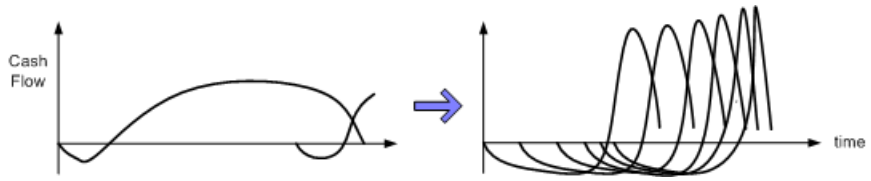
The Need for Speed

The oldest archery bows found are from the Nordic countries. The bows were early very well designed. The oldest Nordic bows were so called flat-bows, which is the best design for self bows, carved from a single wood stave. From archeological findings it is known that this bow design was used for 4000 years. An impressing product life span!

I have an axe that was handmade about 70 years ago, by master blacksmith Skog in Hjärtum, Sweden. It is well balanced, though maybe a bit heavy for a modern weak arm, have an exquisite shape and you can cut three-inch nails without denting or chipping the sharp edge. Hjärtum-axes are highly valued by master carpenters and they demand hefty prices at auctions. And yet, the design has not changed for a 1000 years.

My mobile phone did not exist a year ago and two years from now it will be hopelessly outmoded.

Product life is quickly getting shorter



As product life quickly becomes shorter and development time tends to increase, then problems arise.

- Development represent an ever growing share of total cost. This requires a rethinking and remolding of the organization. And furthermore, it can lead to financial problems.
- It can happen that one has several development projects running in parallel within the same product area (different models) that have not reached commercialization. This is very difficult to handle.
- Time to market is critical. He who is first wins.

An additional consequence of the increased dynamics is increased turn over of companies and increased need from society for more start-ups.

It is desirable to **shorten development time** - this can only be done **through a reorientation** and a decision to use **more suitable methods**.

One such method is ***DPD, Dynamic Product Development*****,** which yields development times that are only 30% of current methods with a corresponding reduction in cost at sustained or improved product performance.

One such method is **Dynamic Product Development (DPD)**, which is most suitable for wish and want driven product development. DPD yields development times that are only 30% of current methods with a corresponding reduction in cost at sustained or improved product performance. Another method is **Lean Product Development (LPD**) that has shown in Swedish applications to increase product development productivity by 3-5 times. LPD is most suitable for need and want driven product development.

When product development speed increases one has to make **ever-faster decisions**, often based on poor information. This requires **experience and intuition**, and an ability to change and adjust decisions. That is: **flexible adjustments to an ever changing environment**.

DPD, Dynamic Product Development

Dynamic product development, DPD, was developed by professor Stig Ottosson, and verified in real development projects, some of them managed by this author, characterized by.

- **Vision**
- **Tempo**
- **Self-organization**

DPD-strategy is based on maneuver thinking and is in harmony with Boyd´s theories of flexible adjustment to changing circumstances. Theoretically interesting is the fact that in DPD one **makes use of the knowledge gained at every step**, which makes DPD the most efficient real life product development method.

Vision

In especially new product development one shoots at a moving target. When the project is guided by a vision instead of detailed plans one gains flexibility/agility and the advantage that fleeting opportunities can be profited on, unpredicted outcomes and problems handled, and the direction is always right.

Tempo

In DPD all activities are directed to the most important activities for realizing the vision, to reach the goal. The pace can be high since all unnecessary (none value adding) activities are avoided and also the tempo itself yields as a beneficial byproduct that thoughts, mental models, problems, caveats, etc, are kept current.

Self-organization

It is possible to rely on self-organization since all team members are fully aware of the goal of the project. They are partaking of the vision. **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. This is a completely erroneous view! The team is guided by the vision and utilizes all their power to fulfill the vision. If by chance anyone should take off in the wrong direction, then it is easy for the project manager to correct him, much easier and more efficient than continuously ordering every team member about, as in traditional methods.

Strategy 1 - A collection of DPD concepts

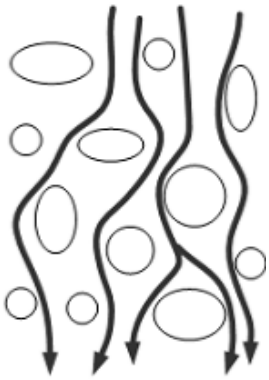
Concentrate on the main problem

Identify the main problem, the big hindrance and attack it. When the main problem has been solved it is often easy to solve the lesser problems.

If the main problem 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 metaphor as well as a principle. The principle is to 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.

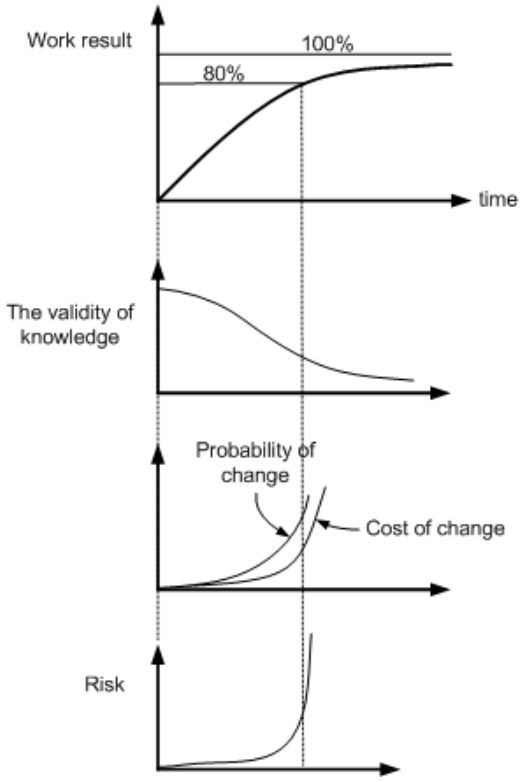


If the obstacle is massive, water accumulates and eventually finds a weak point and breaks through. In the same way larger, perhaps critical, problems are attacked and resolutely solved with the combined force of team members. There is no need to follow a special order when solving problems, except that one should always start at the abstract level and then work downwards to the concrete level.

Like flowing water, our modus operandi should be dexterous, swift, and opportunistic. This flexible taking-advantage-of-opportunities is only possible if team members are fully informed and aware of the overall goal, objectives, and deliverables of the project. The project leader must also allow and encourage initiatives from team members.

The 80/20 rule

Initially the work result grows almost linearly with time. As we get closer to work finished, efficiency diminish, there is a knee on the curve and we now asymptotically move towards 100% finished.



One should stop working at the knee, approximately at 80% of work finished, of the following reasons.

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 go back and redo earlier work increase progressively the further we go.

The cost of changing design increase the longer we continue.

Risk = probability of change * cost of change. The risk increases very steeply beyond the knee of the curve.

It is very 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 one's creativity. During the break we get new impressions while at the same time the preconscious mind works with the problem.

Switch between tasks

Your creative capability benefits from switching between different problems or work-tasks. Switch not only between design problems but also between design, prototype building, testing, talking to users, budgeting, sales, and back to design.

How many problems can you handle simultaneously, or rather consecutively in a repeated iterative way? This depends on experience, if you are tired, how you handle stress, etc, but surely somewhere between two and ten.

Tempo, initiative and money is lost if people spend their time waiting. If you for some reason can't continue with what's at hand, then shift over to something else until you're able to go back and continue with the first work-task.

However try always to work with what is the most important at the time.

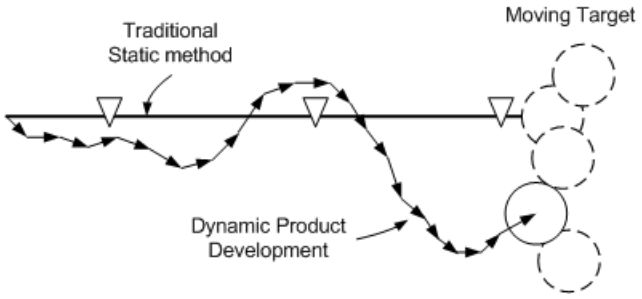
Continuously develop the product concept and goals as you during work, gain more and more knowledge of the product and its user

This is adaptation to changing circumstances, which results in better products more in tune with user requirements.

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



Strategy 2 - DPD Concepts

User vs customer

When designing, always have the user in mind! 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 ***emphatic abilities***.

A consumer product normally has three values.

1. **Functional value -** the product does what it is supposed to do.
2. **Perceptional value -** this is its form, smell, color, surface texture, etc.
3. **Image value -** BMW is not the same as Opel.

Image values are extremely important and are easily destroyed by sloppy design. One little mistake that goes unnoticed can hurt even the value of the brand. Elktest, need I say more?

- When engineers from the supplier of the tunnel console of the Volvo V40 designed the storage for CDs, they fitted the compartment with small ribs where the bottom and sidewalls meet. Their aim was to give support and sideways stability to the stored CDs. Try putting a CD away while driving the car in traffic. You will find the ribs get in the way. Obviously the engineers only looked at the product through the computer screen, or at the most checked a first shot sample on top of their desk. They never became the user.

Another example

- Try driving a Volvo V40 in sunshine wearing Polaroid-type sunglasses. The liquid crystal displays in the instrument cluster go completely black if you tilt your head just by a few degrees. The design engineers never thought of that. They just designed according to specifications. Had they become the user they would not have failed.

What these examples show is, among other things that ***becoming the user*** help catch the things that have fallen through the net of Quality Function Deployment (QFD) and other specification methods.

While maximizing functional, perceptional, and image values help make the right decisions during product development we must also think of our business, our company must profit, and also society as a whole must not suffer from what we do. A way to remember this is to think of BUS:

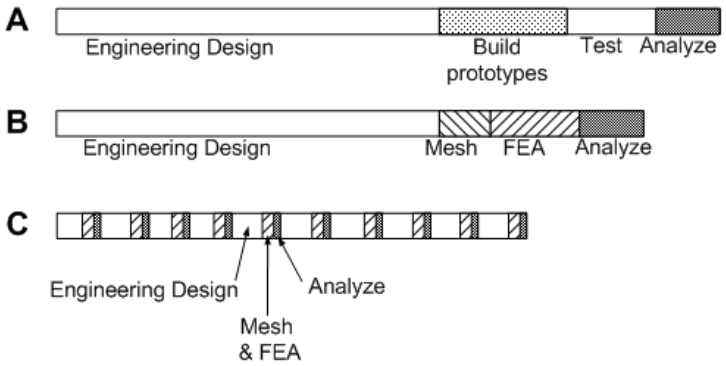
- Business
- User

- Society

There is also an ethical side to this. As a general rule - if it's unethical: Do Not do it. It may not be good for your near future career, but you will be more pleased with yourself and also managers who are not psychopaths are more and coming to the understanding that good ethics is profitable and beneficial to the company.

Design & 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 type **A** in the figure.



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 FEM analysis making the physical testing obsolete, case **B.** (This has not completely happened, and will never happen as long as legislation in many countries demands physical tests, such as crash tests).

Unfortunately **B** has the same drawback as **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 best method, C, consists of short design & FEA steps. By using modern software such as DesignSpace® from ANSYS, that works in the background of the CAD-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 validation activity after design is finished*. Because the design is already optimized as regards strength, NVH, fluid dynamics, etc.

Method C allows for quick iterations. This is fortunate because **the second time you do something you do it faster and better than the first time**. For each iteration you get to know the product and its characteristics better.

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. The mindset is characterized by a preparedness for continues concept development.

Strategy 3 - More DPD Concepts

Reinvent the wheel

It is a catchy phrase to remind you to **be creative first before looking at what others have done**. Because if you don't, you will be so influenced by what you see that for a long time your own creative ability is seriously hampered.

Abstraction

The main problem is often of a higher abstraction level than the lesser problems. It is **important to understand the hierarchical abstraction structure** of the concepts that make up the product. Because it is never possible to make a concept work at a lower level if it does not work at a higher level of abstraction.

BAD - PAD - MAD

Brain Aided Design - BAD

Before you start development work, stop and think!

A large part of concept development and engineering design is the joggling of objects in the mind. We see our design in our mind. We search for and try out different solutions in our mind. It is therefore important to train this ability, but also to create the right circumstances necessary for the ability to function at optimal level.

Take a walk, or at least move the body. According to a theory called NLP, neuro-linguistic programming, the body must move for the mind to change its mode. Other methods are to lie on a sofa and shut the eyes, shut out the world, and visualize. You may function better at some time of the day or during some kind of activity, in some special environment, etc.

By observing yourself and taking note of when and under what circumstances you have peak ability to use your mind for development work you can increase both quality and volume of your output.

Pencil Aided Design - PAD

Pencil and paper are the most important tools for concept development. 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.

The muscle memory is at work. 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 brain. The paper acts both as memory and test bed for the seeking of solutions.

The action is from the abstract towards more and more detailed solutions. At a suitable level the pen and paper sketching is stopped and the work is continued in a CAD-program.

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, there are some merits to models that computers lack. The tactile feedback and the visual impressions, and the possibility to mimic the real thing differ from when using computers only. Also the impressions are remembered differently and more vivid by using models.

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

Estimating extremes

Typically a specification is a noun and a number. Such specifications are necessary but seldom sufficient. Just designing to specifications is not enough.

To find the best solutions it pays to think of the worst cases, the extremes, and to visualize extreme usage of the product. Let's say you design a new camera. Then think of what the camera must withstand onboard a sailboat during an around the world race. Water, cold/hot weather, shocks from tumbling around at the bottom of the boat. This gives you a better, truer, understanding than simply stating that the camera should withstand three consecutive half-sine pulses of amplitude 300 m/s2 and period 30 ms.

By thinking of the extremes and solving for them we almost automatically also solve for the in-betweens.

There is also a contrast effect of regarding opposing extremes that helps clarify problems and lets us see functional solutions with more ease.

Co-location - DPD Work Environment Concepts

Co-location

The importance of co-location cannot be overstressed. Projects failing to yield expected benefits can be ascribed to this fact.

Teamwork depends on constant communication. Through all channels: 1/ hearing the tone of voice, words used, 2/ seeing the body language, clothes used, skin color, 3/ scent: we pick up the messages from pheromones, 4/ tactile information, etc.

We humans have a bandwidth of approximately 10 Mbit/s when meeting face to face. All of this, except less than 20 bit/s, is unconscious communication.

Co-location of the team yields the following benefits.

1. The team stays focused. No stealing of team members' attention from other groups.
2. Short communication routs.
3. Easy to have impromptu meetings.
4. If for instance the project leader talks over the phone with the client, then the team, by over hearing the conversation is informed.
5. Facilitates the very important over hearing effect yielding efficient spreading of information. This also makes possible spontaneous problem solving which can happen when one team member hears about a problem and happen to have solutions to that problem.

When co-locating 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 what we are there for. 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.

Co-location 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 such smart aids to project work. Ones fantasy is really the limit.

Co-location 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.

Using the walls

By writing on the walls:

1) The high-level time plan 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.
    a) Changes to the time plan can be written directly on the plot, making them very visible to the team.
2) All important information such as:
    a) descriptions of the user of the product,
    b) pictures of its use,
    c) pictures showing the styling and environment where the product will be used is hung on the wall.
    d) 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.

Whenever a team member leans back or raises her 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, but it seems to be almost impossible to convince people to use it. Not until they have actually tried, can one convince them. But they say that the proof of the pudding is in the eating, so go ahead and try "writing on the wall"!