

White paper: DfM at a glance.

How to incorporate design for manufacturing (DfM) into the design process.

Introduction

Ask designers, ask makers, ask anyone involved in product design. Ask how do you apply DfM?

Answers fail to materialize. DfM is a concept without substance.

This white paper attempts to make the abstract concept of DfM concrete. Concrete so that it becomes a natural process step in designing.

Summary

Is it possible to design a product without knowledge of the manufacturing process?

Take nature as an example. Does an organism know how to make something? Many times it is evolutionary process of trial and error. It is the evolutionary principle which ensures that the product is optimized to its intended purpose. The Generative design¹ software² mimics the evolutionary process in an accelerated manner. The design is optimized in this software as an example the weight versus the strength. The software includes manufacturability parameters. The Additive manufacturing principle is often used.

Designing is only possible with knowledge of the manufacturing process.

This knowledge can be in the head of the designer or what will become more and more common in the future, is embedded in the design software. For now some design software³ is already provides with one type of manufacturing rules. Using this software without knowledge of creation process is not recommended. It's like using a tool without knowing what it's doing.

For a designer, it is necessary to have knowledge about how something is made and what the limits of the manufacturing process are. Furthermore, it is very important to know what all the design requirements are throughout the product lifecycle. (PLM). Also, knowledge of the business case [BC] and insight into the commercial aspects are very useful.

Since it is impossible to possess knowledge of all the occurring manufacturing processes, it is recommended to obtain this knowledge by going and asking the makers. A recommendation for the designers is to have direct, 1-on-1 contact with the manufacturing specialists. In practice, this means breaking through the commercial firewall. **Designer, go out there and contact the manufacturing specialist directly.**

Perform preferably the DfM study in the concept fase of the design. This is where the impact on costs is greatest.

Definition DfM

Wat is de definitie van DfM?

DfM is the general **engineering practice** of designing products in such a way that they are easy to manufacture. Zooming in DfM engineering practice are:

- **Design Rules:** What must be adhered to for a successful fabrication.

¹ Explaining Generative design software <https://youtu.be/SzKE7oFfF80> (15min)

² Free open source Generative design software <https://youtu.be/o17b7C4N1ul> (6min)

³ aP Design software <https://www.apriori.com/>

- **Process Variability:** Knowledge of inherent process variability.
- **Yield Optimization:** Maximize yield.
- **Reliability:** Ensure reliability throughout the expected lifespan.

All above mentioned aspects **require knowledge** of the manufacturing processes.

Engineer is no longer practical today

This is what you hear in the conversation with the interested party. Is this so?

It is often the managers and senior experts who confirm this. What is a fact is that the designer's level of education is now often of a higher level than it used to be. In the past, that population consisted more of practically educated people. People who have actually been at the lathe. Now they are more theoretically trained designers.

So yes, it's true, the designer is less practical. There is no doubt that practical insight is needed into the design. In order to obtain this, it is first of all important that it is recognized. After that, it is possible to increase practical insight.

In addition to other skills, such as problem-solving ability, willingness to change, IT knowledge, social skills, analytical insight, **technical knowledge is especially necessary.**

Because today's designers mostly have a theoretical education, having sufficient technical knowledge is often insufficient. This in itself need not be a problem. If a designer is aware of this and acts accordingly, it is just a matter of time to become a good designer.

You acquire this technical knowledge during your education and later in the work field and in refresher courses. Technology evolves very quickly, so keeping up is the message. By having sufficient passion and curiosity, one becomes a good designer.

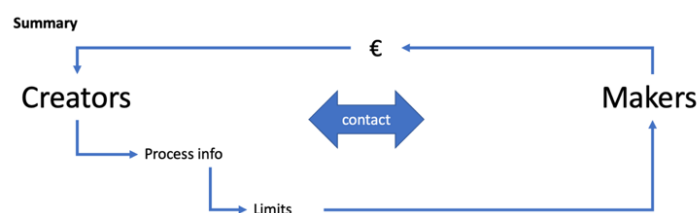
Awareness of the entire product life cycle

Often the designer is only focused on translating the specification into a good (computer) model. Knowledge of the business case [BC] and insight into the commercial aspects of the project are mostly missing.

For a designer, it is important to be aware of the PLM and BC aspects of their design. Knowing these aspects in detail is not necessary for the designer. But it really has added value for the designer if he or she has knowledge of the PLM and BC. Not everything can be described in the design specification. Also here, if you are aware of this lack of information. You can ask for it.

Breaking through the commercial firewall

The 1 to 1 communicating between the creators and the makers is oft missing. As a result, the cost price targets are not being achieved.



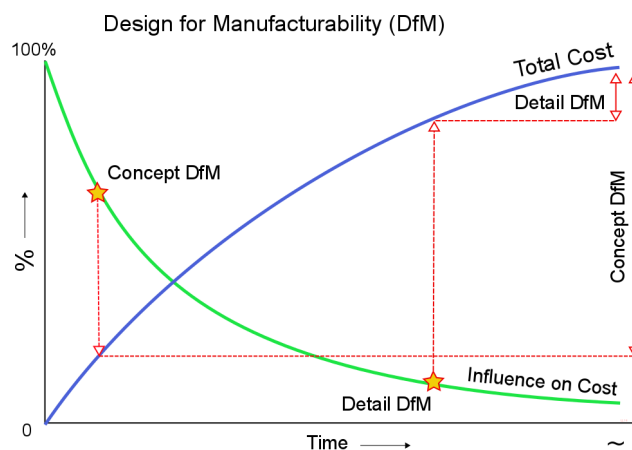
Interactie between the Makers and Creators.

How do you get a grip on cost price as a team? It is clearly a necessary factor, but also a slippery one. How can you manage it as a development team?

At the beginning of a development project, I often see a cost target, but often the team lacks the skills to steer accordingly. They request a quote for the parts which they suspect to be expensive and that's it. Sometimes an older colleague tells us that the cost price can still be reduced once production starts. Letting go of it. The cost price target is often an easy to cut corner. As a result you get over-dimensioning and expensive designs.

The focus on cost management is disappearing in many projects due to the great pressure on lead time. Customers are in a hurry, they want the product as soon as possible.

The idea is that a design step to make it cheaper can be done later. But later often does not come, because then it is already waiting for the next project.



Fortunately, OEMs have their purchasing department on hand. That Colleagues put pressure on suppliers to lower prices calculate. But that's not exactly a good start to a long-term cooperation in which even more discussions about cost price reductions will follow. The discussion by the purchasing department with the supplier is on the right side of the graphic. The influence on the cost is then minimum.

Managing the cost

If the design team is during the complete project is managing also on the cost, the result is a design that will meet the cost price target. To do this it is important to make a cost target breakdown for all aspects of the production process. (Incl logistic, packaging, etc.) Also involve the manufacturer early in the design process. What also will help is do some value analyze. Don't wait contacting the manufacturer until the design is finished. So break the commercial firewall. Contact the manufacturer.

At the beginning of the project, make a cost price target and substantiate it with a cost breakdown. This makes the price target for subsystems and expensive components more concrete. Also include assembly, testing, and packaging, and assign them to the subsystem to which they belong. Also write out a rough draft of the future production process as a flowchart or Gantt chart. This allows you to check whether you are complete. Next, estimate what the outcome of your design could be. Depending on the difference, target versus cost estimation imitates actions to lower the cost or adapt the cost target. In any case, do something! Don't wait for the design to be finished.

Sometimes in the design team has a cost calculator. If so it has advantages and disadvantages. The advantage is that it is easier to assess a (concept) design on the cost aspect. However, it also has disadvantages. The disadvantage is that then the designer has too little focus on the cost aspect of his or her design. After all, the designer is the conductor of the design team. As the conductor, he or she should deploy the cost calculator at the right

time in the design phase. In practice, this often does not happen. In part, this is due to management. If it is not asked for then it does not happen. Another factor is the inexperience of the design team. Often the cost aspect of the design is pushed to the future.

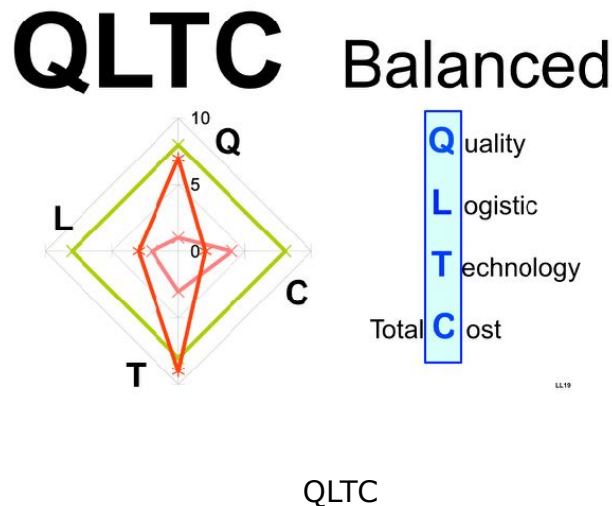
When to perform a DfM study?

The best phase in a project to conduct a DfM study is in the concept phase. This is where the impact on costs is greatest.

Before the DfM study can be carried out, there must be a (concept) design. Without a design that meets all the requirements, it is pointless to conduct a DfM study. It is also recommended to include several concepts in the DfM study. After all, in the concept phase, the choices made can have a major impact on the creative process.

How to perform a DfM study.

The production process is the outcome of a weighing of interests between the different interests.



The QLTC balanced score.

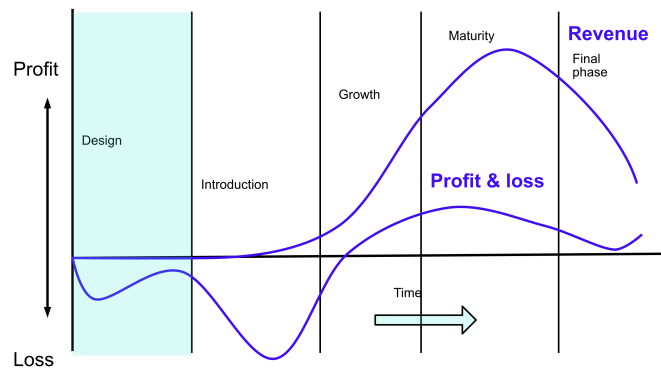
The **quality** of the product or service. This should be discussed in detail in the design specification. The quality can be expressed in: the maximum number of failures per unit of time, probability of failure and in the minimum lifespan. To manufacture a product and transport it to the customer, a well-functioning **logistics** system is needed. This aspect is usually overlooked by inexperienced designers. **Technolog** is usually the core of the document. All **costs** including the expected profit margins. These are usually underestimated and overlooked by the design team. This always causes a hassle afterwards.

Total lead time.

The best way to conduct the DfM study is; First to look at the **total lead time needed to complete the project**. In other words, compare all the future steps of all the concepts that need to be done to complete the project. Focus only on the future. What has been done cannot be changed. Secondly, look at the costs. Costs are always a derivative of future actions.

Time.

Take the time needed to perform the DfM study.



Product lifetime cycli

As you can see in the graph above, for a company the development process is a very large cost item (*the marked part*). That is why it is important that a high-quality design is realized.

As an example, the following rule of thumb is used: Fixing an error in the design costs a certain amount of money. If this error is corrected in the introduction phase, it costs 10x as much. If, on the other hand, the error is discovered when the products and/or machines are already with the users, this costs the company 100 times as much. Preventing a mistake cost nothing. That is why it is important to design methodically. Methodical design does not guarantee the prevention of errors or defects. However, the chance that they occur is very small.

Therefore take always the time needed to perform the DfM study. Don't take shortcuts in the methodologically design process.

'There's never enough time to do it right, but there's always enough time to do it over.'

Justification

This white paper was created to emphasize the importance of knowledge sharing for the manufacturing industry.

For more information about the the DfM proces see the book; **Design for Manufacturing (DfM) Influence on Quality and Cost. Gate way to manufacturing knowledge.** Insight into the production aspect of the design. ISBN 9789403777726

The book is the gateway to knowledge about DfM and DFA. It helps simplify designs and reduce production costs, which usually make up the bulk of a company's investments. The goal of this book is to find the right QLTC balance in a design.

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