SMART MODEL BASED SYSTEMS ENGINEERING EXPLOITS DORMANT POTENTIAL

New, advanced production technologies improve efficiency and decrease time-to-market: both aspects that strengthen your company's competitiveness. They can also help to find solutions to urgent challenges in machine construction, structural poverty in the labour market and new flexible work ethics.

In the widely accepted and widely adopted way of working with OEMs (Original Equipment Manufacturers: companies with their own product), the machine is completely 'customer order driven', being designed, produced and sold in accordance with the buyer's specifications. This was a solvent business model, but it has done our marketplace no favours. It goes too far to describe the process as 'bad', but there is certainly room for improvement.

If we zoom in on the business process part, 'Engineering', we can conclude that in this way of working the technicians are part of the primary chain. In other words: the pace at which the technicians can work out the end products ('developing' is too big a word – but more on that later) determines the total production volume.

Herein lies the opportunity

When the end products have to be worked out under high working pressure within the aforementioned system, you get a specification set with a lot of 'room' for your own interpretation –euphemistically-speaking. In the past, that 'own interpretation' was left to men and women with years of experience determining the client's preferences and possessing enough working knowledge, gained over many years of learning from their mistakes, to make the product. But this luxury is rapidly disappearing.

Long-term employment is not an extravagance that has been spent on the generations that have recently entered or are now entering the labour market. 'New arrivals' have not been allowed time to grow into their employer's products and to develop into specialists in them. In addition, the exodus of employees due to ageing is greater than the growth of new talent. Our challenge, therefore, is to do more with the same (or fewer) people, while maintaining - or improving - the quality.

Better design, more profit

A lot of research has been done into the effects of product design on the efficiency and effectiveness of a primary business process. For example, the 'engineering component' in the cost price of a product is only a few percent, while its effect on the cost price is about 70%. In other words: there is a lot of money to be made with a good product design.

The paradox is this... creating good design takes time. In the aforementioned classical way of working, there was no such time allocated. We base this observation on the logical deduction of facts and circumstances and on our long-standing experience. From the facts and circumstances we can also deduce that changing to a different way of working – let's call it a new or SMART way of working – requires a different way of thinking. This is precisely why SMART Industry initiatives are so difficult to get off the ground.

We took a deep dive into this conundrum, attempting to marry our way of thinking about Smart Systems Engineering with the current interpretive approach. We translated this into our Smart Model-Based Systems Engineering service.

Smart Model-Based Systems Engineering

Quite some time ago, PhD research was conducted at Stockholm University on modular product development. The idea behind this was to be able to put together the end product, without needing to work out a variant every time. In other words: modular product development that takes the technicians out of the primary chain.

This is a most important finding. By putting together exactly the same variants of the same product families instead of having to work them out, you have the capacity needed to make good product design. However, the same paradox still exists. An investment in knowledge and time is needed to make this way of working possible.

How do we do that?

We consider any end product that belongs to the same product family as a variant - a 'configuration' from the same library of finished products. In this family of end products – and there are often many – the same functions are repeated every time, each time in slightly different versions. In the current pool of product data, this information is 'hidden', therefore unnoticed. It is there, but not accessible and therefore not reusable. The knowledge is there, lying dormant, like a vein of gold that has yet to be mined.

We can do the mining by applying what is described in Erixon's thesis. First, we isolate the functions that are in the product. By 'the product' we now mean all variants of end products from one product family. We call this 'modular function development'. Based on the needs and requirements of the market that fit the product family, we design a modular product architecture.

To ensure that we make the architecture accurately fit the market need, we describe the variation within each function. For this we apply System Modeling Language – SysML. In practical terms, we describe each property – attribute – of the function with its different variants.

Validate with the Stress Test

In the V-model, we already have the left leg in the picture, but in reality, we still have to validate it. To perform a validation between the left leg and the right leg of the V-model, we conduct our 'Stress Test'. Remember, we are working on the extraction of a gold vein and in this case, the 'gold' is the product information that has already been generated over the years. In our stress test, we validate the newly designed product architecture. It is not yet geometry; it's simply a definition. We ask the question;

> **"Can we also compile the previously delivered end products – variants – from the architecture that we have now defined?"**

The journey is still feasible – even though it may seem complex, – but there is now a more time-consuming job. We run into the challenge that the existing product information has a different product architecture. On a deeper level, CAD models are structured differently, in such a way that we have to rebuild each variant in CAD, taking into account the new architecture. In this way, we make the CAD models in a form that can be assembled.

Doing more with less

Now that we have the CAD models – both electric and mechanical – and the software in our hands, it is a good time to revisit the premise that good product design can make a lot of money. We now set ourselves the challenge of making different function variants – which we already have to fit into the new architecture – from as few different parts as possible. Naturally, it should have the same number, or more, variation options. We do this with our Lean Product & Process Development method: a way of product design in which we 'serve' both market requirements and production restrictions.

After undertaking this process, we create a product platform, based on the library of previously delivered finished products within one product family. We have found the gold, at last! It has become a System. We can now answer the same market questions by putting together different variants of the different sub-functions.

> **We call this configuring.**

We can now also purchase the parts in a different way, in supply chain management. In the classic way of working, this was only possible after the specifications were ready; now this can be accomplished well in advance. We can move to another 'Logistics Concept'. The idea of 'pulling production' is commonly known under the term 'Lean Manufacturing'. Our argument is that at the heart of Lean Manufacturing lies good product design. It is 'Design Intent'.

Maintain and expand

Now that we have designed a system of mechatronic objects and 'filled' it with an appropriate design, it is important that we maintain and expand this system. This is perhaps the most crucial aspect of our story. The OEM must now further expand and maintain their modular product. Their technicians need to learn their way around the system of mechatronic objects. You cannot just make an adjustment without evaluating the consequences, and there are always consequences. In such a system, maintaining the design requirements, the 'Design Constraints', is a crucial success factor. When an interface – the link between different variants of different sub-functions – changes, as a result of the change, a number of items suddenly no longer fit, and the system therefore becomes less effective. Ultimately, this leads to degeneration of the system, and this needs to be addressed.

VIRO helps

VIRO acts as a vital instrument in this transition. For the transition, VIRO not only supplies engineers who are fully conversant in this different way of working, but also provides our wealth of knowledge in this field to help companies tackle this.

We 'know-how'!

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