Common Language to Ensure More Effective Development of New Products

Products are becoming significantly more complex. Hence, there is an urgency for a cross-disciplinary and systematic approach to product development. For this reason, a Danish chapter of the network INCOSE is being formed, the goal of which is to make people acquainted with Systems Engineering Product Development.

The development of new products is becoming increasingly challenging for many companies. Products are becoming more complex, covering the spectrum of mechanics, electronics, and software. This means that the risk of making expensive mistakes during the development phase rises sharply. Hence, there is a rising need to ensure better cohesion during the development processes.

Against this backdrop, many Danish companies have chosen to increase focus on the discipline of Systems Engineering (SE). Just recently, representatives from a number of companies and educational institutions have formed a Danish chapter of the international SE network INCOSE, in order to disseminate knowledge about SE and establish a forum for an exchange of experiences on how SE is applied in Danish companies.

SE is a holistic approach to development processes. SE provides any company with a common language, which helps to ensure that the development work is carried out optimally, bearing the goal for the new products in mind. In this manner, SE effectively does away with the silo mentality, which often permeates development projects, where the companies' separate development functions sit isolated on each of their own islands, working more or less in a vacuum with no interactive communication.

One of the Danish companies that make extensive use of SE is Terma, headquartered in Lystrup close to Århus. The company develops advanced systems for defence departments, including aviation, aeronautics, and security.

"With SE we are able to identify the actual needs before we initiate a development project. Additionally it ensures that we are continually up to date with regard to our goals throughout the project," explains System Engineer Claus Broch, who works at Terma's division in Herlev.

One of the areas where Terma has applied SE is for the development of the Command and Control System for the new Royal Danish Navy frigates of the Iver Huitfeldt Class, including integration with the missile based air defence system.

"We are convinced that a suitable dose of Systems Engineering has been a contributing factor for a successful project outcome in terms of customer satisfaction, fulfilment of operational requirements, and the financial and time-related matters," ascertains Claus Broch.

Terma has also used SE during the development of a self-protection system for the British Royal Air Force Tornado jets. The project was run on a very tight time schedule, but crossed the finishing line on time and became a huge success. This was achieved by
using mechanical, electronic, and software components from different projects and integrating them into a new solution, which met the customer's requirements.

"Once the pilots had got acquainted with the system, they refused to fly without it when flying on serious missions," recounts Mikkel Vestergaard Hansen, who heads Terma's SE Division for Airborne Systems.

GN ReSound in Ballerup develops and produces hearing aids. Five to six years ago, there was a sharp rise in the complexity of the products, primarily due to the introduction of wireless communication with related accessories and software features. For this reason, GN ReSound decided to introduce SE into its development work, which has been a key factor in the company regaining its lead in the industry.

"We quickly became aware that the situation was even more critical than before; that mechanics, electronics, and software were not developed in separate silos, and that it was paramount to have a system-based approach to prevent grievous errors only being discovered late in the development process, or that we even might be forced to reduce the functionality in order not to delay the launch of new products," explains Niels Christian Jensen, Requirements Manager at GN ReSound's SE Department.

GN ReSound's SE Group is cross-disciplinary and deals with requirement specifications, architecture and design, and test processes. The group also serves as a link between product development and marketing.

"SE has given us a bird's eye view and greater cohesion with regard to our development work. Our development projects are more predictable, and we avoid being surprised by grievous mistakes. We manage to develop the products that make sense to the end customers," says Niels Christian Jensen.

System Engineer Jens Christian Andersen from Novo Nordisk in Hillerød has, among other things, been a visiting lecturer on the development of safety-critical systems at the Technical University of Denmark. In his opinion, it could also be advantageous for small companies to apply SE:

"Small companies, whose products have become increasingly complex with built-in electronics and software, would do well to tap into the experience that larger companies have with SE, and here INCOSE Denmark can play an important role," he says.

System Engineer Henrik Balslev, Partner in the Consulting Engineering Firm Balslev & Jacobsen in Copenhagen, points out that the construction industries in Denmark are discovering the potentials inherent in SE:

"It all began with the construction of the Opera House in Copenhagen, where SE elements, which turned out to be highly effective, were included in the project. These days, the construction industry is introducing fundamental SE elements as the new common industry language, which forms the basis for far more efficient construction," says Henrik Balslev and adds:

"Regardless of the realm in which a company moves, SE will provide it with a simple and precise cross-disciplinary language. Furthermore, the built-in SE management tools
ensure increased efficiency, improved finances, and quality throughout development projects."

Educational institutions are also showing increased interest in teaching SE to engineering students. The Technical University of Denmark and the University of Aarhus are in the process of strengthening their efforts in the SE area:

"There is a clear industry need for graduates with SE skills. To us, it is interesting that we are dealing with a discipline that covers several different domains. As it stands today, we offer a few courses that are related to SE, but are planning to establish an actual degree programme. It is the plan to make SE a pivotal part of several different programmes. In that way, the graduates will still become specialists within their own area, and at the same time acquire a set of skills to make them understand how to build complex systems," says Jan Madsen, Professor at the Institute of Mathematics and Computer Science, Technical University of Denmark.

Jan Madsen hopes that the Technical University of Denmark will be able to launch an SE Programme starting next year, focussing on IT and Electronics Development. Furthermore, he confirms that the Technical University of Denmark wishes to strengthen its SE research, in particular concentrating on the early phases of development, where many of the central parameters suffer from significant uncertainties. A model-based approach would make it possible to model and simulate a system at an early point of the development project, so that SE can be applied as a tool in the decision making process.

PhD fellow Claus Ballegaard Nielsen from the Department of Engineering at the University of Aarhus says: "We are seeing increased industry interest in people who can think in systems and have interdisciplinary understanding, and there is also significant international focus on SE. For this reason we would like to strengthen the SE Programmes. We already offer two SE classes, one of which is an introduction to the subject, and the other an advanced course for engineers at master's degree level.

BOX:

**SE in Brief**

SE has two important components:

- **SE Management** ensures that development takes place in clearly defined stages, where purpose and mutual dependencies are crystal clear. The technique is described in ISO/IEC 15288 - System Life Cycle Processes.

- **SE Technique** ensures that each design successively is segmented into clear subsystems. Each subsystem contains a well-defined responsibility placed in the organisational structure, and is made clear by adhering to specific system design guidelines. The technique is, among other, described in ISO/IEC 81346 - Structuring of Systems.