High-tech systems in their environment - Report on Incose 2008 STT2

Teade Punter
Embedded Systems Institute[1]

High-tech systems

High-tech systems are a main export product of the Netherlands. The contribution of these systems to the Dutch export was 24 billion euro's in 2007[2]. For example, this exceeds the share of food & flowers, a recognized Dutch export product. High-tech systems are complex machines that fulfill a sophisticated task. They are developed and produced by using and integrating several technical disciplines, such as mechanics, hardware and software (digital hardware combined with its software is denoted as an embedded system). Examples of high-tech systems are: Magnetic Resonance Imaging (MRI) systems and wafer scanners for the lithography step in the integrated circuit (IC) production process.

The development process of high-tech systems should be characterized as a concurrent engineering approach, rather than a linear process. Development phases are (partly) done in parallel to shorten development time, to increase quality and to reduce the development cost. This dynamic and flexible approach is needed to deal with the continuous change in requirements: the 'Tsunami' of functionality. Another driver for a concurrent engineering approach is that timing of new products is based on new technologies. For example, in the low-end TV market, TV-suppliers shop around each half year to find appropriate (quality versus cost) components for their TVs.

Environment perceived as a flow of activities and systems

During the Incose 2008 conference in Utrecht, a Sub theme track (STT) was organized to pay attention to high-tech systems. The focus was on *High-tech systems embedded in their environment*. Its goal was to show that high-tech systems are often part of a chain with other machines and systems -'systems-of-systems'- and to find out how systems engineering should deal with it. To illustrate this, the STT attendees were provided with two examples.

The first example is the lithography step, which is conducted by a wafer scanner. It is one of the IC production activities in a process that is done in a chip foundry: slicing of wafers, polishing, material deposition and modification, developing and baking, etching, removing of photo resists, and packaging. Most of these activities are conducted repeatedly, about 40 times repeatedly, to produce a wafer with ICs. The challenge during lithography is to expose the chip design with the right overlay and line width.

Production of wafer scanners

[1] The Embedded Systems Institute has the responsibility for six projects on improving high-tech systems development. The institute works together with industrial and academic partners.
[2] http://sync.nl/nederlandse-hightech-industrie-goed-voor-24-miljard/

Overlay is the measure for displacement of one pattern, result of a lithography steps to another pattern, result of a subsequent or previous litho step. The line width is defined in nanometers, at the moment 32 nm gates common in chip design. However, mutual dependencies between activities in the IC production process exist. After exposure, the line width is for example not yet fixed. The oxygen in the air might change the line width a bit after one of the lithography steps. Only after the baking step the line will be fixed. Metrology data about wafers that are just exposed is needed to define the next activities in the overall IC production process. All this implies that the systems related with the IC production activities should know about each other to improve overall productivity and quality. This will even more important for a wafer scanner producer, like ASML, which aim is at being ahead with shrinking the chip design.

The importance of system environment is also increasing for medical systems, such as MRI and X-Ray scanners, to improve the value of the systems itself. Philips, the host of the STT-tour, showed that a better efficiency -and with that cost control- is becoming more important to enable access to healthcare for all people in the future.

MR Achieve system

Over the next fifty years the rapidly growing world population will add significant stress to already strained healthcare systems. Using new technologies and IT platforms should help to relax the tension. Process thinking is a key issue. An example is the approach to deal with acute coronary syndrome. In the existing situation, the individual activities in the analysis and treatment of this syndrome were done on their own, which resulted in a long throughput time for the patients. Since the implementation of the so-called 'door-to-balloon-time' approach, the activities are aligned in a way that the whole chain is considered. This has resulted in a reduction of treatment throughput for this syndrome.

<u>How to embed high-tech systems in its environment?</u>

Several factors will impact the embedding of high-tech systems in their environment. Interface management is needed to know how and where systems can connect. The exchange of patient files between hospitals was mentioned as an example during the STT panel discussion. Standardized data interchange is required for this. However, in practice this interchange is hampered because of the different dialects in communication between hospitals when interpreting the standards. Latter is due to social and cultural factors as well as to competitors that make standardization harder.

The STT panel agreed that although interface management is important, it is not a sufficient condition when linking systems in their environment. For example, also operational system(s) understanding is needed to find the right system boundaries. Furthermore, a flexible attitude is required. This means that upcoming new requirements should be taken into account and therefore specified in an iterative way. Furthermore, the stakeholders should be able to upgrade the systems in use. Systems once defined for a

particular purpose might be used for other purposes as well. For example, in the Iraq war systems work together that were never designed to work together: a radio controlled toy to clear away mines.

Finally the control of the flow of activities was discussed. However, full control will be not possible. Even if high-tech system suppliers have a major market share, they will have difficulties to get fully control, e.g., due to customers that do not allow a supplier to have a bigger market share. The overall conclusion for this STT is that a systems-of-systems approach is a fact of life for high-tech systems in their environment.