PART II - Drivers & Design Principles

Industry 4.0 is originally a high-tech initiative by German Government for production technologies based on integrated automation & ICT & manufacturing technologies launched 2011. Before we will discuss buzz words or topics like “Smart” factory, Cloud Computing & Big Data, Cyber-Physical Systems (CPS) or the Internet of Things (IoT), we should call back the original drivers for Industry 4.0.

According to a study of McKinsey & Company, Industry 4.0 is seen “more an opportunity than it is a risk”. Around 92% of the companies having been interviewed in Germany, 90% in the U.S. and 78% in Japan share this view. In general, an average increase of turnover is expected: 14% by U.S. corporations,10% by German and Japanese companies. Furthermore, significant cost savings are expected as well: 10% in average by German companies and 12% by Japanese and U.S. corporations. Even if you have some doubts about the figures, you perceive the general attitude. It is nice to have positive expectations. However, the main challenge is still the question: how? Furthermore, which areas have to be improved?

Let us have a deeper look into manufacturing and automation. We assume that it sounds familiar to you that today’s markets having become volatile and turbulent in the context of globalization. Furthermore, we are facing a strong pressure on costs and on product and production life cycles: development times have to be shorten, the number of product variants is increasing and the product quantities are not always increasing, but also decreasing including a shorter product life cycle. Think about the pressure on consumer goods like mobile phones, but also on industrial products like machinery. That is one of the main drivers of Industry 4.0: How can we achieve high flexibility in production, increase quality, reduce costs for an increasing number of variants and (maybe) decreasing quantities at the same time? For better explanation, let us take a general-purpose machine. As the name is implying, this machine type provides a high flexibility; you can produce quite a wide range of variants. However, productivity is low, e.g. due to set-up times, in comparison to flexible manufacturing cells or transfer lines. On the opposite side, transfer lines enable a high level of productivity, linked to lower costs and high volumes; but of course, the level of flexibility and variants is decreasing, even if you consider how many choices you have as a customer to define the interior and colours of your favourite new car.

One of the paradigms of Industry 4.0 is that German industry has to stay competitive or win new competitive advantages not only by process technology and plant building but also by automation solutions providing solutions for decreased volume production, increasing flexibility and productivity on the same side, see figure 1.

How? In figure 2, you can find concepts derived already at begin of our century. Today’s challenge has already been predicted in the research area. The high-automated manufacturing lines and flexible manufacturing cells or Automated Guided Vehicles (AGVs) have become state-of-the-art. Different assistants systems have been developed as research platforms or prototypes, e.g. by Denso company or Fraunhofer society. These are mainly mobile platforms with manipulator arms. But which are the guidelines to develop an Industry 4.0 solution?

- The ability of aggregating and visualizing information and/or support physically human co-workers, i.e. technical assistance, is one of the four main design principles of Industry 4.0.

- Second, in order to enable inter-operability, mechatronic systems have to be able to interact via the Internet (IoT).
- These intelligent mechatronic systems which we call Cyber-Physical Systems (CPSs) have to be able to take decentralized decisions: This means the ability of CPSs to take decisions and perform actions autonomously. This is based on new solutions of artificial intelligence and big data. Multi-Agent Systems could be considered as enabling technologies and solutions in this context.
- Within development and the life cycle, information transparency is the fourth design principle: the ability of information systems to create a virtual copy of the physical world, which is enabling digitalization within product and production development and automation.

Summarizing, Industrie 4.0 is based on fascinating, but ambitious design principles. The objectives are really challenging, but promising if you share the view of its promoters. To understand, how we can take advantage of Industrie 4.0, we would like to consider the concepts and developments within engineering and digitalization in our next article.

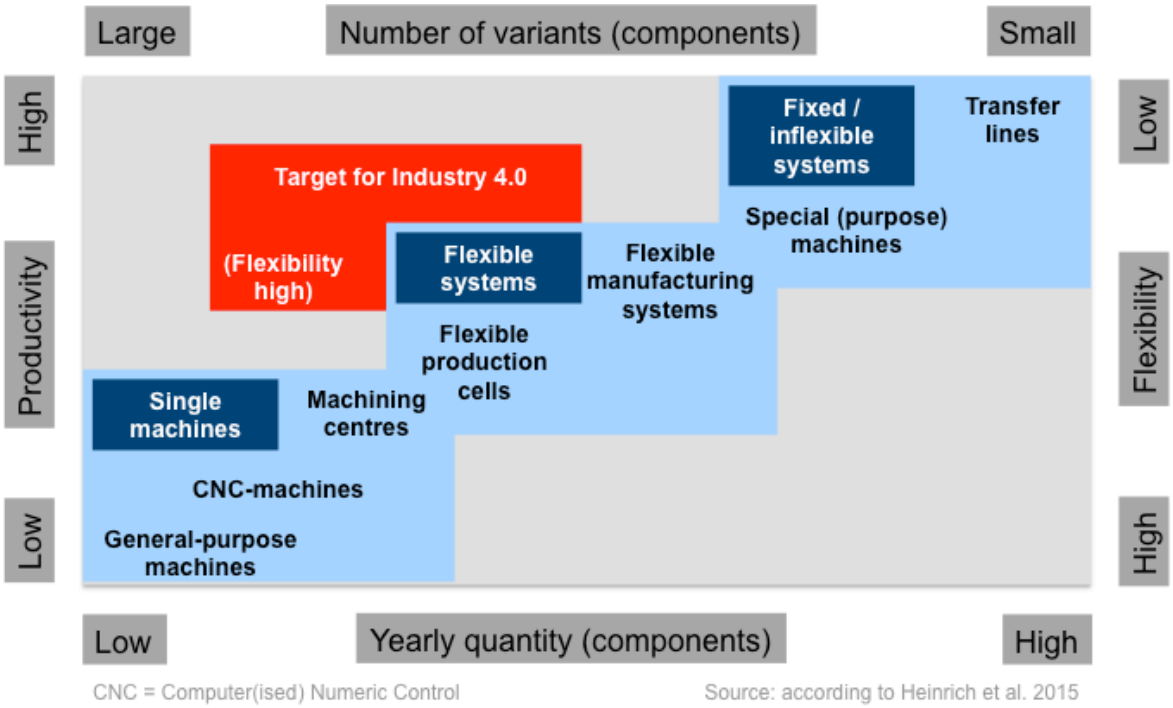

Figure 1: Industry 4.0 – The Challenge

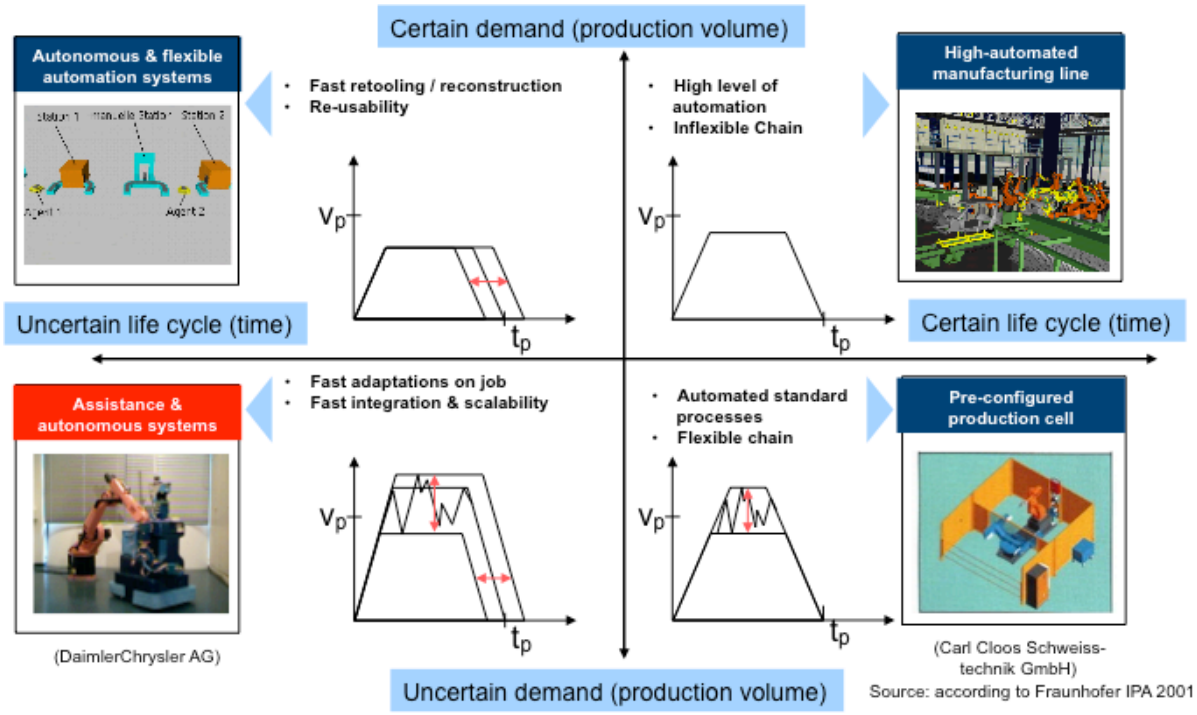

Figure 2: Management – Automation Concepts – From robot to production assistance system