Smart machines need smart engineering

Whether you call it the Internet of Things (IoT), Industry 4.0, or the age of the digital twin, it's clear that we're entering a new industrial revolution. In the industrial machinery market, the impact of new technology will see manufacturing computerised – with production lines featuring smarter, more connected and more complex machines. In this article, Bill Davis, Director, Industrial Machinery and Heavy Equipment Industry, Siemens, explains how this, and other trends, means that the machine-making industry needs new ways to work that are more collaborative, versatile and flexible. In short, in the age of the smart machine, the way those machines are designed, engineered and delivered must be smarter too.

Customers demand more

Those of us who fondly remember the *Terminator* movie franchise will recall the scene from *Terminator 2* when a designer from Cyberdyne Systems realises that machines have become self-aware. While we're not at the point of 'singularity' yet, machines are becoming more intelligent with the ability to do more things automatically. Take a perfume production line. Machines are available now that can work autonomously and continuously, changing the contents of bottles, and their labels, based on digital work instructions.

In the future, machines will also become part of an integrated production line – using sensors, connected over the internet – to provide real-time data on production progress and the status of the machines themselves. For example, machines will be able to monitor their status, including variables such as temperature, hydraulic performance and pressure levels. They will auto-flag anomalies to engineers who can remedy the problem before it becomes a major, and expensive, malfunction. Data collected from machines will be part of a wider data ecosystem with technology such as actuators, sensors, wireless video cameras and RFID readers in plants providing continuous information from the production line. This data, analysed and processed in the cloud, will give better operational intelligence on which people – and machines – can take better decisions. While these developments are to be welcomed, for machine-building companies, they massively increase complexity. In particular, advanced software – with millions of lines of code – is required to control machines.

Touching machines

To date, machine controls and interfaces have been somewhat 'clunky'. But as technology advances, customers are interested in interfaces that are much more intuitive, such as touch-screen systems that require minimal training and allow greater control over the machine. This requires the development of more advanced software – another factor that's adding to the complexity of machine design.

Complexity is increased, too, by demands from manufacturers. In key markets – from cars to consumer goods – people want ever more customised products. And customised products require customised machines to make them, with customers increasingly specifying machines that demand bespoke design. Indeed, the days of designing, building and supplying a standard model of machine, with a long life cycle, are dwindling.

On top of these issues, the environmental agenda, coupled with changing safety standards, means that legislation is a moving target. To comply with demands, machine configurations need to be changed more often. In addition, the rise of machine makers in lower-cost economies means that globalisation is increasing margin pressure.

With these issues in mind, as an industry, we need to find ways to do things differently. We need to cope with the ever-growing rise in machine complexity, find efficiencies to cut costs, and be more flexible – designing, developing and engineering machines in more agile and accelerated ways. In short, we need to move to more advanced machine engineering.

Machine-making the smarter way

The cornerstone of advanced engineering is a digital platform that hosts all project work, enables collaboration between teams, and stores and catalogues all work, ensuring that IP can be easily reused. Moving to a unified system, designed for the project lifecycle of machine design, enables machine builders to take three key steps that enhance production processes:

1. **Adopt mechatronic design:** Using systems engineering principles, a customer's requirements can be traced all the way through from initial discussions to finished design. Importantly, software is enabling the creation of more advanced functional models. The model provides a common framework for mechanical, electrical and automation disciplines to work together in parallel. For example, mechanical designers can use concept models for detailed design; electrical designers can use model data to select the best sensors and actuators for each machine; and automation designers can apply cams and operational sequence data from the models to develop software.
2. **Engineering to order:** Digitising project management also supports a move to modular design – using software to break customer specifications into discrete parts that can be worked on separately. These modules are likely to be reusable and therefore reduce the number of design cycles required to build a new machine. This approach also mitigates the cost and time issues that arise when customers specify a bespoke machine.

3. **Virtual commissioning:** Perhaps the most interesting area in the evolution of machine design is the creation of 'virtual machines'. Complete, and detailed, 3D digital virtual clones of machines can now be built to design, test and commission new products.

Design concepts can be built quickly and the software has the capability to simulate the effect of variables such as gravity, friction and the performance of electrical systems, fluids and pneumatics. The model can also be connected to controllers in the physical world to bring hardware into the loop of the design process. Our software connects with a wide range of controllers from different vendors and supports the simulation of a shop floor Programmable Logic Controller (PLC). The use of virtual commissioning helps to make the development cycle more efficient by allowing testing to start before a machine has been built. It helps identify issues earlier in the process, so preventing unidentified problems causing expensive delays further down the line.

Engineering time savings

Customers we speak to that are using Project Lifecycle Management (PLM) tools with the capabilities described above estimate that development time is cut by between 20 and 30 per cent. The savings especially come from the reuse of IP and the use of virtual models that make it easier to design, test and commission machines. For instance, the team designing the PLC software can be given a conceptual design to kick-start their programming and they can start to simulate their software's performance much earlier (in the conceptual phase) to avoid errors and greatly ease the software design process.

PLM tools also provide the real-time digital collaboration framework that's needed to coordinate global teams across different disciplines. It seamlessly integrates the work of different groups and creates alerts when a change to a design in one area may have implications elsewhere. This improved integration can also save considerable time.

As machines become more connected and autonomous, the designing and building of them will only increase in complexity. To create these advanced machines, advanced software is needed: software that's dedicated to the task in the hand and which, through intuitive collaboration tools and interfaces, makes it easier, more cost-efficient and faster to build the customised machines of today and tomorrow.