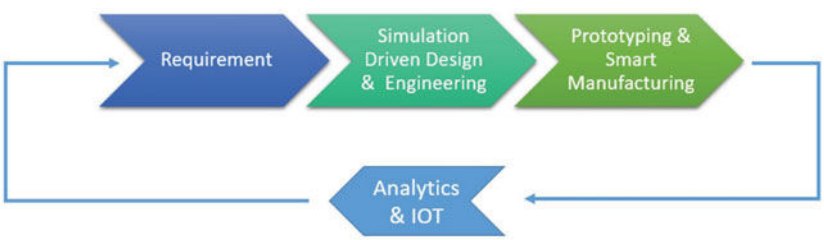
Right design strategies in the age of smart manufacturing

Products from mass customisation segment in the age of Industry 4.0 pose different challenges to design and engineering teams. Smarter tools can make mass customisation possible using smart manufacturing methods in smart factory, says **Karthik Shankaran**

In the digital age, automation, internet, data sciences and analytics are playing a critical role in manufacturing and keeping it smart. In Industry 4.0 and beyond, products that are of 'mass customisation' nature is spread across different industry verticals and have brought together IoT, different dimensions to product design and engineering besides defining the need for emergence of smart factory.

Conventional product development process



The transformed product development process in the smarter age

In today's highly competitive market, each company is trying to get their products to market, better than the previous version, and faster than their competitor. The mandate of fast to market would continue to be relevant not just for manufacturing, but also for design and engineering. This calls for transformation to product development process, from the traditional method, towards a more virtual process. The virtual product development process involves simulation driven engineering, and a model based systems engineering approach. In the age of smart manufacturing, where mass customisation also plays a significant role, time is of the essence. The scope for physical prototypes based product validation from design and engineering stand point would result in a highly condensed timeframe, which would enable products to get to market faster. Design, virtually validates the product performance and then manufacturing would be ideal work flow considering the data and simulation driven approach in the age of "smart manufacturing".

Strategic designing

Generative design approach brings in manufacturing considerations upfront into the design exploration process besides the structural performance and mass optimisation considerations. The advantage is no different, while topology optimisation approach is adopted to come up with mass efficient concepts that consider manufacturing feasibilities. This way the design and engineering methodologies do factor in the downstream "smart" manufacturing methods. With additive manufacturing it is feasible to realise several efficient structural load paths/ topology arrived at by optimisers. The topology optimisation-based approach and connectivity to smart manufacturing method have been leveraged already in aerospace industry.

For instance, in the bio medical industry, methodologies like CAD data morphing, automation of CAE/ Virtual validation process and connectivity to manufacturing method holds significant value. Patient specific hip implants, for example would immensely benefit from this tightly integrated design, engineering and additive manufacturing process. This advantage makes sense to patient specific dental implants and bridges as well. With advances in 3D model creation and morphing techniques it is possible to make patient specific or pathology specific pre operative rehearsal. This is yet another way how morphing tools are helping out realise appropriate product configurations and then with STL interface the morphed model could be used for 3D printing. Smart manufacturing is very much applicable to even 3D print Mitral Valve that could be used as a surgical training tool.

In the automotive industry, smart factory has agile and flexible robots. It is possible to accommodate

changes to the product with minimal intervention. Automotive and commercial vehicle manufacturers have plenty of welded assemblies. Design and engineering teams continue to look at optimisation from process stand point as well. Seam weld length and number of spot welds could be potential design variables from optimisation perspective. Spot weld count reduction without performance degradation could very well save money and time. These are some examples of possible value from tight integration of design and virtual validation tools with manufacturing process in the age of smart manufacturing.

Staying with mobility domain, custom interiors are a major need and smart manufacturing like 3D printing is already being leveraged. This is particularly true for several vehicle or product volumes that do not justify cost of tooling and injection moulding. 3D printing is also being adopted for pre series tooling with reference to interior trims. 3D printing method along with math model morphing is used to fine tune and optimise the mold design before creating steel version of the final mold.

Products from mass customisation segment in the age of smart manufacturing pose different challenges to design and engineering teams. This is particularly true from electronics devices and consumer goods segments. It is almost concurrent engineering where virtual validation is very critical to check and ascertain product performance before it is made. Parametric technology applied to virtual validation models help realise the math model of the product configuration quickly so that performance can be evaluated before product is manufactured.

The application of smart manufacturing is not only transforming the way things are done in various industry verticals but also clearly illustrates the benefit that generative design, virtual validation, and math data morphing bring to smart manufacturing. Smarter tool sets and methods to design and engineer products would go a long way to make mass customisation possible using smart manufacturing methods in smart factory. IPF

About the Author:

Karthik Shankaran is the Chief Innovation Officer (CIO) of Detroit Engineered Products (DEP). In his role as CIO, he helps shape DEP's long-term innovation strategy, accelerating and supporting innovation throughout DEP and creating new businesses. Karthik has more than 20 years of experience across the industry including 10 years in the US working with industry leaders such as General Motors.