

Babies & Bathwater: Can Manufacturing Really Do Without Physical Prototypes?

Manufacturers worrying about whether digital prototyping can ever be a viable replacement for the physical equivalent may be missing the point, argues Mike Lucas, Autodesk Manufacturing business development manager, Northern Europe

The manufacturing industry wouldn't be the first to balk at change on the basis that if something ain't broke, why fix it? And this has been the reaction of many traditional production firms to the notion that it may be possible to dispense with the physical prototype in favour of its more modern digital equivalent.

Arguments against modernising include the suspicion about whether digital prototypes can cater for the very basic need of engineers and customers to be able to touch and feel a product before committing to production. There is also a fear that engineers that rely on machines to process data for them make for lazy workers.

But manufacturing firms that think this way are missing the point about the role of digital prototyping in the design and manufacturing process.

Collapsing the design lifecycle

In most scenarios, the ability to simulate the ultimate physical model is intended as an *intermediary* step, allowing engineers to flexibly, quickly and very cost-effectively 'build' prototypes that allow them to test more outlandish ideas, tweak designs and get a product practically perfect before resources are committed to a physical prototype.

In the long run, this saves everybody's time, quickly eliminates design issues without wasting time or resources, and, most importantly, ensures that the best possible product will be the outcome by the time a real working product is created.

Having this flexibility is becoming essential, as manufacturing firms strive to enhance their competitiveness while keeping costs down. The ability to rapidly generate highly accurate detailed 3D digital prototypes on screen, generated based on real data, means potential problems can be spotted and addressed early on, and that engineers have more scope to play around with a broader spectrum of design variations, without incurring delays or unnecessary costs.

Ultimately, this means they can bring better products to market, faster.

With functional design beginning to play a huge part in manufacturing, for this very reason, it makes absolute sense to reconsider the role of the physical prototype in interim stages of the design process.

Competitive pressure

It is no coincidence, then, that an industry benchmark report published by market analyst firm Aberdeen Group in March 2007 (The Digital Product Development Benchmark Report: Migrating to a Paperless Process) makes a strong argument in favour of the virtual prototype.

The report notes that accurate and extremely 'life-like' 3D digital prototypes are now possible because of advances in design software which allow complex data from a range of sources to be combined to produce truly representative virtual models.

The top-performing manufacturers have already cottoned on to this advantage, it notes. Indeed, Aberdeen's research found that best-in-class manufacturers build only half the number of physical prototypes as the average manufacturer - *halving development costs and enabling them to get products to market up to 58 days faster than average*. Statistics like these make a strong case for 'virtual' prototyping.

The same research found that manufacturers that had made the leap to advanced digital design and prototyping were enjoying a host of other benefits too, such as a 16% higher rate of design reuse compared to technology 'laggards'.

Making a direct correlation between top performance in their markets and the extent to which the firms are using digital prototyping, Aberdeen goes on to note that high-performing manufacturers are around 20% more likely than laggards to digitally prototype a product's performance in each phase of product development.

Encouraging new creativity

Yet this has raised other concerns among traditionalists – for example, will the use of digital prototyping create lazy or bad engineers, as they entrust all the calculations to computer software?

Again, independent experts think not, arguing that the accuracy and efficiency of automated design removes risk of error as data is input, extrapolated, updated and re-used.

This frees up engineers to think creatively about new design variations - because digital prototyping enables any number and scope of changes to be made quickly and inexpensively.

Once these have been agreed and incorporated into a final design, a physical prototype can then be generated, cost-effectively, and safe in the knowledge that this is now unlikely to be changed.

Further findings from Aberdeen Group point to the benefits of extending digital automation right across the design and engineering process. With multiple teams sharing the same accurate, digital information, wasteful waiting time is removed from the design lifecycle, accuracy is improved, and the whole process is accelerated, reducing speed to market.

At no point does Aberdeen consider virtual 3D prototyping to be a lazy or high-risk option. On the contrary, it considers the potential market advantages gained to be crucial, particularly given the pressure on manufacturers to move higher up the value chain - to produce more variations on their products, as well as more complex designs, to compensate for the exodus of commodity product manufacturing offshore.

Examples of success in digitising the prototyping phase alongside other aspects of the design process abound. Building services specialist TROX notes that, since deploying Autodesk Inventor for the creation of 3D models, it has been able to dispense with a whole stage of the development process in which it had to build mock-ups of sections in polystyrene or aluminium. The digital visuals it can produce are so powerful that the company can clearly demonstrate how it incorporates all of its services within the architect's vision without the need for a physical prototype.

Enabling early customer feedback

Being able to show customers an early example of a product is another key benefit of digital prototyping, enabling the design team to get detailed feedback that will ensure that the finished article is exactly inline with client expectations.

Engineering company, Tech-A Ltd, is just one firm to have reaped considerable benefits from this capability. Providing consultancy on bulk materials handling and plant design, the firm puts a strong emphasis on enabling clients to visualise and test a design with a 3D digital prototype through photo-realistic visualisation and animation techniques.

For example, one particular project highlights the effect of mining 14 million tonnes of copper ore over 12 years on a landscape through simulating the changes. Simpler versions show the flow of material down a chute or along a conveyor belt.

To offer this innovative service, Tech-A uses a combination of advanced design tools, in the form of Autodesk Inventor Professional, AutoCAD and Autodesk 3ds Max. Graham Leason, founder and managing director of the company, says that by testing these concepts on screen, clients can visualise the equipment and concepts before committing to production, which can save both time and money.

Clients can review and suggest amendments and these can be fed back into the digital model. This automatically updates itself when changes are made, creating a revised version for the client to consider. Crucially, this can be done within minutes, compared to doing the same thing using a physical prototype, which could take days, even weeks.

Tackling geometry

The calculations enabled by full-featured digital prototyping software extend far beyond the basic properties of a new product, to establish whether the finished article is 'manufacturable'. This means taking into account the performance, power consumption, size, weight, material cost and durability of the finished item.

Traditionally, this information would have required complex geometrical calculations – a very time-consuming process, which produces content other design and engineering applications can't easily work with. Functional design gets around this problem, by focusing on what the product needs to do, rather than the geometry.

By enabling designers to work with a model of the product, and enter requirements that enable the design to be tested, simulated and validated, such software means design teams can avoid the geometry stumbling block, while creating a working design that can be turned into a virtual 3D prototype.

All of this means that users can incorporate real-world design intelligence earlier in the process, to help shape the design at a formative stage.

Market-leading manufacturing design solutions such as Autodesk Inventor already incorporate valuable functional design tools. The latest release of Autodesk Inventor, for example, includes integrated simulation and analysis to enable the testing of real-world performance in a virtual prototype.

Faced with advances such as these, a better question manufacturers should ask themselves is not whether digital prototyping will ever replace the physical equivalent, but whether their organisations can afford to stay stuck in their old ways for much longer, particularly if their competitors have other ideas...