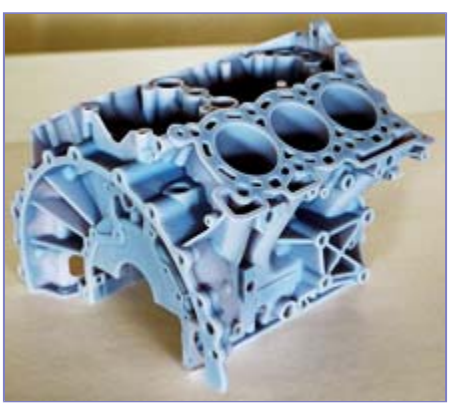
Computer-aided design and time-to-market demands seemed to reduce the scope for making physical prototypes. But then along came 3D printing. John Pullin reports

Even in a recession, time to market is critical to the success of new products. Clothes, cars, cellphones, shoes – the reach of the fashionistas grows ever wider, and woe betide the company that fails to keep pace.

The effect of this pressure is twofold: faster new product introduction (where a public example is the stated objective of Ford to introduce new car models with a development time of just 12 months), and more frequent new product introduction (shown most vividly in the non-stop flow of new trainer shoes into your local sports shop, every pair apparently different).

In conventional wisdom, a casualty of this acceleration of the design cycle is the traditional prototype. The age has mostly gone when a design process could come to a grinding halt for days, maybe even weeks, while gnarled craftspersons created faithful reproductions of designers' whims to see if they worked.

A lot of the development in 3D computer-aided design of recent years has been geared towards ever more realistic simulation on a screen. What you see on the screen is what you'll get in real life. And you get it faster. No need to make a prototype: CAD's simulation and visualisation capabilities engender belief and trust.
But then along came 3D printing.



3D printing is one of a handful of ideas developed in the past 10 to 15 years that came to be grouped together initially as "rapid prototyping". Essentially, a 3D printer or stereolithographic device "prints" products by putting down layers of thin plastics on top of each other until a full 3D model is achieved.

Three things distinguish 3D printing from other rapid prototyping technologies. One is that this is "additive manufacturing" – the model builds up layer by layer rather than material being subtracted, or eroded, as in conventional machining and some other rapid processes such as laser sintering. Nor in many cases does it need further treatment such as curing.

A second difference is cost. Now we're not talking cheap here, of course, but a 3D printing machine at the very top end of the range probably won't set you back $100,000, whereas that's not even the starting point for some of the other rapid processes. There is, of course, an ongoing cost in terms of consumables: the plastics that are printed and become the models and any "support" materials needed to make complex shapes or mechanisms. But that would be the case no matter what technology was used.

The third difference is the seamless integration with common 3D CAD software. At the end, or in the middle, of your product design process, you save your work as a .STL or similar file, click "Print" and then choose your 3D printer as the device to print from. 3D printers take native CAD data from programs such as SolidWorks or Inventor and produce the part or, increasingly, whole assemblies and working mechanisms.

Some people are very enthusiastic about this. Jon Hirschtick, founder of CAD company SolidWorks and one of the CAD industry's intellectual leaders, lists half a dozen technologies that he thinks will be "game-changing" for the CAD sector in the next few years, and 3D printing is right in there, alongside more obvious contenders such as the visual realism that is already being found in computer games.

But users are also keen. Jonathan Ive, iconic designer of design icons such as the iPhone, was quoted a couple of years back as saying that one of the strengths of the Apple design process was the harnessing of "fragile ideas" in discussion – "and then we make lots and lots of prototypes".

Matt Dunbar, senior CAD designer at the running shoe manufacturer New Balance, says that the company's 3D printing machines from ZCorp and Objet "run pretty much nonstop". He says: "We're using 3D models iteratively throughout the design process." The group produces up to 100 models a month out of each machine it has.

Customised consumer products such as Apple's and New Balance's are the ideal fodder for the 3D printing companies. Objet's European marketing manager John Jones says: "No matter how realistic an image can be, it cannot replace the experience of actually holding the model and actually testing its functionality. There's also the benefit of being able to produce a number of prototype models before the very expensive and time-consuming process of having moulds made for the final products."

That might be said of any prototyping process, but the differences that 3D printing has brought are time and speed. "The point is that making the prototype doesn't take a week or cost $5,000," says John Kawola, chief executive officer of ZCorp. "Ask yourself, if the model was free, wouldn't it add a lot of value? It isn't free, but you still have to ask yourself whether it adds incremental value above and beyond what it costs in money and time."

And that incremental value, both Jones and Kawola stress, shouldn't be measured just in terms of the conventional design process.

Jones says: "Having a 3D model in your hands allows the marketing people to have the end-user's experience before the product has been produced." More sophisticated 3D printing systems that allow feel and movement to be built in add to this experience.

Kawola from ZCorp says that a model from a 3D printing process can be seen as a communication tool. Design engineers, he says, are the front-line users for the technology, but marketing, end-users, suppliers and company bosses are all in there too. Networked and internet-based CAD systems that foster collaborative working up and down the supply chain can benefit particularly, he says: distant suppliers find out exactly what you want them to supply by printing off an example.

Of course there are limitations. Objet's Polyjet technologies give deposition layers down to 16µm thick with wall thicknesses of

0.6mm and accuracy of 0.1mm. But generally the higher the accuracy the greater the cost, as you'd expect. New machines can handle different colours and mixes of different materials.
Kawola says that a mainstream machine in the $20,000-$100,000 range would manage accuracies of within 0.5% and that would be fine for the majority of automotive components or consumer product prototypes. "Obviously if you were doing real components for say medical or dental use then you'd need to be at the higher end," he says.

"But where you care most about the geometry and the surface, for things like wind tunnel testing for example, and for a form and fit check, then the mainstream levels of accuracy are fine."

But it's consumer products, and the consumerisation of lots of other products, that is making the big growth for the companies in this technology.

"You're still going to be dealing with a professional community, not a home consumer," says Kawola of ZCorp, "but the growth is moving more and more into consumer-oriented design and from large companies down into smaller companies.

"It's being driven by the take-up of 3D CAD, but it's also attractive to companies whose design cycles are very short, two or three product cycles a year, perhaps, and hundreds of different variations. We can save two or three weeks and that's significant for them. Boeing and Ford would probably value it less."

Objet last year introduced a desktop machine and Jones believes that 3D printing is a tool that every designer "will need to incorporate at some time. I wouldn't like to put a timeframe on it, but if the question is 'will it be available?' and not 'when will it be available?' then the answer is a clear Yes."

So the much-trumpeted death of the prototype in the design process may turn out to be much exaggerated.

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