

# Parts for PRINT

**Rather than wait weeks or months for a body panel, one bus operator has developed a system to produce replacement parts overnight – by 3D printing. Brian Wall reports**

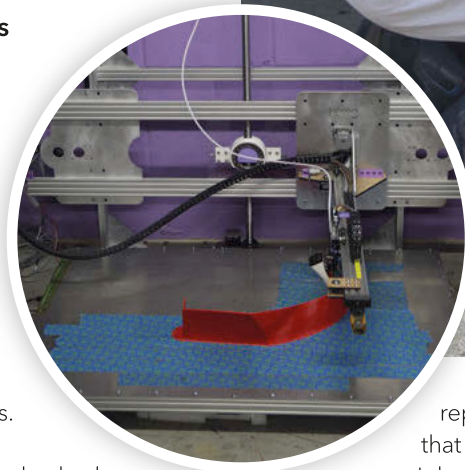
**A** form of additive manufacturing, 3D printing is a reversal of the traditional approach we could now call ‘subtractive manufacturing’, where material is removed through grinding or drilling to make a part or a pattern to mould a part. By contrast, 3D printing involves directly making a physical object from a three-dimensional digital model, typically by laying down many thin layers of a material in succession. It’s still finding new end-use applications in manufacturing, having begun as a one-off prototyping tool. But, if there were ever any doubts as to how 3D printing might help to transform and underpin a company’s business operations, you would need to look no further than Reading Buses to dispel those negatives. From modest beginnings, it has seen a “just about functioning prototype 3D printer” evolve into the real thing – a machine capable of handling large-scale projects.

There have been many challenges en route, as ADMG consultancy’s principal consultant Alex Gibson – the man tasked with designing the printer – readily confesses. “Working in close collaboration with Reading Buses as a partner within its established Tech

Lab, not only have a whole series of early issues been sorted out and eliminated, but also we now have our first 3D-printed bus panel,” he reports. There is much call for these, as the buses get bashed and scraped. “It is at the corners where 3D printing really comes into its own – where things are much more sculpted, with complex geometries,” he says.

While it took “many months of tweaking” to get the mock-up to trial stage, the panels can now be printed in less than a day, which is fast in 3D printing terms and at least on a par, time wise, with getting the part delivered. “Only now we don’t have to worry about the inventory holding, as we can take a ‘just in time’ approach to cover a diverse fleet,” adds Gibson.

Once the 3D-printed panels, up to a metre in size so far, but with rare capacity of up to 0.6m x 1.2m x 2.4m, are ‘on board’ as proven replacements for the originals, they will join a growing list of other 3D-printed parts that are already being driven around on Reading Buses’ vehicles. The first such part to see action was a motor mount, which



replaced an original that had cracked.

John Bickerton, head of engineering and innovation at Reading Buses, acknowledges that the replacement part had a short lifetime. “But a massive win was that we were able to 3D print and install it on the bus very quickly, which was then back on the road while the new part was on a 12-week lead time. In fact, we had to 3D print two iterations, as the first one was the wrong thickness. That means the first manufactured part would have been the wrong thickness when it arrived – it could have been 24 weeks to get the right part, so the 3D print gave back value that was way above its actual commercial worth, because we could make these mistakes much more quickly.” Now 3D-printed motor mounts are regular permanent fixtures on the bus fleet.

“We don’t run a CAD operation or a manufacturing business, we maintain buses, but working with Alex

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Alex Gibson



on this project has been fantastic,” says Bickerton. “The quality is now good enough that I’d be happy to fit it to a bus. It looks ‘printed’, rather than traditional laid-up GRP [glass-reinforced plastic], but certainly acceptable and it’s

encouraging us to think differently, too.”

Gibson was already heavily involved in 3D printing through his own consulting and bureau service when he met up with Bickerton, who was keen to see what 3D printing could deliver. “3D printing comes into its own when interfacing with a part you don’t necessarily own,” says Gibson. “At Reading Buses, with the bus panel we have created something personalised and unique, with the fleet number of the bus it is intended for baked into the structure itself.”

He points to other instances where 3D printing has its advantages. “When on the move, the buses are under constant attack from tree branches and street furniture encroaching upon the route, even taking out front windscreens. Reading Buses has a full mobile data platform in its own right, with robust wifi and real-time sensors on board some of the vehicles [an outcome of another Tech Lab project], gathering all of this intelligence to map where and when such problems occur. Using 3D printing, we can now embed the right housing to contain these sensors within a panel, for example, so we could monitor kerb

strikes as effectively as we can track overhanging branches.”

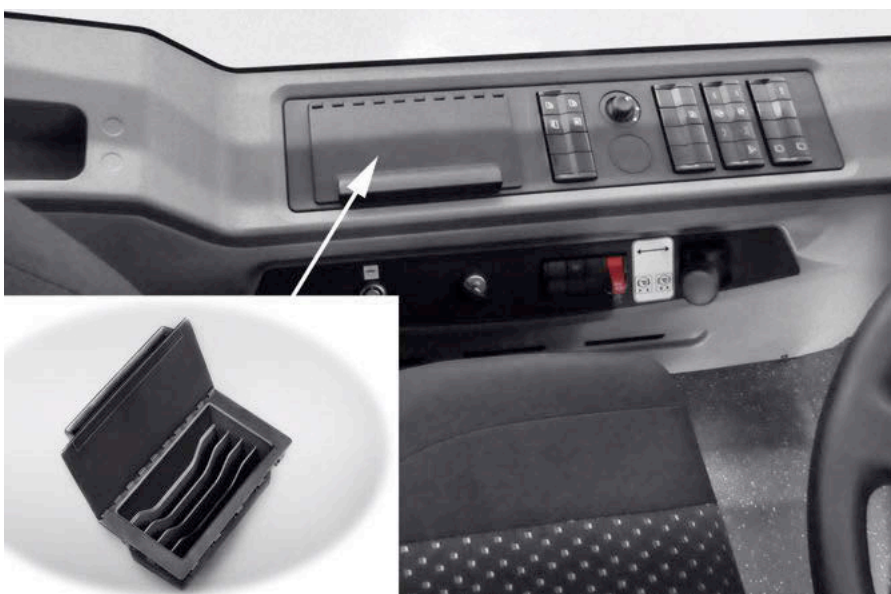
What about patent issues? These are unlikely to be a problem, Gibson states, as patent protection of a bus body panel should have long expired, while there are no copyright issues either. “We will not be using the original designs and duplicating them without permission. We will be reverse engineering parts, in which case there is significant scope to mimic existing features required to make a compatible part and to reasonably blend with the aesthetic of the original parts around it; as a natural part of optimising the part for 3D print, it will be changed in many ways.

“Alternatively, we may be able to develop a relationship where the manufacturer is willing to license the production of the design. This is new territory and we can expect caution – but Reading Buses has a strong record of collaborating at an R&D level with bus manufacturers. This is not a high-volume production industry, and we will have a head start developing printable versions of parts.”

**PERFECT SOLUTION**

In addition to innovators such as the USA’s Local Motors 3D-printing body panels for its Olli autonomous shuttle bus (pictured, p12), established OEMs are getting in on the technology, too. Daimler Buses is also a firm believer in 3D printing for replacement parts in buses, using the technology to manufacture more than 100,000 prototype parts every year for brands such as Mercedes-Benz and Setra. It sees the move as the perfect solution where complex interior components must be made in small batches economically and on demand, with shorter turnaround times than is possible using conventional production methods.

The company’s level of commitment to 3D printing was underscored last





year when announcing it would be using Selective Laser Sintering (SLS) to produce 30 plastic truck components for its Mercedes-Benz vehicles, including covers, spacers, spring caps, air and cable ducts, clamps, mountings and control elements.



Rather than forcing production facilities to maintain old tooling, 3D printing means manufacturers are able to order and create parts from old catalogues or model lines. When a bus operator needs a specific replacement part, they simply order that part, based on a code. Daimler is able to print the parts at will and says making small batches of specific parts (between one and 50 pieces) is much cheaper than before. The turnaround is also a good deal faster than when using conventional production methods – design, costing and production can take just a few days.

It isn't just simple, single-piece components that Daimler is printing. The example provided is the company's banknote storage container, integrated into the driver's compartment in some buses (pictured, p11). Rather than having to make the lid, housing, assembly clips, hinges, handle and dividers separately and then assembling, 3D printing allows the parts to be manufactured in a single step. No excess material is used and specific materials don't need to be stored on site.

"The 3D printing process allows us to install local printers at the production plants operated by Daimler Buses worldwide," says Hartmut Schick, head of Daimler Buses and chief executive of EvoBus (pictured, right). "It also enables us to respond in a flexible manner at local level to customers' special wishes and replacement part needs. In this

way, the availability of parts can be speeded up considerably, while avoiding long transport distances, as well as high transport costs and customs charges." More

than 750 components have been printed for customer buses so far and more than 150 replacement parts are being scrutinised for their potential as 3D-printed replacements.

As well as developing single-piece components, the company is also able to print moving parts. Previously, such complex parts have consisted of several components. However, Daimler can now print these in one step, using printers based on an SLS process. This drastically cuts down on extensive assembly processes and can greatly decrease production times.

Imperial Engineering, an independent specialist air brake supplier to the UK's bus and coach industry, has no doubts as to the increasingly

significant role 3D printing will play. "The flexible nature of the technology and extensive design freedom enables new innovations and enhancements to existing parts to be produced quickly and more sustainably, as the process significantly reduces material wastage," says the company's sales director John Dwight (pictured, left). "Equally, it would be particularly useful for producing bus parts that are now obsolete or no longer manufactured – applicable for historic vehicles, for example. There continues to be demand for these parts, but stock is often hard to source and very expensive."

**A NOTE OF CAUTION**

However, Dwight adds a note of caution about the strength and durability of parts produced by additive manufacturing, in respect of the integrity of layering material, especially with buses and coaches being high-mileage, all-weather vehicles. "Given the regulatory demands on the industry in terms of safety, there would need to be an extensive testing period for 3D-printed parts and strict quality controls put in place, before there's a move away from traditional OE manufacturing," he adds.

None of which is likely to deter Alex Gibson and John Bickerton at Reading Buses, who are now engaged on having another 3D printer built and running in parallel with the first. "Reading Buses has a real entrepreneurial spirit throughout the organisation and the ideas for how we put V2 [the second printer] to work are bubbling," says Gibson. "But we need to get our first version really going before we head down that path." [TE](#)

