**The Future Is (Gasp) Manufacturing?**

***Mr. McGuire***: I just want to say one word to you. Just one word.
***Benjamin***: Yes, sir.
***Mr. McGuire***: Are you listening?
***Benjamin***: Yes, I am.
***Mr. McGuire***: Plastics.
***Benjamin***: Exactly how do you mean?

*The Graduate* (1967)

As it turned out, Mr. McGuire gave the Dustin Hoffman character, Benjamin, the wrong one-word career advice for California in 1967. He should have said: “Computers”. It was computers, not plastics, that enabled characters like [Bill Gates](http://www.forbes.com/profile/bill-gates/) and [Steve Jobs](http://www.forbes.com/profile/steve-jobs/), and more recently [Mark Zuckerberg](http://www.forbes.com/profile/mark-zuckerberg/), to become multi-billionaires of the coming decades.

Is it possible that today the correct one-word advice for the future young graduate is, of all things, manufacturing? Manufacturing? Most economists believe that the US has put manufacturing behind it, ceding primacy to low wage countries like China. When manufacturing is seen as long production lines with economies of scale, it is indeed the past not the future.

Yet the world of manufacturing is now being transformed by techniques misleadingly called “3D printing”. This is the capability to manufacture one-off items more cheaply and quickly than long production lines. The processes are both subtractive (the shaving away or moulding blocks of raw metal to make engineered components) and additive (adding layer and layer to create new shapes).

**A 3D printer-created jaw**

This week, the [BBC reported](http://www.bbc.co.uk/news/technology-16907104) on the 3D printer-created lower jaw which has been fitted to an 83-year-old woman’s face in what doctors say is the first operation of its kind. “The transplant was carried out in June in the Netherlands, but is only now being reported. The implant was made out of titanium powder, heated and fused together by a laser, one layer at a time. Once completed, the part was given a bio-ceramic coating. The team said the operation to attach it to the woman’s face took four hours, a fifth of the time required for traditional reconstructive surgery. ‘Shortly after waking up from the anesthetics the patient spoke a few words, and the day after the patient was able to swallow again,’ said Dr Jules Poukens from Hasselt University, who led the surgical team. The surgery time decreases because the implants perfectly fit the patients.”

Other recent advances include:

* The replication of a [Stradivarius violin](http://www.bbc.co.uk/news/technology-15926864)
* The generation of [tiny blood vessels](http://www.bbc.co.uk/news/technology-14946808).
* The use of of 3D printer to create [new bones](http://www.bbc.co.uk/news/technology-15963467)
* The recreation of [large scale building materials](http://www.bbc.co.uk/news/business-14282091).

**The revolution in how we make things**

20th Century management was built on economies of scale. To make a single unit of a thing typically cost a lot more to produce than 10,000 would. The price per unit goes down even more as the numbers increase.

In the foreign outsourcing of manufacturing, managers chased these economies of scale, often overlooking the additional costs of transport, inventory management, quality control, sales, marketing and distribution of large production runs, as well the risks involved in such extended supply chains. They paid scant attention to the long-run costs of losing knowledge and the opportunity to learn. In so doing, they [destroyed whole sectors of the economy](http://www.forbes.com/sites/stevedenning/2011/08/17/why-amazon-cant-make-a-kindle-in-the-usa/).

Now the economics of large-scale production runs carried out overseas are being disrupted by the possibility of making, selling and delivering millions of manufactured items one unit at a time, right next to the customer.

**Re-making existing products vs doing something entirely new**

The question most people ask when thinking about the possibilities of 3D printing is: which of our existing products could we make with it? This is what happened when people first discovered mechanical power of steam engines: they started asking whether it would be possible to make a mechanical horse and cart? For a long time, the results were impractical mechanical replicas of a horse and cart, like the weird contraption shown above. It took more than a hundred years before people were able to think through the possibilities of mechanical power and developed comfortable and convenient transportation devices (cars) that were unlike any horse and cart we had ever seen.

Similarly, with digital manufacture, the important question is not which of our existing products can we make but rather: what can we do with this new technology that we couldn’t even dream of doing before?

**What are the new possibilities of manufacturing?**

Taken as a whole, digital fabrication creates whole new possibilities. They include:

* ***Transforming the supply chain***: The ability to reduce or eliminate major aspects of the costs of the supply chain will further undermine the economics of foreign outsourcing.
* ***Taking back manufacturing capability****:* Manufacturing is likely to return by working segment by segment, rebuilding the capability and expertise to make things, and gradually moving up the chain towards the high end.
* ***Customizing products***: The possibility of customizing products on the spot will transform the marketplace. Now the physical store will no longer be a warehouse but rather a miniature factory, where the child designs and manufactures his or her own toy on the spot exactly to taste. The same with shoes, jewelry and other basic products.
* ***Spare parts***: There are huge costs involved in maintaining large varieties of spare parts. Why bother with all that when you can manufacture the part on the spot with a digital printer?
* ***Medical and dental manufacture***: All forms of one-off production like dental work or orthopedic implants will be done on the spot.
* ***Exploiting time as a competitive weapon***: Just as a Kindle enables readers to buy and and read a book instantly, 3D printing will enable customers to make things instantly, which they would otherwise have to go to the store to buy. This will help put [the forgotten competitive weapon – time—](http://www.forbes.com/sites/merrillmatthews/2012/02/07/the-future-is-gasp-manufacturing/2011/03/09/part-4-measuring-the-worlds-most-neglected-competitive-weapon-time/)back on the management agenda.
* ***Enhancing innovation***: The potential to experiment very cheaply in close proximity to customers offers huge promise for enhanced innovation.
* ***Rediscovering the joy of making things***: Perhaps the most important aspect of the transformation will be the effect it will have on us–the social impact of digital manufacture. Over the last century, we have gotten used to having everything made for us. Where computers enslaved us, now is it possible that they might liberate us? In the same way that personal computers have turned us all into amateur computer technicians and software administrators, so digital manufacture has the possibility of turning us all into amateur engineers who rediscover the joy of making things.

**A new kind of management is required**

Exploiting these possibilities will however require imagination and continuous innovation—something that [large traditional organizations are not good at](http://www.forbes.com/sites/stevedenning/2011/12/02/why-are-there-no-successful-innovation-initiatives/). They will have to learn how to disrupt their own supply chains and develop new products that have not even been heard of. Traditional management won’t get the job done. They will have to [set aside maximizing shareholder value](http://www.forbes.com/sites/stevedenning/2011/11/28/maximizing-shareholder-value-the-dumbest-idea-in-the-world/). They will have to learn how to be part of the emerging [Creative Economy](http://www.forbes.com/sites/stevedenning/2012/01/31/is-the-us-in-a-phase-change-to-the-creative-economy/). Firms like [Apple](http://www.forbes.com/companies/apple/) [AAPL] Amazon [AMZN], Salesforce [CRM] and [Intuit](http://www.forbes.com/companies/intuit/) [INTU] have shown us that any firm can learn how. It’s not rocket science. It’s called [radical management](http://www.forbes.com/sites/stevedenning/2011/12/02/2011/07/08/the-five-big-surprises-of-radical-management/).

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Steve Denning’s most recent book is: [The Leader’s Guide to Radical Management](http://www.amazon.com/gp/product/0470548681/ref%3Das_li_ss_tl?ie=UTF8&tag=stevdenndotco-20&linkCode=as2&camp=1789&creative=390957&creativeASIN=0470548681) (Jossey-Bass, 2010