

High tech, high touch, revolutions, evolutions

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"The most reliable way to forecast the future is to try to understand the present," so claimed John Naisbitt, a US writer known for his visions of the future: it is what we will endeavour to do in this article. His book titled 'High Tech, High Touch' captured in four words footwear manufacturing today and how it might become. He affirms that to be high touch more than simply high tech, technology must preserve our humanity rather than intrude upon it: technology is the creative product of our imagination.

If we think of footwear and its constant innovation in terms of styles, colours and materials or look at the technologies used for components and manufacturing processes, we see that such a statement is certainly true. But we have also added revolutions and evolutions to the headline of this retrospective and predictive article celebrating World Footwear's 25th anniversary.

Looking at a modern shoe factory equipped with the most high tech

devices, we see proof of these statements as the human touch is always there. Machines perform repetitive tasks diligently and automatically, while workers concentrate on the delicate steps of the process, where their skill creates the added value to produce a perfectly made shoe, accurately checked and carefully delivered to the customer.

High tech, however, becomes low tech and machines that were state of the art a century ago Naisbitt would now say are 'high tech nostalgia'. High tech is therefore a relative term related to a defined moment in time or specific era in the evolution of an industry. Our focus is on the last 25 years: how the entire shoe manufacturing process has changed and the most important innovations that have driven change. In time, these too may become 'vintage', but will probably drive noticeable evolutionary trends, the seeds of which are already clearly visible today. Five technological 'revolutions' of the past 25 years of footwear production and the five evolutionary trends that could

transform the industry in future years are considered.

LASTS

The last is a key element in footwear production. Among the first things to be conceived by designers, the whole design process generally begins with it. When the design is passed to production, there is no shoe that can be built if its corresponding last is not available. Lasts used to be produced on mechanical turning lathes until this old fashioned process was completely overturned by the introduction of numerically controlled, or NC, milling machines.

The old mechanical copying lathes existed until the 1990s and were a technology progressively introduced as shoe production evolved from a craft to an industry where large quantities of mass produced lasts were needed to cope with increased production. In these machines, a wooden 'model' last was copied using a probe mechanically linked to the cutting tool and scaled up and down to generate the different sizes. It was a simple process, using



Hotter Shoes

CREDIT: KIRSTY THOMPSON/LANCASHIRE LIFE



The five revolutions

relatively simple machines, and perfectly adequate for the high volume/low flexibility manufacturing typical of that phase of footwear manufacture.

Seeing how prototypes as well as batches of lasts are produced today, one would not believe that such an old fashioned technological approach ever

existed. Nevertheless, pioneering companies found it difficult to abandon the old, purely mechanical, machines as they tried to develop completely new systems that took full advantage of the most advanced technologies of their time. Two of these were major innovations, replacing the physical wooden model with a digital one and

equipping the machines with the most powerful electronic numerical controls available, specifically designed to work with them. After several unsuccessful attempts, the first families of NC-controlled last turning machines appeared, together with the necessary software tools to create the digital models required.

Last makers all over the world can now essentially handle all the phases of the last making process digitally. Digitisers are available to capture the shape of the sample last (which is still produced manually), software to edit the geometry, grade the different sizes and generate the tool paths the machines must execute. NC machines are available for both roughing and finishing operations, combining speed, accuracy and flexibility in a way that was previously unthinkable.

The latest systems, launched only a few years ago, saw another innovation: the last located in the machine at toe and heel is now clamped on its top surface, thus allowing NC milling of its entire geometry, including the toe and heel.

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NC controlled lasting machine

CREDIT: CERIM

This eliminated the need to finish these two critical sections manually and so produced even more accurate lasts. Indeed, a high quality shoe needs an accurate last so, in this sense, the revolution in last making has also greatly contributed to improving the quality of shoemaking overall.

SOFTWARE

The revolution in last making was enabled by the software tools that were available to model the last. This was part of a much deeper transformation that, during those same years, drove the footwear world fully into the digital era. A revolution that for the first time in the technological history of the industry was not driven by power (steam, electricity) or hardware (tools, machines, equipment) but one made possible by the appearance of software programs to design and engineer the shoe. It was a revolution that the introduction of these new tools into design departments necessitated a change of mindset and organisation that went beyond the simple adoption of the technology of the moment.

At the beginning of the 1980s, we saw the first attempts to transfer to the footwear world those CAD technologies that were then becoming state of the art in many other industries. It was very soon realised that the problems of shoe design were so specific and peculiar that standard



Latest generation of last milling machine

CREDIT: NEWLAST

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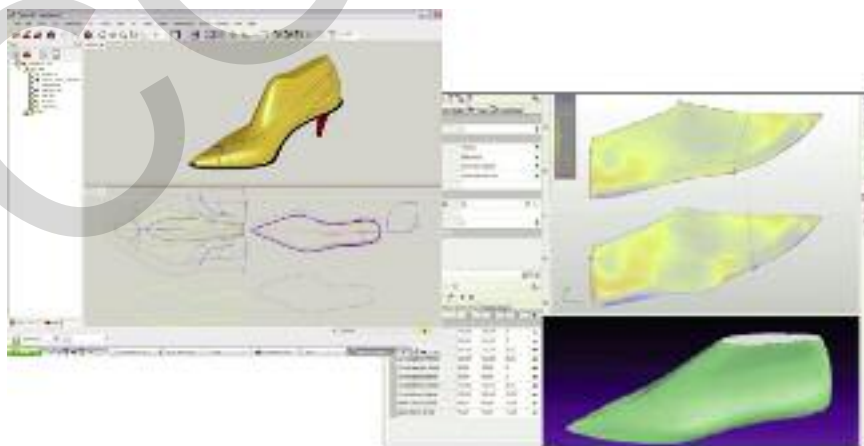


Passion in every fiber.

tools were not usable and that specialised applications had to be developed. Shell flattening to go from 3D design on the last to pattern engineering, size grading, lasting allowances and stitch notches were part of shoe jargon; they had no place in any general purpose CAD system.

That pushed a group of software developers, both large and small with a solid background in shoemaking, to develop the first families of specialist shoe CAD applications. Some are still in business, others failed and have disappeared. Specialist shoe CAD systems, however, whether the simpler 2D or more complex 3D versions, are now used in virtually all shoe design departments in the world. The way they work mimics very closely each step of the typical design process, including drawing style lines on the shell, flattening the shell and separating each individual part of the upper. So, in a way, there is no true revolution in this approach. The real change is the shift from the analogue to the digital world, in the wealth of information a complete CAD model of the shoe affords, the ability of the designer to control it and the manufacturing potential it contains.

CAD designers can also work faster, do more and control much more of the manufacturing process than with the classic manual approach. This was a major step forward and a change of mindset that taught them to anticipate manufacturing decisions at the design stage and to predict the impact of design choices on downstream processes.



CAD for shoe design CREDIT: CSM3D AND INESCOPE

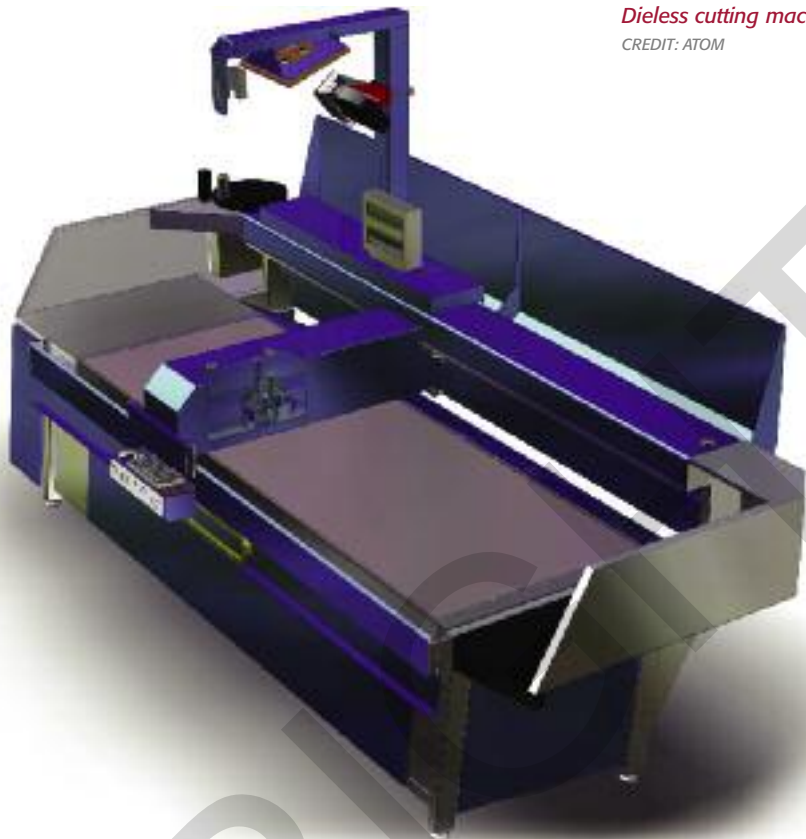
DIE-LESS CUTTING

Both the revolution in last making and the one in shoe design were enabled by digital technologies. Software to model the last and design the shoe and numerical controls to drive the new generation of milling machines, originate in the domain of the so called IT world which was rapidly developing in the years when these innovations were introduced. It is therefore no surprise that the next revolution shares the same roots.

In this case the trigger was different

and relates more to the transformations the shoe industry was undergoing two decades ago than to the availability of the appropriate enabling technologies. At that time shoemaking began to change; production quantities, especially in more industrialised countries, were shrinking under competition from low labour cost nations. Flexibility, versatility and rapid market response began to matter more than production efficiency and pure throughput. Shoemaking starts with cutting all the necessary components out of the different materials the product is made from. No surprise then if the first technology to be revised in light of this structural change was cutting.

Whilst the problem was quickly identified, a complete solution took longer to achieve. Smaller production volumes made it increasingly difficult to justify the cost of the knives traditionally with the clicking presses then in use and called for an alternative system that could do without them. This led to the development of a new class of shoe machine, now commonly known as NC die-less cutting systems, that have in time replaced traditional knife cutting, initially in sample making and then in bulk production.



Dieless cutting machine.

CREDIT: ATOM

That was again a major revolution. Machinery producers, particularly specialists in cutting, had to completely rethink their systems. They had to acquire new knowledge and build up skills in electronic controls and software that were totally alien to them, a change that transformed both themselves and shoemakers at the same time. Observing any one of the latest generation of die-less cutters, with projection systems, interactive pattern nesting and high frequency oscillating knives, we can, despite all the different implementations and machine variations, detect a single dominant design that all suppliers seem to comply with.

The evolutionary path towards this design was far more complex and tortuous than it might at first appear. Explorations in different cutting technologies including water jet and laser were tried, automatic detection and classification of leather flaws and quality areas attempted — and many failures made — before the consolidated systems that we see today finally appeared. The fact is however that die-less cutting has changed cutting rooms in virtually all shoe factories in the industrialised world just as CAD has done in the design departments. These two technologies depend very much on each other and together have had probably the greatest impact on shoemaking today.

MECHANICAL TO MECHATRONIC

Shoemaking became an industry through the introduction of machinery and early methods of work organisation. Machines in particular, by alleviating human labour and allowing workers to perform their tasks more rapidly and efficiently, provided the growth in throughput and production volumes that the market was demanding. All through the first part of the last century machines became ever more complex, covering all major steps in the shoe manufacturing process. First there was stitching, then die-cutting and, finally, making with the first pulling over machines. In order to operate, these machines needed a form of 'power'. Initially this was provided by steam, gas engines and then electricity. Pneumatic circuits and, later on, hydraulic pumps enhanced the power applied and allowed a greater level of control of the machines themselves.

Finally there was electronics, enabling more and more functions to be regulated, controlled and programmed by means of the electronic controls the machines were equipped with. And, with electronics, came IT to cover those high-level programming tasks that required more attention and, quite often, a multi-axis control of the tool path the system had to follow. Toe lasting and heel and side lasting machines, bottom and side roughing and cementing machines, bottom pounders and other similar machines are now complex 'mechatronic' systems, in which the mechanical, electronic and IT components are equally important and contribute evenly to their performance. These machines can be fully programmed by using CAD-generated data to execute their tasks automatically. They have effectively de-skilled the operators who attend them and contribute greatly to a more consistent quality shoe, enabling moreover the transition of shoemaking from the "mass market – high volumes" era into the "niche market – high flexibility" one.



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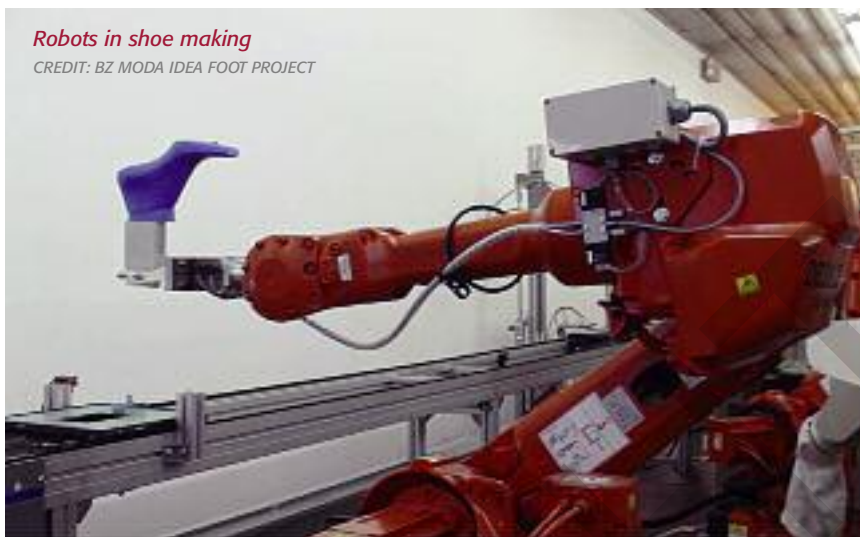
ROBO-COBBLERS

The 'revolutions' described so far are fully accomplished events that we can look at and comment on as clearly recognisable scenarios. The last one we want to mention here is still more a potential than real, but signs are evident that we are close to seeing a clear consolidation in this trend too. We refer to the introduction of robots in footwear manufacturing and, last year, *World Footwear* featured a full article on the topic, in which a complete description of the many different implementations of robotised cells in shoe making was presented.

There are in fact already dozens of

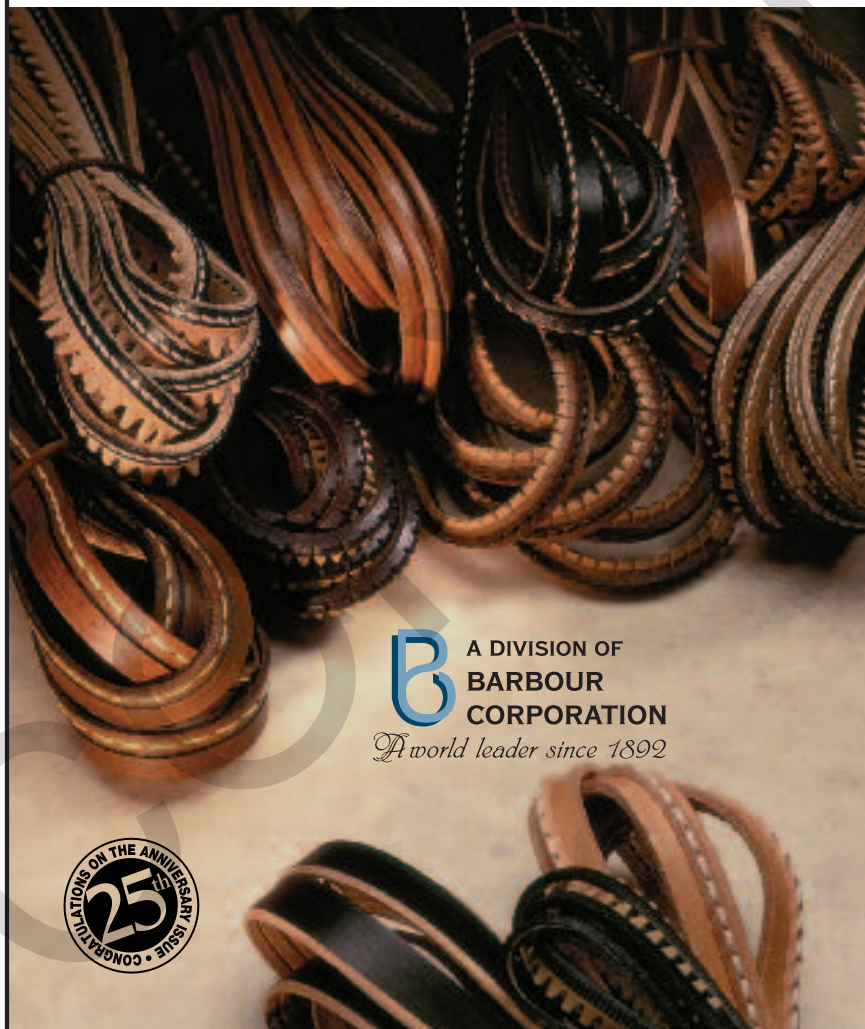
Robots in shoe making

CREDIT: BZ MODA IDEA FOOT PROJECT



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different robot applications covering virtually all the most important steps of the manufacturing sequence after last pulling. The vision of shoe factories in which robotic cobblers take care of all the major steps of the making process, leaving humans to perform just a few, is still too futuristic. This is perhaps more of a negative utopia than a goal to aim for. Interest in these highly flexible, versatile machines is however growing and, with costs coming down, robots are already present in many shoe factories, even in the luxury sector. We will see more and more of them in the future.

MARKET OF ONE

Since technology is a transient definition, what might the future hold in store? There are some clear trends and the first is customisation or, more precisely, mass customisation of shoes. Personalisation of products is consolidating up to the point where a recent study referred to personalisation as the 'future of products'. World Footwear dedicated an article to this important topic as well last year. Dealing with individual consumers means considering each as a market of one with their preferences, desires and expectations. Serving them and creating fulfilment for them while generating margins for the company is a challenge both commercially and technically. It is nevertheless a phenomenon that shoemakers cannot underestimate.

DIRECT MANUFACTURING

Rapid prototyping technologies, allowing designers to quickly and simply transform their drawings and 3D digital models into physical objects

that could be touched and also, in some cases, functionally tested, have been around for a long time. These technologies are evolving very rapidly, both in terms of machine and systems and, more significantly, in the nature and variety of the materials they can process. Moreover, they have moved out of the design department to be used extensively to build entire parts of the shoe.

Their name changed into direct manufacturing technologies (or layer manufacturing to recall the way in which the object is created by solidifying, layer after layer, thin slices of the target material), to anticipate the relevant role they will play in future in the manufacturing industry in general (the Economist mentioned them in two articles as important enablers of what that magazine calls the third industrial revolution) and in shoemaking as well.

LEAN, GREEN AND CLEAN

When considering a shoe company as a whole and how it interacts with the environment, there is a new paradigm emerging that can be summarised by the slogan 'lean, green and clean'. This means producing only what is needed, minimising waste in the manufacturing process and using energy and other resources in the most efficient and environmentally friendly way. Such a paradigm would imply rethinking machines, systems, process flows, company organisations and even approach to the market. Quite a shift that could profoundly transform the world of shoemaking and one that may be triggered by changes in consumer attitudes and priorities that could force companies to follow this path sooner than they think.

LOCAL FOR LOCAL

We are used to thinking of footwear in general terms as a 'decentralised' type of business. Manufacturing facilities concentrated in distant parts of the world chosen through cost considerations, serve a multitude of markets spread across the globe. That is the concept that we know and that has so far proved to be successful — certainly for the balance sheets of many companies.

This concept is now under discussion and 'local for local' is an emerging trend that some companies are already considering. It aims to serve local

markets with local manufacturing facilities of a smaller size and that take advantage of the best and most modern process technologies to limit manufacturing costs to an acceptable level. If a minimum break-even cost threshold is found, benefits in terms of higher flexibility, better service to the market, reduced carbon footprint are evident. This is a further mindset change that has the potential to revitalise a manufacturing sector still important for the economies of many western countries.

HUMAN-ROBOTIC COOPERATION

Producing footwear in high labour cost countries certainly requires a different approach to manufacturing as such and a great deal of rethinking regarding the mix of manual and automatic operations in the various steps of the shoemaking process. We have already said how robots can take over various processing and handling tasks. What we will see in future will be more advanced forms of human-robotic cooperation or manufacturing setups in which people and robots work side by side, even with no physical barriers to separate them, each covering those tasks that are most suited to their skills and abilities. There are already research teams working on this advanced topic.

NEW PRODUCTS-NEW PARADIGMS

Probably the most disruptive innovations that we might see in the future will come from the product side.

The pairing of new products — new paradigms can be an extremely powerful driving factor to change the way shoemaking is carried out. Virtually all the revolutions and trends we have described are in fact based on the assumption of a 'constant product'. They rely on a concept of a shoe, with all its parts and the way they are assembled to create it, that is more than a century old and, with only a few sporadic enhancements, to a process flow that was coded long ago. What if the shoe concept as such was to be totally rethought so that manufacturing processes will have to change as well? This would probably be the most dramatic transformation that the product, its manufacturing processes and, potentially, the whole shoe business may undergo.

Far fetched? It is already happening. *Business Week* March 2012 published an article on the new Nike Flyknit running shoe; type in flyknit on Google and read what it says. In the author's words 'the new running shoe is spun, not sewn, reducing material, time and labour and, moreover, the most labour intensive part of the footwear manufacturing process has gone'. With it also go many shoe machines and manufacturing steps as well as concepts of work organisation; an entirely new footwear concept with a new manufacturing process and new machines. But, in the words of John Naisbitt: "We must learn to balance the material wonders of technology with the spiritual demands of our human race." 🧠

