Interview

Mark Thaxter of Crispin Orthotics

Mark Thaxter was kind enough to attend the BAPO Conference this year to present some of his innovations to delegates in our networking area. As an Orthotist and owner of Crispin Orthotics, Mark has invested many years into looking at how he can provide patients with the best design of orthosis using modern manufacturing techniques.

Talking to Mark, I found his journey fascinating and the technologies he was using forward thinking. I encouraged him to agree to be interviewed for BAPOConnect to share this with the profession.

So a few weeks later I travelled down to Crispin Orthotics in Leeds on a sunny spring day and spent a few hours talking to Mark about his orthotic practice.

To start the interview I posed Mark a few questions:

"Why choose orthotics as a profession?"

My father, stepmum and uncle worked within the industry, and so as a teenager becoming an Orthotist wasn't at the top of my list! I had an interest in computing and considered a Robotics course at Salford University. It looked good on paper, however the course was centred around programming which was too dry for me. I went back to the drawing board and spent some time with my father in clinic.

I worked out that orthotics still provided the problem-solving element of computing alongside working with people, which I enjoyed. I struggled to find many professions that combined both.

I decided that P&O was to be my career pathway and was lucky to have the option of either Salford or Strathclyde Universities for my education. Strathclyde was the choice. However, before starting the course in 1993, I worked for an insurance company to earn some money to help keep my student debt to a minimum! I really enjoyed the course and the education I received has been invaluable in the development of my company.

Upon graduating, I went to work with my father. It was a small company at the time with two Orthotists and I was lucky enough to be mentored by an experienced clinician, Ian Sanders, who gave me great support in my early years, especially in the practical application of my theoretical knowledge.

The NHS was changing in the UK, with contracting of services which had traditionally been provided through a relationship base moving to a tendering business model. My father wasn't a supporter of the concept and didn't wish to engage with it and therefore believed that it was a good time to introduce me as a director of the company. They say working with family is difficult and this proved to be the case, with the business relationship only lasting 18 months. My father had control of the finances and was reluctant to invest due to the uncertainty within the orthotics profession, therefore it was decided that I would purchase his share of the business. He nearly didn't receive payment though! He thought it a good idea to tell the bank manager who I was presenting my business plan to that I wouldn't make it through my first year! Surprisingly, the bank supported my plan.

Even though raising finance was more straightforward back then, the early years weren't easy. Being a small company, it was difficult to win contracts. NHS Trusts would provide positive feedback on our tender submission and presentation, however, they often perceived the organisation at a higher risk of failure. Fortunately, one of the Trusts we submitted to had the confidence to contract with us and help build the organisation into what we are today.

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"What drives you, what makes you get out of bed in the morning?"

What drives me? Definitely the product development side of my work, in particular the use of modern technology. It links back to my original interest in computing. About five years ago I was worried about the apparent lack of progression within the profession and was losing faith in the future of our industry. I began researching other sectors that had been developing technology that we could use. 3D scanning and printing were becoming far more accurate and no longer cost prohibitive as they were now available in the consumer market. This stimulated my imagination and enabled me to look at different ways of progressing our profession and developing new products for market.

I do struggle to maintain an interest with the more business side of running the company. Thankfully, I have a great management team and in particular my operations manager who helps keep me on track!

"Are you still in clinical practice?"

Yes, I still work with patients. I have a good grounding in most areas of the profession with complex lower limb provision being my main area of expertise. I enjoy using my knowledge in biomechanics and engineering whilst working with individuals to create unique orthoses that help people maintain active lifestyles.

"Where do you see the profession being in 10-15 years?"

It's very dependent on what happens to our health service. As clinicians, we are directly or indirectly employed by the NHS and how we practice and what we can provide depends on the expectations of the individuals commissioning the service. In some ways we are constrained by the contracting model. With the current funding streams we are often unable to supply the ideal orthosis without having to apply for a special funding stream. Many services still code using a variation of the MHM50 system created in the 1950s! The current system isn't flexible enough to encourage innovation in everyday clinical practice.

I believe that more simple orthoses and stock orthotic products could be provided by other professions with the right supervision and training. This would allow our profession to become more specialised, combining our engineering knowledge, materials science and clinical assessment methods, which puts us as best placed as the right individuals to treat the more complex cases.

Advanced practice would enable us to look at managing all of the condition rather than just the supply of an orthosis.

Fig 1. A variety of 3D printed devices

"So what technology do you use in your clinics, Mark?"

We have various technologies we implement within our clinics. The use of scanning technology has been the area I feel is significantly changing our assessment.

We use both white light and tablet based scanners within our clinics, the tablet being significantly less costly.

We performed tests to compare the accuracy of plaster cast models to the tablet based scan using the white light scanner as the control. We found that the tablet based scan was still more accurate in shape capture than the plaster model. By the time the plaster strip is accounted for and the model filled, a plaster cast expands in volume by varying amounts. A scan produces a far more accurate capture of a body segment than a plaster cast.

The tablet scanner is not so good for tracking any movement of the subject so for large body segment shape they work well e.g.

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spinal or knees but for AFOs we have found it more accurate to use the white light scanner.

The software to support these scanners has greatly improved in recent years, and with the introduction of the tablet scanner, they are far more portable, allowing easier integration into regular clinical practice.

"What have been the recent innovations in practice?"

Following on from using 3D scanning, I feel the introduction of subtractive and additive manufacturing methods are providing a good basis for innovation.

An example of subtractive manufacturing is the creation of an anatomical model for the provision of footwear. The Orthotist takes a scan of the patient standing with the tablet scanner, which takes no longer than 2 minutes. We process the scan through an industry-specific software package called Rodin 4D which enables the Technician to be very accurate when rectifying as opposed to traditional methods of shape capture. The scan is milled from a polystyrene type of material which is very cost effective and provides the Technicians with an accurate 3D representation of the feet. For the manufacture of made to measure footwear, we are still using the old-fashioned last creation to provide a cosmetic finish. The model enables accurate matching of heel contours as well as providing an indication on exactly where depth allowance is required e.g. for a hammer toe. We have found that it helps to reduce manufacturing time and reduces the necessity for re-lasting.

The only negative with subtractive manufacturing is that the model created is usually required for an additional manufacturing process. For example, in the provision of an AFO, the model will have thermoplastic vacuum formed around it which creates slight compression of the model. Also vacuum forming high temperature thermoplastics can introduce some creep within the material thus creating slight inaccuracies.

With additive manufacturing or 3D printing, you cut out the middle step therefore reducing inaccuracies within the dimensions of the final product. I expected the difficult element of this technology would be the software in how you create a product around a scanned image, however this part was relatively straight forward compared to finding the right 3D printer to use. 3D printing technology tends to be aimed at the prototype market rather than producing the finished article. Some printers use powder, some lay-up materials in layers and some with liquid resins. It took 18 months of research to identify the right machine which would work for prosthetics/orthotics.

3D printing does not only provide accuracy in product dimensions, it also allows for the design of complex components and the variation in thickness of the material. The only material which comes close in the design elements has been the use of carbon fibre which Crispin Orthotics has been using for over 10 years. Unfortunately, once carbon fibre is manufactured it is very difficult to adjust and is prone to brittle failure, whereas some of the materials we are using in 3D printing have more an elastic type failure and can be adjusted slightly with heat as per traditional thermoplastic materials.

Fig 2. Pneumatic testing jig

"So how do you pass this knowledge onto your clinicians to enable them to prescribe correctly?"

We have found that communicating new technologies and materials knowledge to clinicians has been the stumbling block with implementing new products and practice. To overcome this, we are about to employ an individual as the expert point of contact between the clinicians and Technicians to provide advice and produce the best product possible for the patients using the most appropriate material.

It can be frustrating trying to pass this knowledge on to the profession at large. Of course there is a commercial aspect to this. We are a business but we do have to pull the profession with us and quite often I am just viewed as trying to sell a product. Therefore it's difficult to educate Prosthetists/Orthotists to the potentials available for their patients with this new technology in the UK market. We have to find a way to work together as a profession and industry to provide the best products we can for our patients.

"Current clinical prescription is limited by materials and components available. Using 3D printing technology, the only limitation is your imagination"

WORKSHOP TOUR

As we walked around the workshop I noted a testing area (Fig 2.) sitting beside the milling machine. A gauge was repeatedly loading a strip of 3D printed nylon to prove how many cycles of loading it would withstand in all three planes. Mark thought that sample would keep going for many months before it showed any signs of deforming.

He has also been working on integrating silicone into orthoses. He has created slimline hybrid orthoses using plastics as the frame with cut-outs over sensitive pressure areas and merging with a silicon sheath to provide total contact. Traditionally we could have used a Northvane liner to provide a similar result but this manufacturing technique provides a much lighter, thinner equivalent.

Lynne Rowley
BAPO Chair

Case study

Male pilot, right shoulder disarticulation. Patient wishes for a prosthetic arm to **enable throttle control whilst flying.**

The prosthesis already provided via standard manufacturing techniques unfortunately fell off during a test flight resulting in the aeroplane going into a spin. The pilot lost all faith in that prosthesis and designed a device himself which was approved for flying. His device works great functionally, however was uncomfortable to wear, and Mark was approached to see if a limb could be manufactured to this man's unique requirements.

He needed a combination of adjustability, lightness and strength. The shoulder is required to flex and extend, the arm to be easily disconnected in case of emergency, the forearm extendable, the elbow and wrist to rotate and the hand section to grip and lock onto the throttle handle. In order to control the forces involved, Mark decided to incorporate the prosthesis onto a flexible body jacket so the pilot can use his torso to control the throttle.

He scanned the residual limb and used CAD to design the prosthesis, as you can see from the computer image Fig 3.

Scanning and printing enabled Mark to design the prosthesis to be light weight, have integral components which would not break under the forces applied as well as be comfortable to the patient. The pilot has tried the arm already and it is back in the workshop to have final alterations to allow slightly more elbow movement. The final piece was hot off the printer whilst I was visiting.

Fig 3. CAD system used to design the model around the scanned body image ready for 3D printing.

Fig 4. Finished 3D printed prosthesis

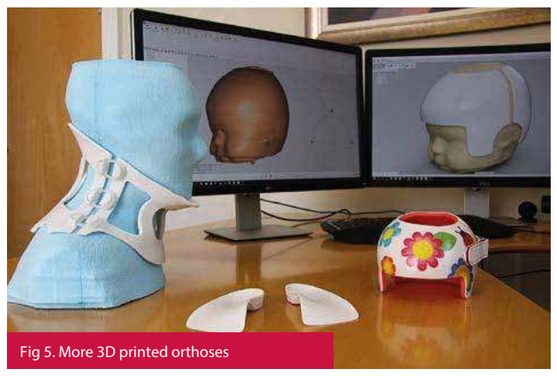

Fig 5. More 3D printed orthoses