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THE INTERNATIONAL JOURNAL FOR FOOT ORTHOTICS

ORTHOPÄDIE SCHUH TECHNIK 2023

The meeting place for pedorthists

Plaster and scan

How to get the right cast of the foot

3D-Printing?

Digital disruption in Pedorthics?

Official organ of the "International Association for Orthopaedic Footwear" (IVO).

ORTHOPÄDIE SCHUH TECHNIK

International Trade Show and Congress

20/21 October 2023, Cologne

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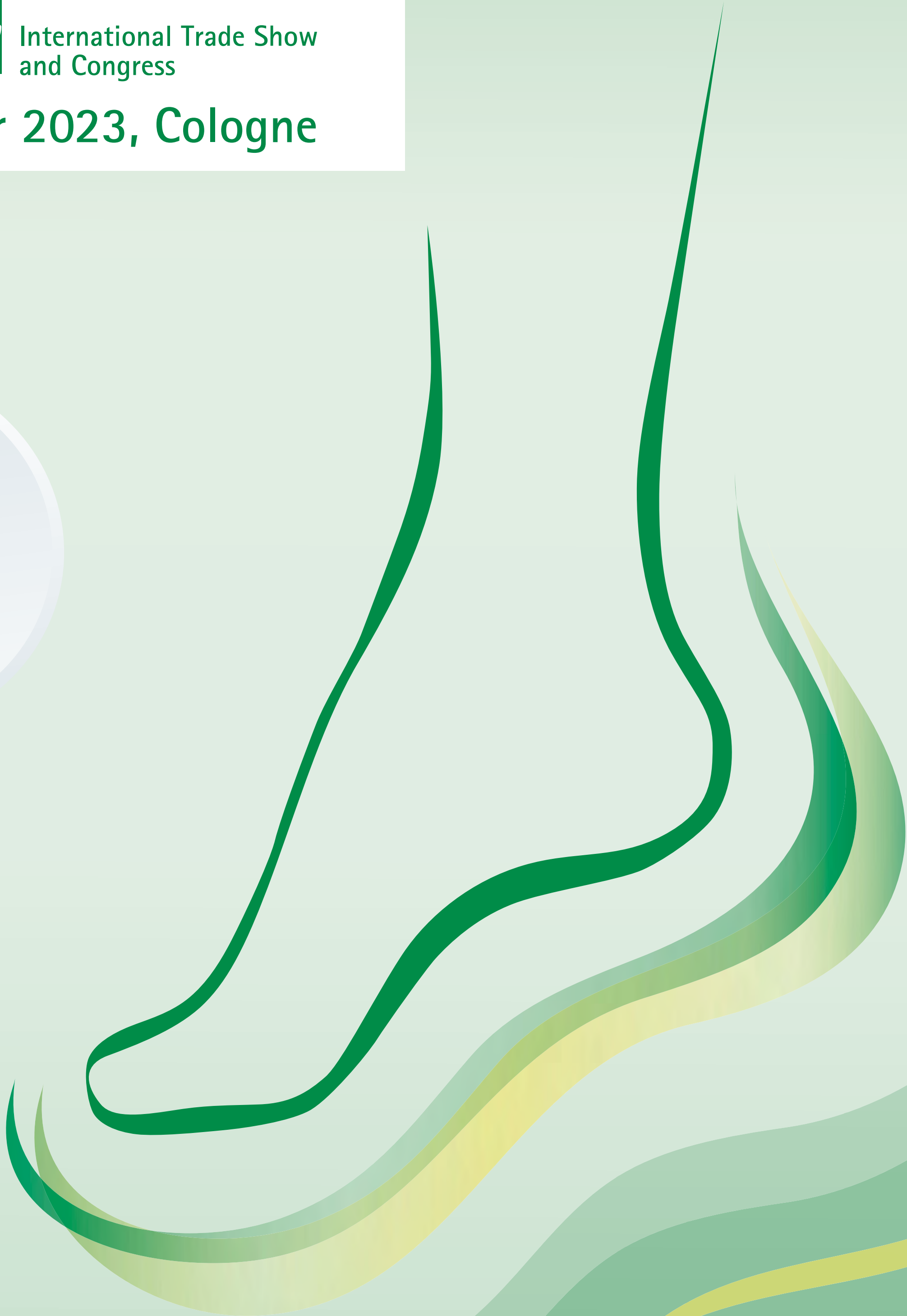

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From innovators to the majority

There are life cycles for us humans, but also for products and innovations in markets. The best-known example of this is Apple‘s iPhone. Hardly comprehensible today, no great future was predicted for it when it was launched. But then what in economics is called the five phases of the introduction of a new technology set in.

At the beginning are the innovators, who are always interested in new technologies and try them out and use them even when they are not yet fully developed. They are followed by the so-called early adopters. They are not quite as willing to take risks as the innovators, but are happy to be among the first to pick up on new trends and forward-looking technologies. One of their motives is certainly to stand out from the crowd that will soon follow if the product is a success. They are the ones who prepare the ground for wider distribution.

Once a technology has proven itself, it is followed by the early majority, who are described as conscious consumers looking for useful solutions. After all, the early adopters have shown that it is useful. The so-called late majority follows suit when the product is established and its usefulness has been proven - or it is now a product that you simply have to have in order to be on the cutting edge.

This is certainly true of the smartphone, which no longer necessarily has to be from Apple, but which has a penetration rate of more than 80 percent. Those who still don‘t have one are among the latecomers who are forced to switch at some point because their old technology is no longer available.

At which point in the innovation cycle is Pedorthics? What is certain is that the innovation cycle is not as fast as it is for digital devices. The innovators in Pedorthics started using technologies like scanners, CAD and milling over 30 years ago. The early adopters followed after a few years when the technology was cheaper and, more importantly, easier to use.

If we look at the market share of new technologies in Pedorthics - for which there are only estimates and no exact figures - we can say with some caution that currently the early majority is still forming, which is responsible for a widespread spread of new technology. Today, probably even more insoles are made by hand than with milling machines, 3D printers or other technologies.

When this ratio will turn around is one of the exciting questions in the industry. Especially 3D printing, which is preparing to replace milling in some areas, is expected by many to bring about digital disruption in pedorthics as well.

Currently, it is the shortage of skilled workers in many places that has business owners looking for solutions that enable manufacturing with high competence and quality with fewer employees. This could be computer-aided manufacturing or the use of an external service provider.

It will certainly be several years before new technologies are actually capable of solving all supply tasks, as was possible for decades with manual labor, so the two will probably coexist for some years to come. And technology will not be able to replace manual labor entirely. However, the fact that most companies will eventually have scanners, printers and other technologies that will be used alongside traditional techniques is no longer a pipe dream.

Wolfgang Best
Chief editor

Photo: C. Maurer Fachmedien/Eisele

Photo: Trans2Form

On October 20 and 21, 2023, ORTHOPÄDIE SCHUH TECHNIK - International Trade Fair and Congress in Cologne, Germany, will once again provide a comprehensive overview of the pedorthic industry. The accompanying congress will offer many ideas on how pedorthic companies can progress. Page 6

3D printing has now also reached Pedorthics. What possibilities does the new technology offer? Page 12

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Photo: Fischer

Whether manually or with the scanner, anyone who builds shoes needs a good cast of the foot. Pedorthist Franz Fischer explains what needs to be taken into account with both techniques. Page 20

Imprint

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DEUTSCHE FACHPRESSE

Orthopädie Schuhtechnik

Shaping the future of Pedorthics

WOLFGANG BEST

“Analyzing, understanding, providing” and “My company – my future” are the main topics of the ORTHOPÄDIE SCHUH TECHNIK congress on October 20 and 21, 2023 in Cologne. The question that unites both topics is: With which competencies and concepts will I be successful with my business in the future?

Pedorthics is under pressure from many sides. In many countries, there is a shortage of well-trained specialists in the workshops. The production of assistive devices is shifting more and more towards technology and external service providers. While some companies are growing and branching out, many owners are unable to find a successor for their business. Competitors from outside the industry are trying to gain a foothold in the orthopedic footwear market with the help of digitized processes.

All these developments are no reason to bury one’s head in the sand. They challenge us to find new solutions and new concepts for this craft, with which committed and well-trained orthopedic shoemaker masters can continue to hold their own on the market with their own business in the future.

Analyzing, understanding, providing

How can pedorthists differentiate themselves from their competitors in the future if feet can simply be scanned and the data sent around the world for fitting? One answer is: in the future, pedorthists will concentrate even more on those service areas that require direct contact with the customer and cannot be digitized. These are not additional “services” for the patient that can actually be dispensed with. This is about those examinations of the patient that give the pedorthists the right information about which solution will best help

The fair again offers an overview of the complete assistive devices industry for foot problems. Photos: C. Maurer Fachmedien

In the forum in the exhibition hall, numerous companies will again present their innovations in lectures.

ORTHOPÄDIE SCHUH TECHNIK 2023
The meeting place for pedorthist worldwide

October 20-21, 2023
Koelnmesse, Hall 4.2

Organizer: C. Maurer Fachmedien

Opening hours trade fair:
Friday, October 20, 2023: 9:00 a.m. - 6:00 p.m.
Saturday, October 21, 2023: 9.00 a.m. - 5.00 p.m.

ORTHOPÄDIE SCHUH TECHNIK is the only trade fair specifically for the orthopedic footwear industry. Manufacturers, wholesalers and service providers in the industry will find their ideal platform here to present their range of services in the field of therapeutic appliances and assistive devices. Visitors to the trade fair can find out about all the developments in the field of technology, materials, aids, software and services. Over 130 exhibitors, many of them from abroad - including Iran, Pakistan and China - are represented at the fair. 24 exhibitors are at the fair for the first time. Many of them are from the sector of new technologies. In addition, more than 200 apprentices are expected, for whom there will be a special seminar program.
Information on the congress and trade show at www.OST-Messe.de.

Greetings from the organizer

Personal contact remains invaluable

With this year's event, ORTHOPÄDIE SCHUH TECHNIK - International Trade Fair and Congress returns to its normal event rhythm. Always in the odd-numbered years, Cologne is the meeting place for everyone involved in the care of foot problems.
We are very pleased that we can welcome the vast majority of exhibitors who were already present at last year's trade fair, which had been postponed due to corona, again this year. With their offers, they ensure that ORTHOPÄDIE SCHUH TECHNIK will once again be able to present the world's most comprehensive range of products for this craft. We are particularly pleased that this year 12 companies are participating in Cologne for the first time.
This shows us that even in the digital age, personal contact remains invaluable. And as a craftsman, you ultimately want to take things in your hands and evaluate them - whether it's a special leather, a new material, or a foot orthotic fresh from the 3D printer.
New technologies have transformed the craft in recent decades and, by all accounts, will continue to gain a foothold in pedorthics workshops. Many businesses are looking for technical solutions and services to compensate for the shortage of skilled workers. Suppliers from this sector are represented in unprecedented numbers this year, offering the opportunity to gain comprehensive information on this topic. Some of them will present their solutions in lectures in the forum in the exhibition hall.
The possibilities for development and future opportunities for pedorthic companies will also be the focus of the congress this year. Under the titles „My company - my future" and „Analyzing, Understanding, Providing", numerous lectures and seminars will deal with the concepts with which a pedorthic can survive on the market in the future - be it from a professional or business management point of view. You can look forward to an exciting program of lectures and seminars, which we have put together in cooperation with the German Association for Foot and Ankle (D.A.F), the German Society for Foot and Ankle Surgery (GFFC), KomZet O.S.T. and the Studiengemeinschaft Orthopädieschuhtechnik.
See you in Cologne!

Carl Otto Maurer
Managing Director
C. Maurer Fachmedien

Seminars in English

2D and 3D motion analysis in the treatment of athletes

Friday, Oct. 20 11.00 a.m.– 12.00 p.m.

The correct use of suitable motion analysis methods enables the formulation and implementation of treatment goals in the individual care of athletes and the monitoring of the achievement of these goals. For this reason as well, one of the main focuses of the seminar is the correct and practical use of instrumented motion analysis in the pedorthic care of athletes. On the basis of practical examples from everyday care, the participants will acquire skills for the selection and use of suitable methods and meaningful parameters. In the seminar, participants will also have the opportunity to get to know and use more complex methods, such as markerless 3D motion capture systems. Potential participants should be interested in motion analysis and have basic knowledge in the field.

Digital revolution: How can pedorthists make themselves indispensable? Patient interaction – Assessment – Design – Manufacturing.

Interactive International Seminar.
Friday, Oct. 20., 3.30 p.m. – 5.00 p.m.

The digital revolution has arrived in orthopedic footwear technology. Burying one's head in the sand or regarding the new technologies only as a threat to the craft does not help. The industry must come to terms with the new technologies and develop concepts on how new technologies can be used sensibly in the industry to expand and improve its own possibilities for treatment. Only in this way will it be possible to compete in the future with automated supply approaches, as they are increasingly being offered.
In the interactive international seminar various experts will report on the potential of new technologies. After the presentations, there will be plenty of opportunity to discuss various aspects of the impact of new technologies and with which concepts the craft can meet the challenges.

Program:
Introduction: How digitalization affects pedorthics: What are the challenges? (i. e. Big Data, AI, new design possibilities, scanning and production technologies)

Fred Holtkamp/Jessica Hohenschon
BIG DATA: Choosing the right assistive device – Indication Portal of the NVOS
Rob Verwaard
Digital data – 3D scanning, Measurement techniques
FredHoltkamp/Jessica Hohenschon
CAD and 3D printing.
Parametric thinking and design of orthopedic appliances
Daniel Petcu
How to prepare the current and next generation of pedorthists for the digital world. Training and Education.
Fred Holtkamp
Working groups, 30 min.

Discussion and exchanging experiences,
reporting back and summarizing
Please note: Participation is free of charge, registration in the ticket shop is required. Booking: https://ost-messe.de/seminare/

the patient. In addition to the patient evaluation, this primarily involves the manual, functional examination of the foot and the assessment of gait and posture.
Anyone who has attended congresses and educational events in recent years will have encountered this approach time and again. Only when we really understands where the patient's problem lies will we be able to help him or her, whether from the medical, physiotherapeutic or pedorthic side. It has become widely accepted that the location of the pain and the location of the cause of the pain are often not identical. Only those who have a good understanding of the functional significance of the anatomical structures are in a position to treat the causes of problems.

In the congress focus "Analyze, understand, provide" there are therefore numerous lectures and seminars that provide a more comprehensive understanding of the functional relationships in our musculoskeletal system. The topics range from foot examination to the assessment of walking and standing, concepts for the correct choice of assistive devices, sensorimotor function and new findings from fascia research.

This knowledge is not only fundamental for successful fitting, but also gives pedorthists a decisive competitive advantage. The treatment of foot problems is becoming increasingly important, especially in the aging societies of the industrialized nations. People who are well on their feet determine their own lives and participate in social life. The market is growing and offers opportunities for those who provide individual and high-quality solutions. Anyone who studies what successful companies do right will come across the above

Cologne will again be the meeting place for pedorthists from all over the world.

In the congress hall all lectures will be translated (German - English and vice versa)

criteria again and again: The individual grasp of the problem and just as individualized treatment. This is always complemented by an outward appearance in which the customers also feel and experience this performance - for example, through the equipment but also the way in which communication with the patients takes place.

My business - my future

Which concept is right for my business? If I want to become self-employed, how does that work? How can I hand over my business? These questions will be addressed on the second day in the congress as well as in a seminar. Different companies will present their concepts and models will be presented on how the start into self-employment can be succesful.

Standards of care and the integration of new technologies will be presented in a cooperation session with various professional societies, with both concepts and practical implementations in the company being presented.

In addition to the main topics, new findings from science and practice will also be presented at the congress, as usual. The extensive seminar program will on the one hand intensify topics from the congress and on the other hand again present a wide range of topics from pedorthic expertise to business management and marketing.

In the forum in the exhibition hall, many companies will once again present their innovations. One focus this year will be 3D printing.

On the second day of the congress, the issues of the future will once again be addressed and discussed in a large panel discussion - with the opportunity for everyone to contribute their ideas.

The congress thus offers many opportunities to get fit for the future in times of change and to actively shape the future of pedorthics.

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Diabetic Foot – New Guidelines from the IWGDF

The International Working Group on the Diabetic Foot (IWGDF) has been producing evidence-based guidelines on the prevention and management of diabetes-related foot disease since 1999. In 2023, all IWGDF Guidelines have been updated based on systematic reviews of the literature and formulation of recommendations by multidisciplinary experts from all over the world.

The IWGDF Practice Guidelines describe the basic principles of prevention, classification, and treatment of diabetes-related foot disorders based on the seven IWGDF guidelines. The information in these practical guidelines is aimed at the global community of health professionals involved in the care of people with diabetes.

The IWGDF guidelines are divided into seven subchapters:

1. Prevention of foot ulcers in persons with diabetes
2. Classification of diabetes-related foot ulcers
3. Diagnosis and treatment of foot infection in persons with diabetes
4. Diagnosis and management of peripheral artery disease in persons with a foot ulcer and diabetes
5. Offloading foot ulcers in persons with diabetes
6. Interventions to enhance healing of foot ulcers in persons with diabetes
7. Acute Charcot neuro-osteoarthropathy (CNO)

Many studies around the world support the belief that implementation of these prevention and management principles is associated with a decrease in the incidence of diabetes-related lower extremity amputations.

The burden of foot disease and amputation is increasing rapidly, and comparatively more so in middle- and low-income countries. These guidelines should therefore also help in setting prevention and care standards in these countries. In conclusion, the authors hope that these updated practical guidelines will continue to serve as a reference document to assist healthcare providers in reducing the global burden of diabetes-related foot disease.

For more information: https://iwgdfguidelines.org

World Guidelines for Falls Prevention

Falls become more common with age. Although some falls may seem insignificant, the consequences for older people can be devastating from a psychological and physical perspective. Falls can lead to loss of confidence, loss of independence, pain, injury, depression and even death.

The number of falls and related injuries is likely to increase, in part because the global population of older adults is growing, but also because of the increasing prevalence of multimorbidity and frailty. The „World Guidelines for Falls Prevention and Management for Older Adults: A Global Initiative" are intended to provide a framework and expert recommendations for health professionals and others working with older adults to identify and assess falls risk. They recommend what interventions should be offered to older people, individually or in combination, as part of a person-centered approach to falls prevention and management.

The guidelines were developed by the World Falls Task Force. It includes 96 multidisciplinary experts from 39 countries on five continents, including 36 scientific and academic societies.

Read more at: https://worldfallsguidelines.com

Pedorthist successful in round one of the National Industry PhD Program

Sayed Ahmed, PhD Candidate and Certified Pedorthist Custom Maker from Australia, has a research project accepted in the first round of the Australian National Industry PhD program in collaboration with Charles Sturt University and Foot Balance Technology. The Australian Government is investing $296 million under the Increase Workforce Mobility initiative. This includes funding to establish the National Industry PhD Program, which aims to develop research talent that is skilled in university-industry collaboration. An Industry PhD is a doctoral program that is designed with an industry application. PhD candidates work on a research project co-designed by the university and industry, under appropriate academic and industry supervision. The program is intended to equip PhD candidates with the knowledge and skills to translate university research into commercialisation outcomes.

Sayed Ahmed's projects aims to address the general issue of generic medical care and assistive device prescription for people with diabetic-related foot disease by utilizing and advancing artificial intelligence to guide personalized device prescripitons.

Sayed Ahmed is the Founder and CEO of Foot Balance Technology, a creative business model that provides pedorthic services to clients with various foot problems and conditions through primary and allied health clinics. As a certified pedorthist custom maker in Australia, he has over 12 years of experience in lower limb biomechanics, gait assessment, foot problem diagnosis, and design and manufacture of foot orthoses, ankle foot orthoses, and custom orthopedic footwear. He is also completing a Ph.D. in the area of diabetes foot care and footwear through the School of Health and Human Science at Southern Cross University.

PAA-Conference: Pedorthic Partnerships

The Pedorthic Association of Australia invites to its national Pedorthic Conference 2023 from 12th – 14th October 2023. The venue will be the Esplanade Hotel in Walyalup – Fremantle, Western Australia's historic port city. Visitors can expect a high quality conference program and a pre-conference program with several workshops.

Leaning on the success from 2022, the Pedorthic Association of Australia invites professionals from across the allied health industries to learn more about pedorthics and related fields dealing with feet, footwear, and the lower limb.

This conference is the only pedorthic conference in the southern hemisphere. The Theme – Pedorthic Partnerships is supposed to encourage all participants to explore and understand the value pedorthics brings to allied health for the benefit of clients with foot health related matters.

In 2023, the goal for the Conference Organising Committee is to bring together more delegates from the full range of industries and disciplines working in foot health. Attendees from around the globe will include scientists and clinicians, retailers, students, educators, and other interested stakeholders.

3 keynote speakers will share their knowledge with attendees at the conference

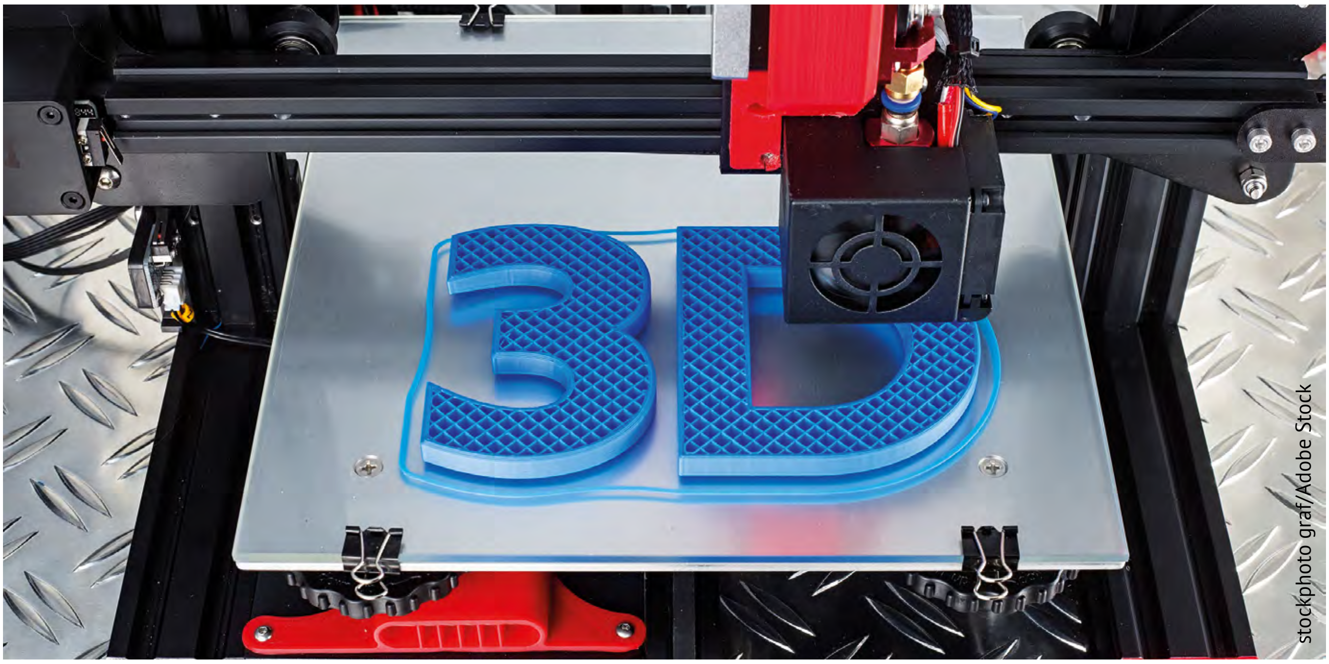
Sicco Bus completed his doctoral dissertation on the structural and functional aspects of the neuropathic foot in diabetes. In his work at the department of Rehabilitation Medicine at Amsterdam UMC, he leads and supervises research on lower-extremity biomechanics and injury prevention in diabetes and sports.

Cylie Williams is a clinical researcher and educator in the School of Primary and Allied Health Care at Monash University. She has extensive clinical experience in all health care settings, with a particular focus on paediatric lower limb conditions.

Sayed Ahmed is a Bangladeshi-bred Australian pedorthist, researcher and entrepreneur in the healthcare business. His experience includes over a decade in footwear and foot care. As part of his PhD project, he has conducted a multisite clinical trial in some Sydney hospitals and clinics to explore best clinical practices for diabetes-related foot ulcer management and prevention through appropriate footwear.

The pre-conference day workshops will address the following topics: Footwear Modifications,. Digital Scanning Techniques, Sensomotoric Foot Orthoses, Basics of Pedorthic Footwear Fitting, Pressure Mapping and Analysis.

For more information about the program please visit the PAA-website: https://pedorthics.org.au/



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3D-Printing: Digital disruption?

WOLFGANG BEST

3D printing has developed rapidly in recent years. Additive manufacturing is being used in more and more industries in a wide variety of processes. 3D printing has also long since gained a foothold in the pedorthic industry. What potential does this technology have in the assistive technology market. Does it really mean disruption as some believe?

We first reported on 3D printing on a larger scale in our magazine 9 years ago, including a research project in the UK that explored the possibilities of manufacturing assistive devices using this new technology. At that time, there were hardly any printers suitable for the use in pedorthic businesses.

But more than a few people involved with the process already believed at the time that the next revolutionary step in the production of assistive devices was now just around the corner. The possibilities of additive manufacturing early on fired the imagination of those looking for new solutions to improve the way products functioned. With CAD milling technology, one was limited to carving out the shape from a block with predefined material properties.

With 3D printing, this process has been completely turned on its head: In 3D printing, you can create any shape you want and also set the material thicknesses and material properties completely differently, so that you can also vary the stiffness in the assistive device. It is therefore not surprising that this technology was initially successful in the manufacture of orthoses for the lower leg and hand, because they were printed at a lower weight with the same function and stability and also looked good.

Whether this technology would also be suitable for pedorthics was still questioned at the time. But soon the first pedorthists began experimenting with 3D printing, printing lasts and trial shoes. At the time, many still considered 3D printing unsuitable for the production of foot orthotics - partly because of the long manufacturing times.

Field of application has changed

Today, the picture has changed. Many who manufactured their lasts using 3D printing have returned to the classic wooden last. The reasons for this were mostly the more expensive manufacturing process compared to wood, but also the manageability and durability of wood as a material in the production of custom orthopedic shoes. Only trial shoes, which are printed with the CAD data of the last for fit control, have become established. The advantage: Any necessary fit changes can be made in CAD before the last is milled.

For this, 3D printing in foot orthotics production has developed rapidly - although not without stumbling blocks. Pioneers in this field report numerous setbacks in production when the printer simply stopped and it sometimes took hours to find the error. It was particularly annoying - against the background of the sometimes very long printing times - when the error only occurred after several hours and the process then had to be started all over again. This could be because the print head was too hot or the filament was not transported properly. Poor quality filament can cause the print head to clog and if stored incorrectly, the material can form bubbles during printing. The right materials and the ability to combine them are still areas where there is room for improvement for many users today.

But development is not standing still. In the meantime, it seems, many manufacturers have worked on the technology, processes and materials to such an extent that the printing process runs much more stably - provided the defined framework conditions are met.

The market is still on the move

New technologies do not have an end in themselves, but must prove that they offer a significant advantage over established processes. In 3D printing, these are the design possibilities already mentioned and the fact that, compared to milling technology, there is practically no waste because (almost) only the material is consumed that is later also in the foot orthotic.

Even though printers have become faster in recent years: The duration of the printing process is still a disadvantage of 3D printing for many. Others are more relaxed about the length of the production process and emphasize that a foot orthotic they have at least in their hands that requires virtually no reworking and that they save time - especially manual work that has to be carried out by employees.

At present, filament printing seems to be the most commonly used process for the production of interlinings. The investment costs are manageable and the application can be easily integrated into the workflow with a little experience. The printers use relatively little space - compared to a milling machine. They usually take longer to make a foot orthotic, but in return they don't cause any noise in the shop. However, other printing processes such as selective laser sintering or resin printing have already become established in the industry for some applications.

It is therefore not yet possible to assess whether there will be a printing technology that will become established across the entire industry or whether the various printing technologies will become established for specific areas of application. For example, those who rely on classic rigid heel cups currently seem to be able to achieve better results with resin printing or selective laser sintering.

As with the milling of foot orthotics, there are now also suppliers in 3D printing who take over the printing as a service provider. This means that entry into this process can be made without any investment in printing technology at all. This also makes 3D printing interesting for those users who are still unsure whether they can implement their ideas of an optimal foot orthotic with this technology. Milling technology had also received a major boost with the introduction of milling as a service years ago.

The popularity of 3D printing is certainly helped by the fact that many in the industry have already gained a lot of experience in the past decades with scanning feet, CAD design and computer-aided manufacturing of assistive devices. The knowledge gained here can also be applied to 3D printing. In the end, it's all about how the data is processed. In principle, both is possible: milling or printing.

Is 3D printing already the revolutionary step in pedorthics as was suspected in 2014? At the ORTHOPÄDIE SCHUH TECHNIK trade fair on the 20th/21st of October 2023 in Cologne, more suppliers of 3D printing solutions will be exhibiting than ever before. This can also be taken as a sign that the industry has discovered the pedorthic sector as a viable market for this technology. More and more manufacturers are launching new or enhanced printers on the market, which are often also capable of faster production. By using different printing processes, the design possibilities are expanding all the time. For example, two materials of different hardnesses can be combined in a single printing process, allowing stabilizing and cushioning zones to be realized in a wide range from hard to soft.

Some are convinced that this will once again make it possible to create highly individualized assistive devices that were no longer financially affordable to manufacture by hand due to the high proportion of manual work involved.

Shortage of skilled workers drives development

As with the introduction of all new technologies that partially replace craft work, 3D printing raises the question of how the craft sector should respond. On the one hand, it is often the sheer necessity for businesses to turn to technology to replace skilled manual labor. In many countries, it is becoming increasingly difficult to find trained professionals who could do the work. In other countries, there is a lack of training opportunities

3D printing popular in many industries

To understand the changes that 3D printing can bring to the footwear industry, it's helpful to look at how other industries are using the technology. It is clear that 3D printing has a long history in some industries. While 3D printing was initially often used to produce prototypes in a short period of time, it is now widely used in production. This is especially true in areas where high quality, low volume products are required. The aerospace industry, the automotive industry, and the entire engineering industry integrated 3D printing into their research and development decades ago, and have steadily expanded the applications of 3D printing for themselves and other industries over the past few decades. In medical technology, everyone in the industry has certainly seen 3D printed orthoses or foot orthotics. But 3D printed medical devices are also being used today for "spare parts" in the body. For example, dental technicians are now using 3D printers to create custom dental implants. Even endoprostheses are now being printed individually for the patient's anatomy. One possible development is to use imaging technologies to measure a patient's knee or jaw and obtain a CAD design of the desired implant, which can be printed immediately after being finished and inspected. 3D printing doesn't stop at tooth or joint replacement. Bioprinting is a much-discussed development in the medical field. This involves printing complex organic structures from previously grown cells. It will be some time before the first functional organ is produced. But printing tissue for blood or printing joint cartilage from the body's own cells already seems within reach. In the future, printed cartilage tissue could replace many of the endoprostheses used to treat osteoarthritis. It's a multibillion-dollar market, and pedorthic applications are still on the fringe. But sooner or later, the innovations and developments in 3D printing will find their way into the assistive technology industry, where they will expand design and manufacturing capabilities.

Dental implants are already frequently 3D printed.
Photo: M.Dörr_M.Frommherz/AdobeStock

for skilled trades. Here, it is obvious that the available experts work on the patient instead of in the workshop. While countries that have not had any fixed training structures so far can approach the subject quite unencumbered, countries with a long tradition of craft training face the challenge of combining tradition and modernity. Traditional training should not be neglected, since it is precisely through manual work that important skills are trained that are also essential later on when using new technologies. In particular, three-dimensional thinking and a sense of the material are best learned by working on three-dimensional objects by hand, almost everyone in the industry who knows both worlds is convinced. It is therefore important in training not to neglect the old and at the same time to familiarize the next generation with the new technologies. The fear that new technologies could open the door to suppliers and investors from outside the industry is also not unfounded. With the possibilities of online business and the further development of the mobile phone and its built-in photo lenses, which can also be used to scan and measure the foot, it now seems easier than ever to collect data for an orthotic supply and to provide it to customers via online platforms. Attempts to take market share from traditional providers have been made time and again in the recent past. That's why, even with 3D printing, you shouldn't forget what you learned with milling. The CAD and the machine do not create the assistive device.

It only executes what the craftsman has conceived. Many 3D printing pioneers point out that it's not enough to run a scanner around the foot and capture its shape. The goal, they say, must be to use digital methods such as a scanner to capture the shape of the foot, or correct it if necessary, just as well as the footprint or plaster. And in the end, it is the craftsman who, with his knowledge, recognizes the problems and needs of the patient and designs the device with his skill and sense of form. ■

foot & shoe
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6.5 Creating a negative plaster mold

More than 80% of custom-made orthotic footwear is created in this or a similar way (Fig. 6–8).

An essential basic task for the pedorthist is creating an exact negative plaster mold of the foot. Prerequisite to this is a correct, manual examination of the active and passive musculoskeletal system of the lower extremities (see Chapter 22). This provides information about the optimal position of the foot in the shoe. Ideally, the patient will have already been treated by a physiotherapist so that an optimal range of motion can be used when creating the mold.

The mobility of the ankle is tested based on the corrected hindfoot, the position of which is paramount to treatment (Fig. 1 a – d). The calcaneal tuberosity is maximally corrected for a non-contracted valgus hindfoot. An equinus foot deformity is tolerated. The procedure is similar for a clubfoot: maximum hindfoot correction, plantigrade adjustment of the ankle. To achieve a consistent left-right result in the plaster mold, the deformed foot is plastered first and then the healthier foot is adjusted.

Preparations:
1. Welcome.
2. Medical history.
3. Findings.
4. Foot as non-edematous as possible.
5. Optimal patient positioning (on a chair, in bed, on a seat shell, on mother's lap, ...).
6. Explain and define treatment goals.

Material (Fig. 7):
1. Original/planned footwear (socks, compression stocking, bandage...).
2. Plaster area.
3. Plaster bandages (4 cm x 12cm).
4. Insulating foil.
5. Scalpel, knife.
6. Cutting mat.
7. Container with water.
8. Latex gloves, sized appropriately.
9. Block for the heel pitch.

Procedure (Fig. 7, 8):
1. Wrap foot with foil from distal to proximal in the intended direction of correction: On the one hand, the edema is pressed ... from p...
2. Fix the ...
3. Put on ...
4. Hold p... squeez...
5. Wrap ... foot an... reache...
6. Sprea...
7. Adapt ...
8. Foot c... forefo...

Fig. 7 Set up the plaster working area.

Fig. 8 Cut open plaster on the cutting mat with scalpel.

Fig. 9 Finished plaster negative.

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9. Allow the plaster to harden.
10. Cut open with the knife.
11. Carefully pull off the negative mold.
12. Close with a strip of plaster.
13. Remove foil and clean area.
14. Make the next appointment and explain the further procedure before seeing the patient out.

6.6 3D foot scan

3D scan technology is becoming more and more important (Fig. 10 – 12). A distinction is made between:

A Scanning in the box: The patient is put into a position where the foot can be scanned from every side. The surface of the skin is registered. Corrections are not possible for patients requiring custom orthotics. It is easier to treat patients when the frontal median is not important and a template is available from the shoe last archive or the digital last library.

B Hand scanners have the advantage that they can be used around the patient, allowing the patient to maintain a more relaxed posture. Good corrections, however, are not always possible with these (Fig. 11, 12). Newer and smaller scanners are available from the company Gebiom, among others.

6.7 Plaster negative and scan technology

One way to take advantage of the positive correction capabilities of the plaster cast and the advantages of scanning is to combine these two methods. A plaster cast is first made as described above, and subsequently scanned. For this method, it is also possible to use a last from the shoe last archive. The virtually generated raw lasts can also be modeled on the computer with the aid of suitable software, and then milled.

6.8 Foot foam and scan technology

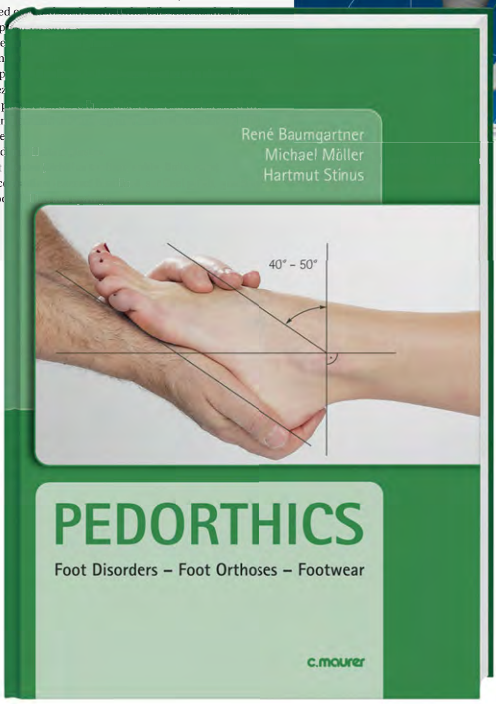
With special software, the data from different scans can be combined and assembled into a virtual object. In this way, the footsole mold can be scanned from the corrected foot foam and then mirrored (Fig. 13, 14). The dorsal portion of the foot and lower leg is scanned directly on the patient. The object to be scanned should move as little as possible. Subsequently, the two virtual halves are joined to form the complete foot. The changeover from manual work to virtual computer modeling is particularly challenging in this case.

Fig. 11 Scanner (manufacturer: Gebiom).

Fig. 12 Scanning a positive shoe last (manufacturer: Spenle).

Fig. 13 Scanning the foot in the foot foam.

Fig. 14 Scanning the corrected foot foam.



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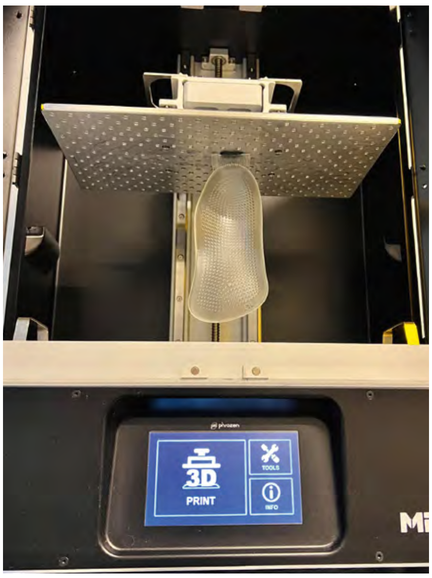
Resin printing as a new 3D printing process for pedorthics

MARTIN JAEGER

Most pedorthic companies that print in-house have so far worked with the FDM (filament printing) process. However, a promising process is also resin or SLA printing - printing with light-curing resins. How does it work and how useful are the printed products for the needs of pedorthics?

The digital process chain from scanning to modeling and final 3D printing - despite all the progress that has been made in recent years - currently still presents us with the challenge that what has been created by 3D scanning and CAD modeling cannot be produced in the required quality at favorable prices. For example, it is still not possible to reliably print two materials of different firmness together in one operation, apart from FDM printing (filament printing) with its sometimes modest results. But these printing processes are also continuing to develop, and there are some very promising approaches, especially in the area of manufacturing 3D-printed bedding foot orthotics. Overall, however, the results are still far from meeting the requirements of our craft, especially as far as stability and finish are concerned.



1 Printing of a foor orthotic with the Phrozen Mega 8 K LCD printer.

The two best processes currently available, laser sintering and HP Multijet printing with the materials TPU 95, PA 11 and PA 12, have the disadvantage that the investment in hardware is not affordable for a small to medium-sized pedorthic company and that the components, if printed externally, are still quite expensive when calculated by weight.

In addition, both printing processes are so-called powder printing processes, which entail special protective measures in handling because of the potentially dangerous fine dust pollution.

Therefore, in this article we deal with the resin printing processes (SLA, DLP, LCD), which are not new but have become interesting due to massive price reductions in the hardware, and examine their applicability for the requirements of pedorthics.

In this article, we also use the term SLA printing (stereolithography) as a synonym for the various types of resin printing processes, whose common feature is based on the use of UV light-curing synthetic resins (resins).

About the history of stereolithography

Stereolithography (SLA) is one of the first 3D printing technologies and was developed in the early 1980s. Japanese researcher Dr. Hideo Kodama learnt that UV light could be used to cure light-sensitive polymers.

The term stereolithography was invented by Charles (Chuck) W. Hull, who patented the process in 1986 and founded the 3D Systems company to use it comercially. Hull described the technology as a method of producing three-dimensional models by sequentially "printing" layers of a material that is cured by UV light.

Stereolithography (SLA) is now used professionally in a variety of fields such as hearing aids, dentistry and jewelry making, especially where high precision and repeatable results are required.

The process

The so-called build tank (a tank with a transparent bottom and non-adhesive surface) in the printer is filled with a resin that is cured by UV light. Depending on the process, the object stands on the build platform, which moves down (SLA/Laser), or the object hangs on the build platform, which is pulled up from the liquid (DLP or LCD).

A UV light source is used to cure the liquid. Resin printing takes place in layer-by-layer overlapping, where each layer is cured by the UV light before the next layer is applied, or better: cured, by pulling it down or up.

Different resin printing processes

SLA (Stereolithography), DLP (Digital Light Processing) and LCD (Liquid Crystal Display) are three different technologies for resin-based 3D printing. They differ primarily in the light source used.

SLA (Stereolithography)

SLA uses a UV laser as the light source to cure a liquid photopolymer resin solution (resin) layer by layer. The laser print head moves parallel to the surface of the resin solution and cures the resin upon impact.

Once one layer is fully cured, the next layer is cured after the so-called build platform moves down step by step. The finished print object is thus immersed in the resin tank.

SLA is known for its high precision, complexity, surface quality and strength. It is a slower process than other 3D printing technologies and also very expensive due to the high-intensity UV laser used.

DLP (Digital Light Processing)

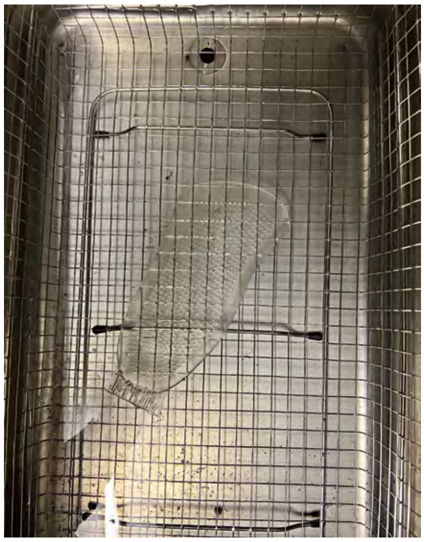
DLP uses a digital light source (beamer) to cure a liquid photopolymer resin solution layer by layer. The difference with SLA is that with DLP, the entire build platform is irradiated with light at once, rather than the laser print head moving over the resin solution.

This process is faster than SLA, but not quite as precise. Due to the distance required between the projector and the exposure point, the printers are either very tall or have a small installation space. The corresponding light-intensive projectors are also relatively complex to build and therefore expensive, and the lamps, which have to be replaced regularly, are also quite expensive.

LCD (Liquid Crystal Display)

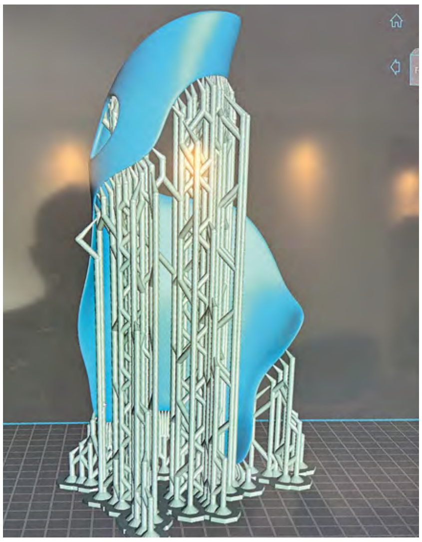
LCD is a newer technology for 3D printing that works similarly to DLP, but instead of a digital light source, it uses a Liquid Crystal Display (LCD) to control the exposure. Like a variable iris, the LCD blocks certain parts of the build platform while irradiating other parts to cure the resin solution.

LCD is known for its speed and efficiency, but it can sometimes be more difficult to print complex shapes with

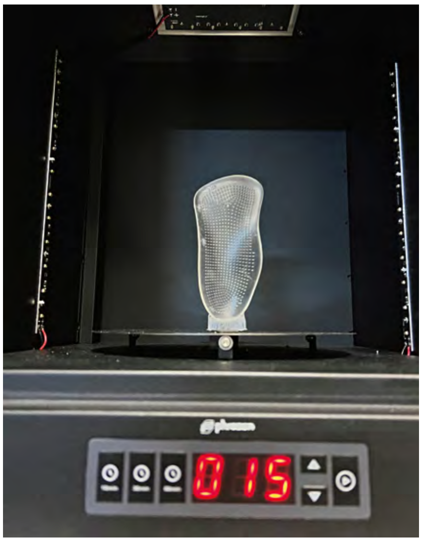


2 After removal from the printer, the print object is cleaned in an ultrasonic bath.

this technology. On the downside, the LCD monitor is a wearing part in this process, so it must be replaced regularly. The cost of this is manageable, since in principle any LCD can be used. How-



3 During slicing, the object to be printed is divided into print layers. The constructed support structures for the component are clearly visible here.



4, 5 The final strength of the printed object is only achieved by post-exposure in the curing box (left) and by thermal post-treatment during tempering (right).

ever, the effort required for the conversion should not be underestimated with the appropriate calibration.

Also, the installation space is much larger than with the other methods. Due to the layer-by-layer exposure, this means that the printing times per part are massively reduced if the printer is loaded appropriately.

The great advantage for our trade is the low acquisition costs with high surface quality and stability. It can be assumed that the market for desktop LCD printers will move tremendously in the near future, mainly because of these features.

Slicing

Before printing, a 3D model file (STL) specifically for the process and the material is divided into layers by software (slicing), provided with support structures (supported) and sent to the printer. In addition to the printing process, the necessary settings for slicing depend on the material used and the desired material properties, such as surface quality and stability. Basically, as with any 3D printing process, faster printing means lower quality also in resin printing.

There are various slicing programs, usually distributed by the manufacturers, for example Chitubox, which already contain so-called presets for the individual materials and printer types.

The print object is positioned in the installation space in such a way that overhangs of more than 45 degrees are avoided and it is usually supported (assisted and stabilized) with automated algorithms, since the print object is still far from reaching its final strength in the printing process. It is often also necessary to provide additional manual support in order to achieve an optimum print result. However, support algorithms are improving all the time and are delivering increasingly better results.

Necessary finishing work

After printing, the objects still have to be reworked in various steps - the final strength of the component is only achieved in this reworking process.
First, ultrasound is used in a bath of isopropyl alcohol to remove the excess uncured resin, since its high viscosity tends to fill smaller structures or perforations that would then become solid during curing.

After that, the support structures are removed, which is still quite feasible at this stage. Then the printed object is dried and cured to final strength in a so-called curing station, an internally mirrored machine with UV lamps, under a protective gas atmosphere (nitrogen gas) on a rotating platform.

Some materials require further tempering, i.e. heat treatment, to achieve final curing. Overall, the post-processing procedure is very complex and time-consuming. However, compared with other processes, for example powder printing (SLS and HP-Multijet), the effort is put into perspective and is rewarded with a perfect surface and a very high material quality.

Which resins are available?

Not all resins are compatible with the different printing technologies. For example, SLA 3D printers have a very powerful laser that requires a slower curing resin to achieve a stable printing process. LCD 3D printers have a low-power LED light source that works better with fast-curing resins. DLP 3D printers can be configured in many different ways, making it impossible to predict resin curing behavior without testing.

Because of the certification and biocompatibility testing required, there are currently few materials approved for our applications for the medical devices being manufactured.

After many attempts with FDM printers, I have now been working with resin printing for about 12 months and have been able to gain experience with printers from the company Phrozen (Mega 8K) and the resin "Insole A" produced by

6 Shell orthotic, perforated.

7 Butterfly orthotic.

8 Heel cap.

the company Dreve. I consider the process and the material to be very promising, especially for printing shell orthotics, but also for orthoses. Its properties are reminiscent of the legendary Plexidur. It is thermoplastically very well moldable, grindable and can be bonded very well. Unfortunately, as a so-called duroplast, it is currently not recyclable.

According to Dreve, which has already enjoyed great success worldwide with its 3D-printed earmolds in the hearing aid sector and its solutions for the dental sector, the company is currently working intensively on new formulations in order to offer 3D-printed lasts in the future, among other things.

Incidentally, it is amazing how normal the topic of 3D printing has already become in hearing aid acoustics and dental technology. In my opinion, this also offers a glimpse into our future.

Conclusion

SLA printed parts have the highest resolution and accuracy, the sharpest details and the smoothest surfaces of all 3D printing technologies. Stability is excellent, depending on the resin used; this is referred to as isotropy, which means there are no predetermined breaking points due to layer-by-layer processing that reduce the stability of the printed product, at least in one direction, as in FDM printing.

PROS

– moderate acquisition costs
– high resolution detail and precise contours
– very smooth surface
– high stability (isotropy)
– distortion-free (minimum shrinkage of approx. +/- 2 %)
– high printing speeds
– several components at the same time printable

CONS

– the supports cause visible traces
– relatively expensive finishing
– early signs of wear when exposed to UV radiation
– drain hole for cavities is needed
– material costs relatively high

Material manufacturers have developed innovative SLA resin formulations with a wide range of optical, mechanical and thermal properties that match those of standard, technical and industrial thermoplastics. Flexible material blends are also available, although they still need to be further developed to meet the needs and requirements of our craft.

As technology becomes more accessible and affordable, and hardware and materials evolve, I strongly believe that this technology will be a very useful addition for our craft. Personally, I see the greatest potential in the printing of shell orthotics, for which, after all, we don't have a digital counterpart, unlike today's excellent milled and printed softbed orthotics.

There has been a big change in stereolithography in particular. Originally, SLA printers were inflexible and prohibitively expensive. It required expensive machines, trained technicians and costly maintenance contracts. Today, small-format desktop printers can produce industrial-quality parts at a fraction of the cost and with unprecedented versatility.

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Plaster and Scan: Traditional and new techniques in last construction

FRANZ FISCHER

In order to be able to produce a custom orthotic shoe, it is of crucial importance to cast the foot and lower leg accurately and in a corrected position. In the same way as many aspects have to be taken into account when casting in order to obtain a usable result, preparations must also be made by the expert when scanning in order to actually obtain meaningful data. A self-developed scanning aid facilitates the procedure.

How can 3D scanning of the foot and leg achieve similarly good results as individual castings using plaster? The more accurate and clean a plaster cast is created, the less reworking is required later and the better the individual production of the assistive device is accomplished. This also applies to the use of digital technology. As easy as it may seem for outsiders to scan the foot, it must be clear: For a pedorthic shoe fitting, it is not enough to simply let the scanner move around the foot and leg or to guide it. It is necessary to find solutions with which digital technology can be used to achieve results similar to those achieved with plastering. So let's first take a closer look at the plastering procedure.

1 With a specially developed footbed as a scanning aid, it is easier to scan the foot in the corrected position.

Creating a leg last from a plaster cast

Preparation

The cast can be made with conventional plaster bandages, a plastic bandage or a Copysock. A normal stable square template is used for marking the plumb line. A copying pencil is best suited for marking (Fig. 2).

In order that little has to be changed later on the plaster or the last, the cast is made with the heel drops determined by the diagnosis. The corresponding heel and positioning wedges are ready before the cast is made.

It is particularly important to avoid mistakes in the area of the sole of the foot. If the foot is simply positioned on the heel block during plastering, an edge is created during plastering which must be compensated later (Fig. 3, number 1).

If the midfoot is not stabilized from below during plastering, this area will sink (Fig. 3, number 2). As a result, the foot bed must be corrected from below during subsequent last construction. Then the measurement at the instep is missing later and must be applied subsequently.

Similar problems arise at the plantar cast. The cast should be made while standing. The soft tissues of the heel and the ball of the foot lose their roundness (Fig. 3, numeral 3). To avoid poor pressure distribution, the last must be reworked in this area.

A stable footbed with a plastic core and an applied foam rubber that protrudes about 1 cm over the edge of the footbed eliminates all these disadvantages. The cast gets a nice spherical heel, no edge in the heel area presses into the cast. The midfoot is stable and no correction is needed from below during last construction. The ball area also gets a certain rounding and thus also a better pressure distribution (Fig. 4).

We put out the following additional materials:

- a cutting pad to protect the foot when cutting open
- water or a water sprayer to moisten the plaster or plastic bandages
- a piece of household foil about 12 cm wide to protect the foot against contamination
- a knife, an oscillating saw or plaster scissors for cutting open the plaster

The plastering procedure

The footbed with the foam rubber layer is selected according to the foot size.

2 Plaster bandage, copysock, plastic bandage, square, copying pencil.

3 Plaster cast with edges (1), sunken midfoot (2), flattened heel and forefoot (3).

The appropriate height wedges for heel and toe drops are positioned under the footbed. If supination, pronation or detorsion is envisaged in the subsequent last, the corresponding wedges are put out to be placed underneath (Fig. 5).

The patient wears the everyday sock or stocking when casting. The cutting pad is positioned on the foot and wrapped with the household foil. In this procedure, the stocking with its corresponding thickness is taken into account when making the last (Fig. 7).

In the first step of casting, the patient is seated. The malposition gives the direction of how the bandage is wrapped: One always wraps against the malposition in order to achieve a correction just by wrapping.

With the plastic bandages, the first layer is in the ball area, the toes can remain free. The bandage is wrapped twice and then offset by half the width of the bandage. This creates a stable cast without gaps. In this way, the bandage is wound upwards piece by piece (Fig. 8). Special attention is needed at the heel - gaps easily occur there due to the larger radius in the heel area.

After wrapping, it is of great importance to correct the foot. Depending on the malposition, the hands are positioned on the foot and the foot is brought into the correct position (Fig. 9). It is important to examine the position of the foot in the upper ankle joint. Patients tend to move the foot plantar, which later results in a positional error in the cast.

The foot of the patient, who is still seated, is held in the corrected position until the cast begins to harden and achieves some stability. The flexed index finger is used to tap against the cast when it begins to harden (Fig. 10). The foot is then positioned on the prepared pad and the position of the lower leg is set up. A great danger is to position the foot too early if the malposition is severe: The foot resumes the malposition and the cast must then be extensively rebuilt during last construction.

If the cast hardens further, the patient stands up. The patient's gaze should be directed straight ahead to achieve an exact position of the lower leg. In this position, the plumb line is marked on the outside and back of the cast using the square and the copying pencil (Fig. 11).

The cast is then opened at the front with the knife or the oscillating saw. The patient stands while doing this - this avoids distorting the position of the cast from standing to sitting. After cutting, the patient can sit down and the cast is pulled off the patient's foot with a twisting motion.

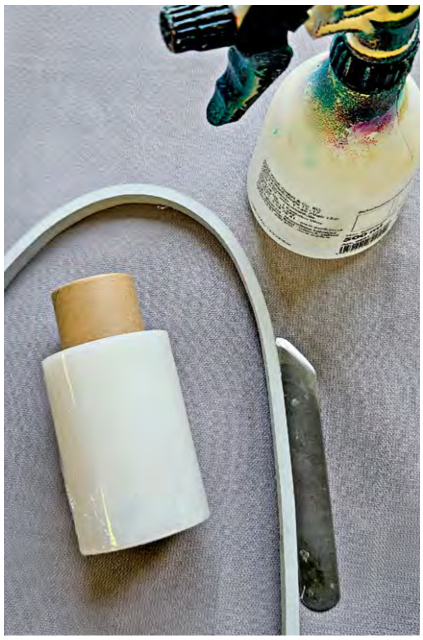
In order to control the position, it is important to check the cast by means of the previously made positioning drawing (Fig. 12).

Source of error

If you only cast the foot in a sitting position, the cast will never represent the correct position of the lower leg. A bow leg position or a hyperextended knee are not taken into account and must be corrected later elaborately during the last construction (Fig. 13).

4 Footbed with protruding foam rubber.

5 Footbed with all underlays prepared for plastering.



6 Water sprayer, cutting pad, foil, knife.

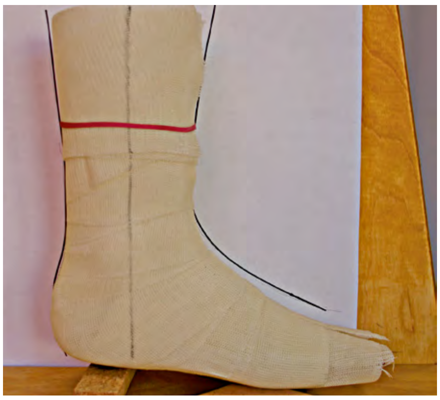
7 Wrapped foot with cutting pad.

8 Wrapping the plaster bandage.

9 Fix foot in corrected position with hands.

10 Tap against the plaster with the bent finger.

11 The patient stands on the plaster aids and directs his gaze straight forward.



12 Plaster with positioning drawing.

13 Plaster with incorrect position.

Conclusion

A well-made cast saves a lot of work during last construction. Once the cast has been made with the appropriate heel drops and the necessary correction, all that remains is to attach the tip.

Creating a leg last with digital technology

Preparation

We need a scanner to capture the foot. A lot has changed in this regard: A few years ago, it was very expensive to afford a technology that would give you good results. Today, scanners with such a high resolution, so that the amount of data has to be reduced in order to be able to process the data efficiently on the computer, can be obtained for as little as 400 to 500 euros (Fig. 16). The big challenge is to create a coherent scan from the foot without interrupting the scanning process. Various software solutions help with this problem.

However, the task remains the same as with the conventional approach: How do I create a good cast that requires little rework so that I can use it to create a last?

As with the plaster cast, the corresponding blocks for the heel and toe are prepared. The blocks are also ready for the necessary supination, pronation and possible detorsion.

In order to achieve a nice spherical heel and a good support in the metatarsal area, we use a scanning aid in our company (Fig. 1 and 14). It is a footbed created with the 3D printer and has a parting line in front of each of the heel area and the ball area. An approx. 2 cm wide rim runs around the scan aid – this makes it easier later to join the scans of the lower leg on the one hand and the scan aid on the other. By dividing the scan aid into three sections, the scan aid can adapt to the different heel drops. An insert with a self-modeling mass adapts to the individual shape of the foot and creates the appropriate roundness in the heel and ball area for good pressure distribution.

A scanning aid in the respective foot size is provided for scanning. The heel drops are prepared according to the initial examination and positioned under the scanning aid. The self-modeling material is placed in the scanning aid.

The workflow

The patient stands on the scanning aid, his gaze is directed forward so that the exact position of the lower leg can be recorded (Fig. 15).

14 Scanning aid with self-modeling support.

15 Patient standing on the scanning aid.

16 Ipad with add-on scanner, hand scanner.

In the next step, the position of the lower leg is recorded with the scanner from the inside, front, outside and back (Fig. 17). After this procedure, the patient removes the foot from the scanning aid so that it can be scanned.

The scans of the lower leg and from the scan aid can then be merged in a software. In this way, a scan is obtained with the correct position of the foot and lower leg, with partial correction of the midfoot, a slight ball heel and an embedded forefoot area.

The toe allowance and the shape are then modeled in the software.

Sources of error

Scans in the unloaded condition, with the patient sitting and extending the foot forward, are not helpful. The position of the foot and lower leg in relation to each other do not correspond to the position when standing. Another source of error is to scan the foot of the seated patient on a glass screen. The heel and forefoot lose their curvature and thus a good distribution of pressure (Fig. 18) - this is no different from plastering in this position.

Conclusion

Regardless of whether plastering or scanning technique: the goals remain the same. A well-positioned and corrected foot during casting or data acquisition saves a lot of work during last fabrication.

If corresponding preparations are made, good results can also be achieved with digital technology. However, from today's point of view, it has to be said that when it comes to correcting severe malpositions, scanning technology does not yet have a solution for achieving a good result. The only solution is to make a plaster cast of the corrected position. The cast can possibly be scanned later or, as was traditionally done, filled with a PU foam. ■

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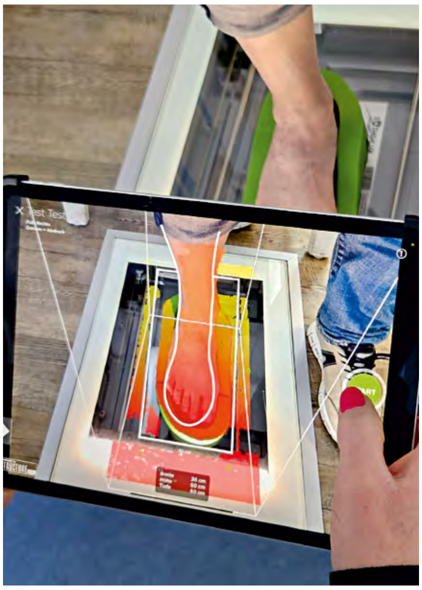

17 Scanning the lower leg with the foot, scanning the plantar part.

18 During the 2D scan of the foot on the glass plate, the heel and forefoot lose their curvature.

Expertise required

A quality, individualized fitting based on the data collected with a scanner can only be achieved if the craftsmanship and pedorthic expertise are available - and this is incorporated into the scanning process. The scanner alone will never be able to replace pedorthic expertise.

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