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# REVOLUTIONARY DEVELOPMENT IN ORTHOPEDIC INSOLE BY ADDITIVE MANUFACTURING

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## ABSTRACT

3D printing has had a revolutionary impact on the orthopedic insoles at several levels. While in additive manufacturing areas, researchers are produce revolutionary studies and invention as in medicine. The classic and elegant in design, features a simple structure by [1] Shun Ping Pek—and so much so that the whole shoe can be 3D printed at once. Consisting of an inner mesh and an outer covering designed to protect the foot with quite a few different parts, the shoe is shock-absorbing and can be soft in one area while more rigid in another—as the wearer wishes, based on customization via data from foot pressure graphs. The inner lattice is the result of a generative design algorithm, also accountable for preparing the entire structure of the shoe, including the placement of the outer shell. For this model, Shun Ping Pek relied on resin-based 3D printing for disable peoples. While the Armies Slide may not appear extraordinarily sturdy,[2] hopefully (we have not been supplied with a price point thus far) the greatest benefits in additive manufacturing play a role through affordability, and less raw material is required to recycle along with hard to believe speed in manufacturing, and the ability to make modifications for customer-specific comfort. Apparel and footwear designers run the gamut enjoy 3D printing these days. Digital invention is a tool clearly in step with the artistic spirit as the middleman and factories can be cut out altogether. A designer can come up with an idea at any time of day or night, convert it into 3D, and begin printing prototype or actual functional pieces (depending on their level of software, hardware, and material) in small batches.

**Keywords-** Hybrid additive and conventional manufacturing, Rapid tooling, remote manufacturing, 3D Printers, Consumer adoption, Medical applications, Bio-printing.

## INTRODUCTION

### 3D printed footwear a new manufacturing process

In other sectors 3D printing can be used to enlarge new manufacturing processes but It can give more potential and opportunity to any company for example: [2] Feetz It is an American company introduced and run by Lucy Beard. They make tradition shoes, easy to wear and with a good method. On top of that, Feetz is also dedicated to protect the environment. They develop their own 3D printer, using a Fused Filament Fabrication method [2], and their own 3D printing material by a patented polymer. They want to change the whole manufacturing procedure, in order to make it more sustainable and reliable. [3] Feetz use the recyclable materials, water reduced by 60% their carbon footprint. Furthermore there is no material waste because with 3D printing they only use the quantity that they need. The use of 3D printing in the manufacturing process shows that it is possible to change the thinking of shoes industry affects the environment. But we can also get custom made shoes and insoles, as they are offering different models from slides and sneakers for men and women, to wedges with a lattice plan. 3D scanning of your feet in order to get a 3D virtual model. Then, we just have to choose the shoes and insoles among the different models that Feetz offers. They will make us a ready-to-wear pair of shoes and insoles based on the 3D virtual model of your feet. The purpose of this study were to build up low-cost and custom-built insoles for orthopedic people with a 3D scanning and printing method and to examine the effects of custom-made 3D printed insoles on gait patterns of orthopedic people. Finally, this study wanted to check the possibility of 3D printed insoles.

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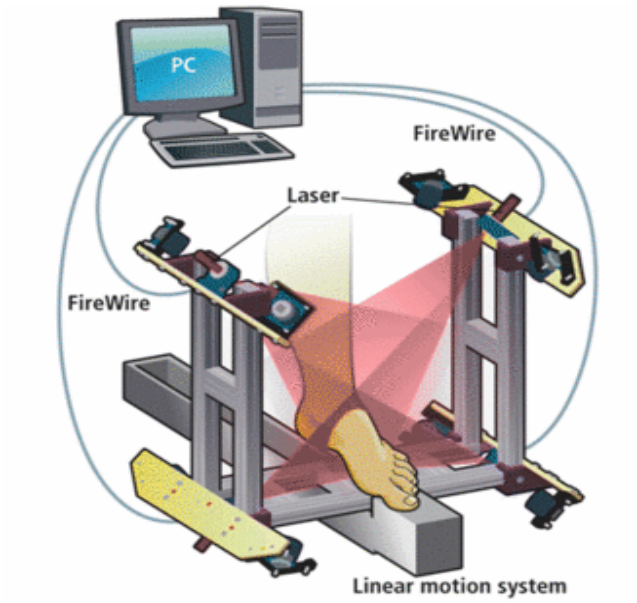


Fig.1 3D laser feet scanning machine [4]

**The future of 3D printed footwear for orthopedic**

3D printed insoles can easily be incorporated to our daily life, for example Phits [3], with their 3D printed insoles, are a good examples. Some project is really easy to get to anybody like orthopedics, and could be urbanized more widely. Modified pairs of insoles are now available to everyone's and mass customization will gain ground in the future. The footwear industry is more linked to 3D printing of insoles for physically handicapped. All these examples show that there are dissimilar ways to create shoes [4]. It can be to push design limitations or to change manufacturing methods by verdict an ecological way to produce, or even to get shoes or insoles made to calculate for more comfort. Reasons to create 3D printed shoes are numerous, and it could be pushed further in the impending years in 3D printing of insoles.

**Foot Problem affects your Posture-**

Foot is the base of body and Feet, Knee, Ankle, Hip, Back, neck are all interconnected. E.g. Flat Foot is one of the main cause of Back problems, Knee Osteoarthritis, and many Foot and Ankle troubles.[5] As per research people with Flat Feet are 50% more likely to have Osteoarthritis. in the same way Plantar Fasciitis disrupt balance, causing you to recompense with other parts of the body. Plantar Fasciitis Disrupts back Health over the Long period.

**METHODOLOGY**

For achieve particular design succeeds by using lattice tools in software such as Simple way to modify insoles for customers this involves growing or falling the lattice volume and node thickness to add such flexibility or increases support in certain areas of insoles, [6] such as the heel and arch of insoles, from force map data[FMD]. Lattice structures are also an ideal structure for testing out different types of flexible TPU (thermoplastic polyurethane) and different elastomeric material, as they allow for the important designs and structures when looking at areas from orthopedic insoles to running shoes and everyday walking. The center of pressure (COP) and ground reaction forces were record by the force platform. calculation of kinematic variables were performed on Cortex [7]. All subjects performed five repeated trials at each condition. The ensemble averages of each subject and each condition were calculated. Three group results such as people of normal, flat-foot, flat-foot with 3D printed insoles were compared only during the posture phase of the gait. A fast process does not always produce the most accurate results, predominantly give the high risk or small errors affecting the 3D printing method [6] fast but careful design work with a customer's feet scan data is therefore an significant part of avoiding any defects that might weaken the value of a custom insoles.

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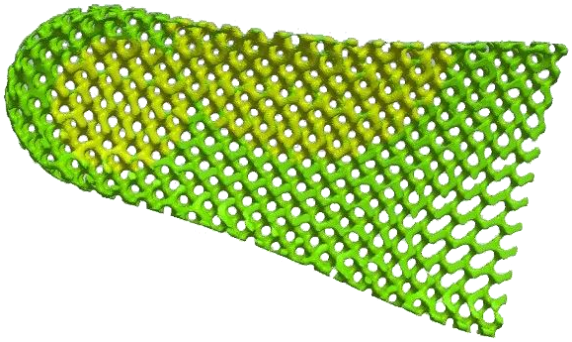

Fig.2- The yellow portion of the insole are familiar to provide stiffness and support [6-7]

**Orthopedic Insole Design Process**

Design procedure begins with analyzing the 3D scanning of foot geometry from scaning procedure and the file is converted from mesh format into solid surface format of foot data. Solid works 2014 is capable to do this process with the help of surface wizard features. This feature can be used for only when scan to 3D body features is activated.

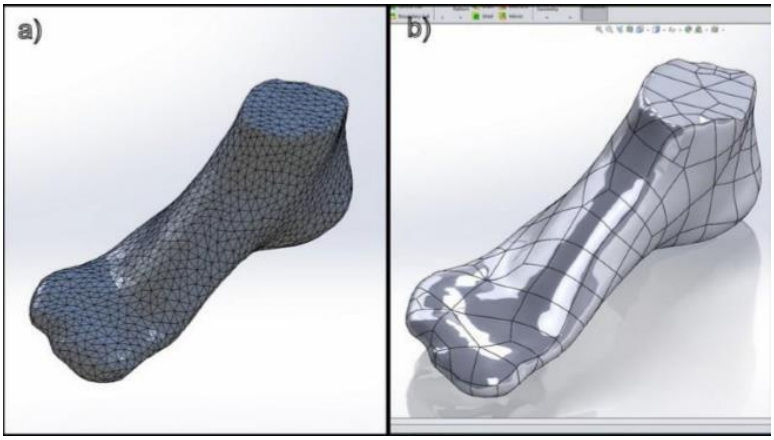


Fig.3. (a) Initial mesh format. (b) Solid surface model after surface wizard applied [11]

The surface wizard feature will converted the mesh file into solid surface as where the solid surface format can be edited accordingly the foot design. [7] T he Figure shows the 3D scanning of foot geometry from mesh format to solid surface format by apply surface wizard features. The next step is to draw a box from the base surface area and extrude the box up to the half of the foot area. The area must consist all of the arch support at the bottom of the foot surface. The extrude authority need to set unmerge so that the extruded box and the foot geometry are not join together as a solid model. Then, [8] both box and the foot geometry body is subtracted with the box as the main body and the foot geometry is the body that needs to be detached. Figure (3) shows the geometry before and after subtraction.

**Data acquirement**

Tradition of printing and additive manufacturing of 3d shoes and insoles begins with a scanning of the customer's feet. This data is used to create exclusively contoured insoles that enable proper ergonomic support and an ordinary walk. The good result comes when the range of different necessities are combined, with additional sources including podiatrists and footwear professionals.[9] The Foam impression of kits are also useful in the respect of rapidly acquiring a mould that can be scanned to begin creating the custom insoles.

Casting provides by podiatrists can also be used when designed insoles for orthopedic harms. Other potential ways in which this information may be composed in the future include scanning apps and tools. However there is higher risk of problems with measurement, accuracy and constancy when using this approach to collect information.

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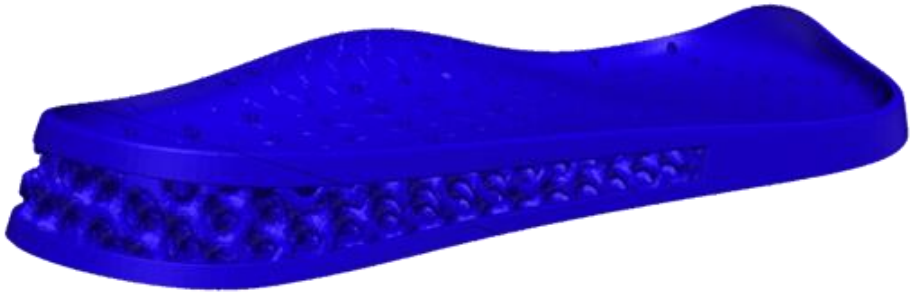

Fig.4- From the scans a CAD file is created and the complete midsole is connected.

**Ensuring correctness of Additive Process**

The correctness of 3D scanned image data is crucial to getting the right custom shoes and insoles, whereby the geometry and design of the foot requirements to be accurately reconstructed in 3D software. Compare to generic data, [9]3D scanning of feet means that subject-specific products will be designed that are more relaxed and tailored to the particular necessities of wearer. Some of the good results come from effective with tools that allow 3D scanned image data of feet to be easily mutual with CAD software, where foot designs can be quickly tested out to decide on the best outcome for customers without the required for using multiple software packages. It is also necessary here to make certain that CAD and STL files are ready to send in a straight line for 3D printing process, with no need of repair. Failing to do this can manufacture printing problems and wasted materials.

**Cost-Effective 3D Printing**

Once the model has been ready, it can be sent to a 3D-printing process. Selective laser sintering (SLS) is often used for its accuracy and suitability in working with TPU powder and polyurethane to create a complete product that is both durable and waterproof. [10]The exclusive particle bonding of this approach means that energy can be more evenly dispersed throughout the shoe and foot, and at a slower rate than with conventional manufacturing. However, SLS printing methods can be expensive and include post-processing demands, as well as a relatively imperfect number of suitable materials. By comparison, fused deposition modeling (FDM) is less expensive and achieves comparable results without the need for significant additional work after printing. [9]Keeping the workflow simple for 3D printing custom shoes is crucial to ensuring that the services and products are still reasonable. Resin-based systems could also eventually be a viable technique, although for now FDM and other approaches like fused filament fabrication production arguably represents the most cost-effective explanation for customizing soles.

**Recycling Materials and Future Challenges**

A fundamental approach employ software and 3D printing is able to cut down on waste and only use optimal quantity of materials. Another way to save time and money on the manufacturing procedure is to swap out soles from accessible shoes to the new ones, whereby an upper sole can be fitted to a shoe to help test outsole and midsole designs.

During manufacturing, it is also promising to use a vacuum bag as a low-cost alternative to a hydraulic press; this technique creates high pressure contact on all sides for gluing. Soles can then be joint with the rest of a shoe to create a unique product that is ready to be used by customer. Keeping these costs down and maintain an economic process does, however, mean having to stay an eye on potential problems with the printing process. For example, when working with very precise designs, any small defects can upset the printing, adding more costs to the overall work. While the hydraulic press is better, it's also very costly and not essential. [10]Vacuum bagging can be used to quickly adhere the upper to the printed sole in prototyping. The continuing goal for 3D printing better custom shoes is to reduce the amount of material waste as much as likely, while exploring new and existing method for rapid customization of digital models for every customer. Receiving the soles printed within a day of an order is one ideal target, as are keeping defect in the manufacturing process as low as possible to ensure a quick turnaround from receiving customer data to design optimization, production, and release to customers.

**CONCLUSION**

This study investigate the possibility of low cost and custom-made 3D printed additive insole for orthopedic people have difficulty in walking and running in order to alternate high cost orthoses. On behalf of the prototype for new application of materials for additive manufacturing 3D-printed manufactured orthopedic insoles for shoes. Which is professionally produced using an automated and completely digitalized and scanning process that generates almost no waste of materials. The part in query is the form of a 3D file that can be sent anywhere in the entire world. On site, the printer uses this data to produce the physical product in spite of whether only a single individualized insole or millions of insoles have to be shaped by geometrically. Thermoplastic polyurethane is the material of choice for this

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application thanks to its favorable range of properties. The hardness can also be accustomed by changing the printing structure. This allows manufacturer to print shoe and insoles that are completely customized with hard or soft contact areas and the Initial tests have been promising, both in terms of functionality and permanence. Orthopedic insoles are often produced by hand and take a lot of moment in time. Besides that, conventional insoles are e.g. made by forming or machining rigid foam blocks and are also less breathable. Using additive manufacturing processes offers a more sustainable approach to producer. It could help significantly more people to get access the orthopedic insoles. The correctness of the reconstructed geometry by scanning are taken into high consideration during this study since the geometry of the orthopedic insole is 100% depends on the patient's foot profile or geometry and the manufacture of the insole where it promises low cost, less time consuming, and convenient insoles.

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