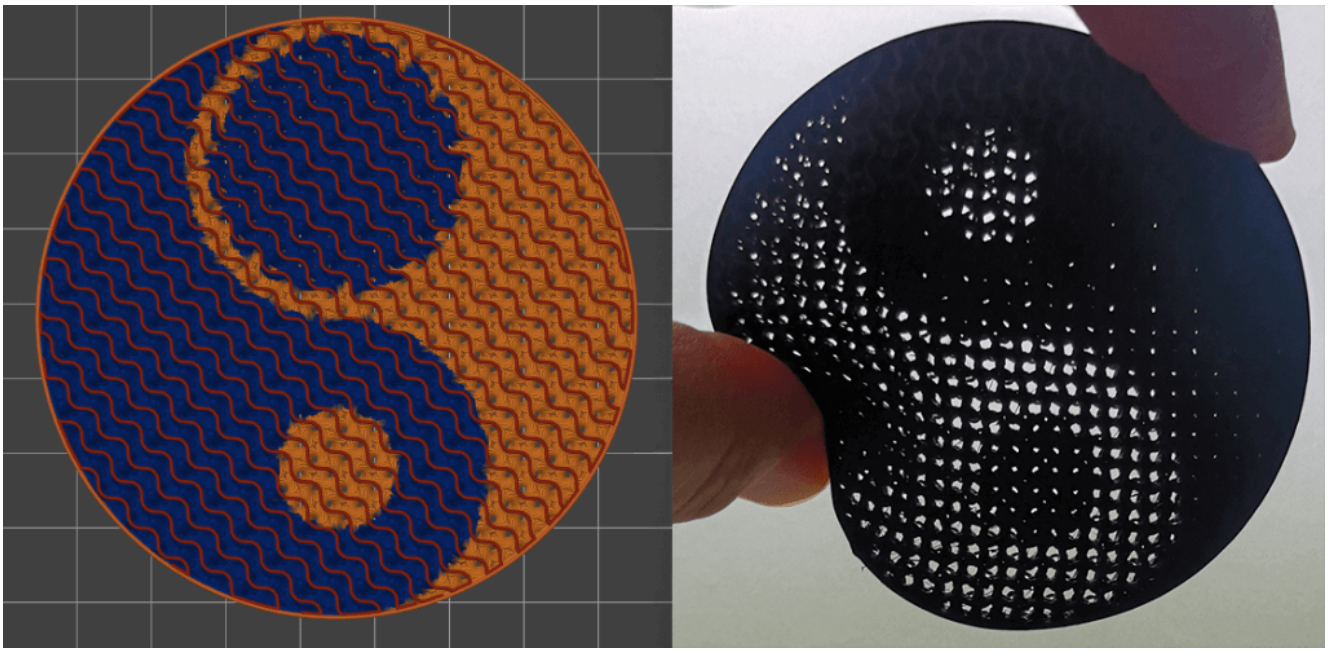
Pedorthic Information Modeling: Revolutionizing Orthopedic Footwear with 3D Printing and Computational Design

In the world of orthopedic footwear, traditional hand-made techniques have long been the norm, but digital technologies are starting to change the game. One of the most innovative approaches leading this transformation is Pedorthic Information Modeling (PIM), created by footwear engineer Daniel Petcu. Inspired by Building Information Modeling (BIM) in architecture, PIM adapts parametric design principles to the creation of orthopedic footwear, using 3D printing to offer a more efficient, customizable, and accessible way to design functional and stylish shoes.



THE BIRTH OF PEDORTHIC INFORMATION

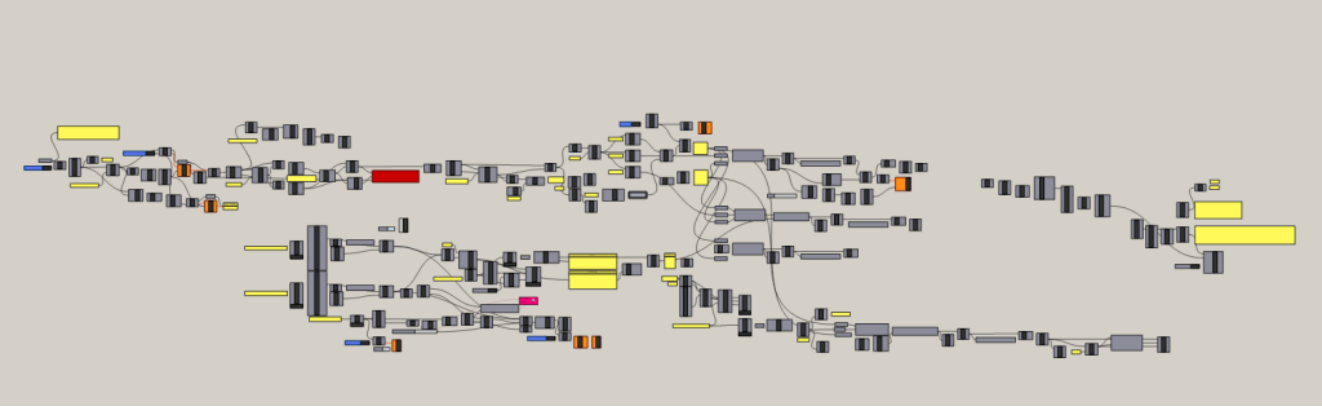
MODEL (PIM)

PIM was born from Petcu's desire to merge traditional craftsmanship with the capabilities of digital fabrication. Using Rhino and Grasshopper, Petcu developed a digital model for orthopedic shoes, capturing their aesthetic, functional, and physical features. The key innovation here is the ability to digitally design shoes with unparalleled precision, addressing a common issue in the orthopedic shoe market: patients often rejected their prescribed footwear because it was not visually appealing.

3D PRINTING: A GAME CHANGER FOR ORTHOPEDIC FOOTWEAR

3D printing enabled Petcu to push beyond the limitations of traditional manufacturing. "By using flexible materials like Ultrafuse® TPU, Varioshore TPU, Petcu created shoes that were not only functional but also biocompatible and durable. These materials offered the perfect balance of comfort and strength, essential for orthopedic shoes.

The process begins with a detailed digital model created in Grasshopper, where Petcu's code allows for precise control over key parameters that define the shoe's fit, structure, and stiffness. One of his key innovations is the concept of Gradient Stiffness, which allows for varying levels of rigidity across different parts of the shoe. This technology, unique to Petcu's work, is used to create shoes with customizable areas of flexibility or support, such as for diabetic feet or children's flat feet.



GRADIENT STIFFNESS & GRASSHOPPER TOOLS

Gradient Stiffness allows for continuous modifications in stiffness without the interruptions caused by traditional slicing methods. This is essential for creating medical footwear that needs to offload pressure in certain areas. The G-code for 3D printing is processed through Grasshopper, allowing Petcu to control the rigidity of the shoe’s components directly from the design code, resulting in a shoe optimized for both comfort and function.

OVERCOMING CHALLENGES

Petcu faced initial resistance from the orthopedic community, where traditional methods were deeply entrenched, and digital tools were seen as intimidating. However, Petcu was driven by the need to find a better solution for patients, especially after seeing a case where a patient could not walk without specialized footwear. This experience reinforced his belief in the potential of 3D printing to solve complex medical challenges.

Despite skepticism, Petcu’s combination of medical knowledge and technical expertise allowed him to bridge the gap between traditional shoemaking and digital fabrication successfully. His work highlights the potential for 3D printing to revolutionize the design and production of orthopedic shoes.

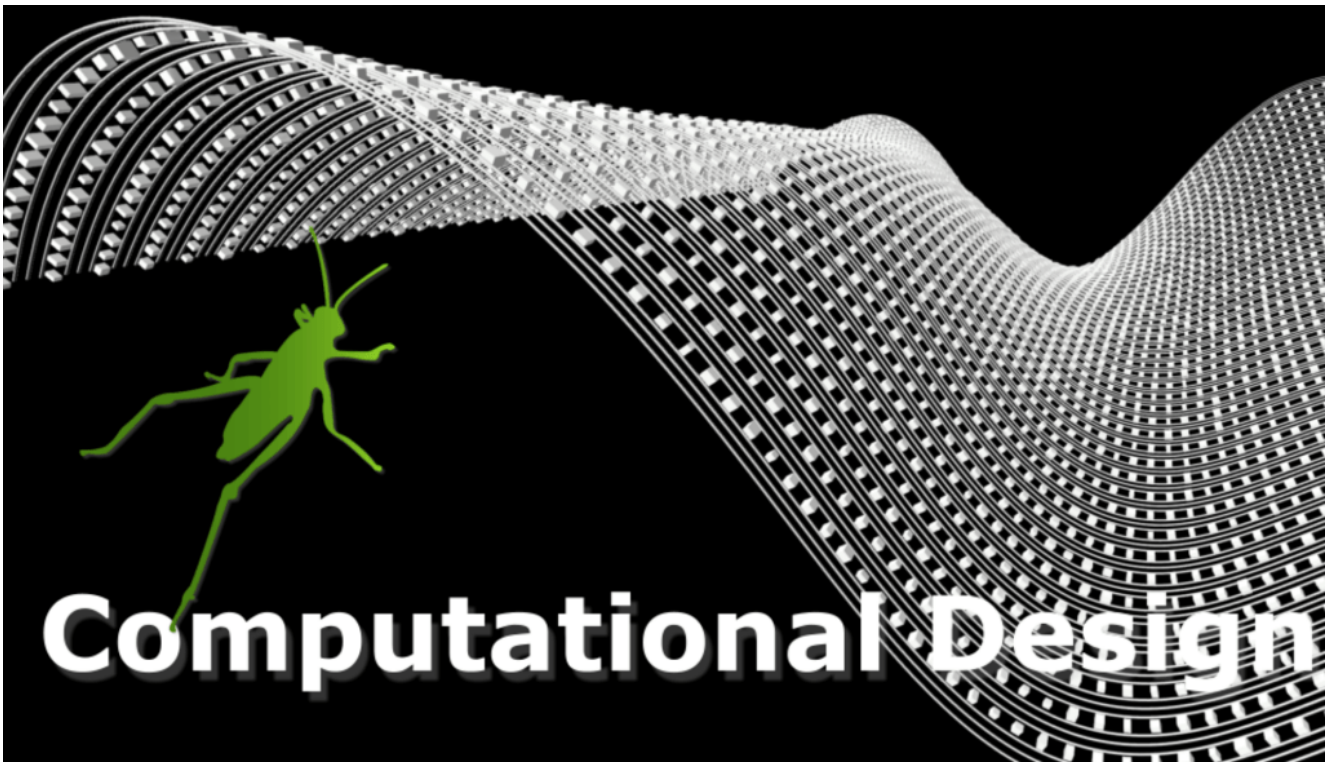
KEY ELEMENTS OF PIM

PIM is not just about digital design; it also optimizes the production process. Key elements include:

1. **Parametric Design and Customization:** Using Grasshopper, Petcu tailors each shoe to the specific needs of the patient, adjusting key parameters like pressure points and foot anatomy to create a perfect fit without manual alterations.
2. **3D Printing for Precision:** FDM 3D printing produces complex designs quickly and accurately. Petcu’s Gradient Stiffness code ensures that parts like midsoles are optimized for comfort, improving the design and manufacturing process.
3. **Material Innovation:** Ultrafuse® TPU materials, like TPU 85A and TPU 64D, and Varioshore TPU Prosthetic, offer flexibility, durability, and biocompatibility, creating shoes that can withstand daily wear while remaining comfortable.
4. **Streamlined Production:** 3D printing automates production,

reducing time, labor, and errors. This results in a more efficient and reliable process, reducing costs and improving quality control.

5. **Patient Involvement and Satisfaction:** Patients can select colors and textures, improving satisfaction and compliance with medical footwear recommendations.



See Also

COMPUTATIONAL DESIGN WITH GRASSHOPPER

LOOKING AHEAD: THE FUTURE OF PIM

Petcu's work has gained international recognition at events like OTWorld and FootPRINT3D. His PIM approach is setting the stage for the future of custom medical footwear, combining functionality, comfort, and style. As the field evolves, Petcu hopes to refine PIM further and address complex conditions like Charcot-Marie-Tooth foot.

Petcu believes the widespread adoption of parametric design and 3D

printing will require a shift in how the profession views technology, particularly within educational curricula. By embracing computational tools, future designers can better address complex patient needs while continuing to advance the industry.