Custom Soles From Additive Manufacturing

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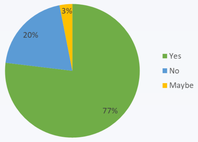
1 - INTRODUCTION

In 2018, a study by the National Library of Medicine found that 63-72% of participants wore the incorrect shoe size for their feet [1]. Custom 3D printed soles can address this issue by tailoring to the unique contours of an individual's feet, unlike conventional mass-produced shoes. This project was established to create a sole catered to a person's specific foot shape using additive manufacturing.

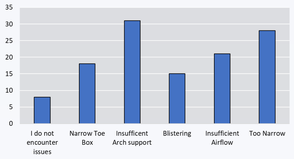
2 - CUSTOMER RESEARCH

A survey was conducted to gauge customer needs and received 70 responses.

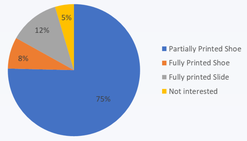
Would you buy a custom 3-D printed shoe?



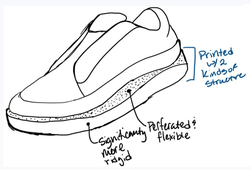
Do you encounter any of these common issues with standard shoe sizes?

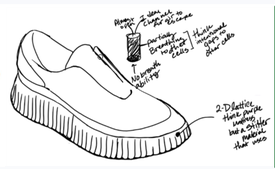


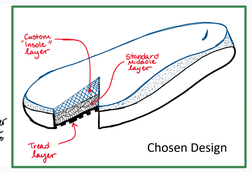
What style of 3-D printed shoe appeals to you the most?



3 - CONCEPT GENERATION







4 - TESTING

Filament:

- PolyFlex™ TPU95
- Varioshore TPU
- Filaflex 70A

Printer:

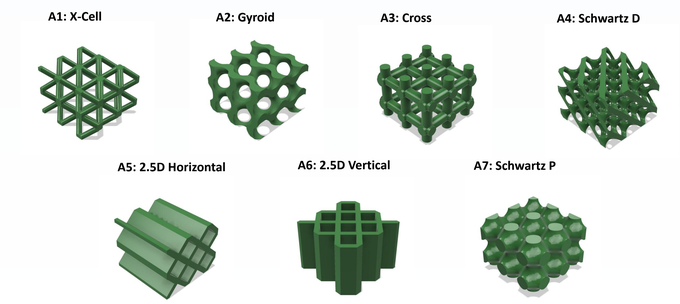
Sovol SV06 Plus

- Direct Drive Extruder

Tests:

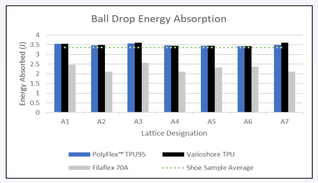
- Ball Drop: *1.19lbs ball*
- Shear: *pulled to failure*
- Instant Compression: *50% of height*
- Abrasion: *tumbling for 24 hours*
- Heat: *175° F for 24 hours*
- Cold: *-16° F for 24 hours*
- Duration Compression: *25% of height*

Lattices:

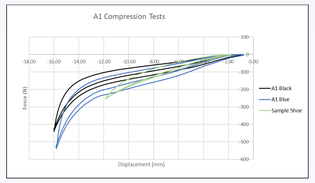


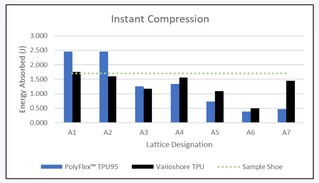
5 - RESULTS AND ANALYSIS

A benchmark was created by testing the energy absorption of a selected shoe sole. Test samples, 77 in total, were compared against this benchmark to determine the viability of material and lattice types.

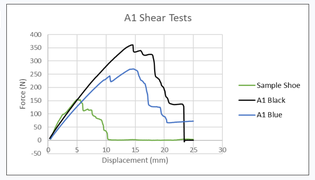


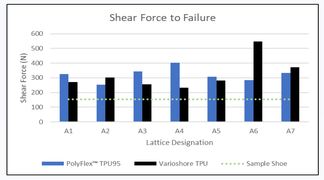
The ball drop test ruled out Filaflex 70A as a material due to lower energy absorption than the benchmark.



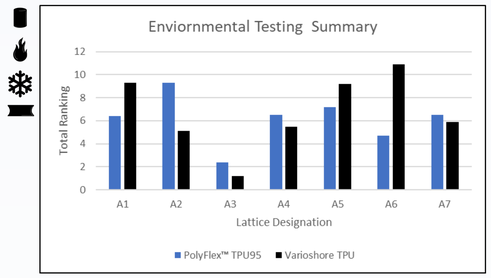


Samples A1 and A2 had similar energy absorption to the sample shoe.

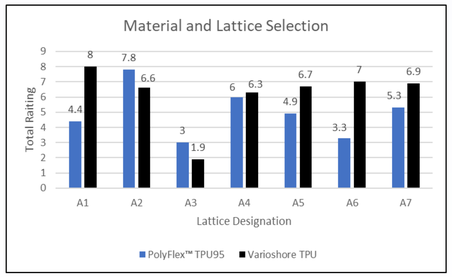




All samples outperformed the sample shoe at resisting shear.



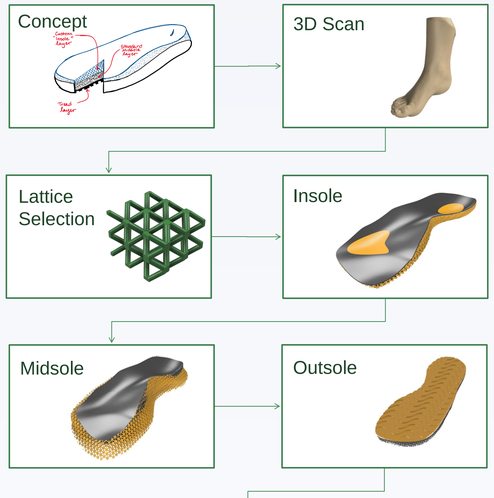
Samples were put through environmental testing and compared with original samples. Samples A3 of both materials fractured.



Samples were ranked based on performance from each test and total cost to produce. An x-cell structure with Varioshore TPU had the highest cumulative rank.

6 - MODELING & DESIGN

A shoe sole was created to fit the geometry of a 3D scan of a foot.

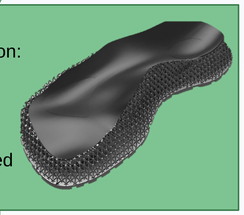


Final Design

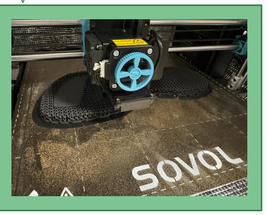
Highest scored combination:

- Varioshore TPU
- X-Cell lattice

The selected lattice was scaled to the sole and used in the final model [2].



Prototype Creation



7 - CONCLUSION

A sole was designed and successfully constructed using an additive manufacturing process. The results were incorporated into a fully functional midsole by narrowing the scope of the project using customer feedback. Using a 3D scan of any foot, the model can easily be customized to any individual user. Further research could explore additional factors such as environmental sustainability, manufacturing feasibility, and user preferences to refine and optimize sole design.

REFERENCES

1. Buldt AK, Menz HB. "Incorrectly fitted footwear, foot pain and foot disorders: a systematic search and narrative review of the literature". J Foot Ankle Res. 2018 Jul 28;11:43. doi: 10.1186/s13047-018-0284-z. PMID: 30065787; PMCID: PMC6064070.

2. Xia, Huanxiong, et al. "Evaluation of the Equivalent Mechanical Properties of Lattice Structures Based on the Finite Element Method." MDPI, Multidisciplinary Digital Publishing Institute, 20 Apr. 2022, www.mdpi.com/1996-1944/15/9/2993.

ACKNOWLEDGEMENTS

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