

User-Centred Design Innovation - Developing Smart Insole Solutions through 3D Printing and App Prototyping

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<https://mypad.northampton.ac.uk/researchconference23>

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Technician Demonstrations by Jason Duggan (App and Video), Paul Tallon (3D-scanning & Meshmixer), Jayne Corfield (Screenprinting)

Introduction

Additive manufacturing advances customisation and design flexibility. Increasingly, Rapid Prototyping technology is being used within footwear fabrication applications. This project develops competencies across our university and provides designers and podiatrists with an understanding how 3D printing and app design can modernise existing practice and create a novel solution to more effective and repeatable insole/orthotic therapy and wellbeing of our feet. In a two-part assignment product design students have been tasked to design 3D printed custom insoles for footwear that can be fitted with force sensors. Digital personalisation in the form of an app allows users to measure their feet via 3D scanning, or monitor posture, pronation, gait and pressure points. User interface (UI) and user experience (UX) will be investigated to develop a crucial awareness and understanding of the relationship between the human factors, wellbeing and good design. This presentation maps the initial findings of an undergraduate Design Project so to build up interdisciplinary research capacity around health-related customisation, working with colleagues in Health Professions/Podiatry and potentially benefitting our Physical Activity & Life Sciences Research.

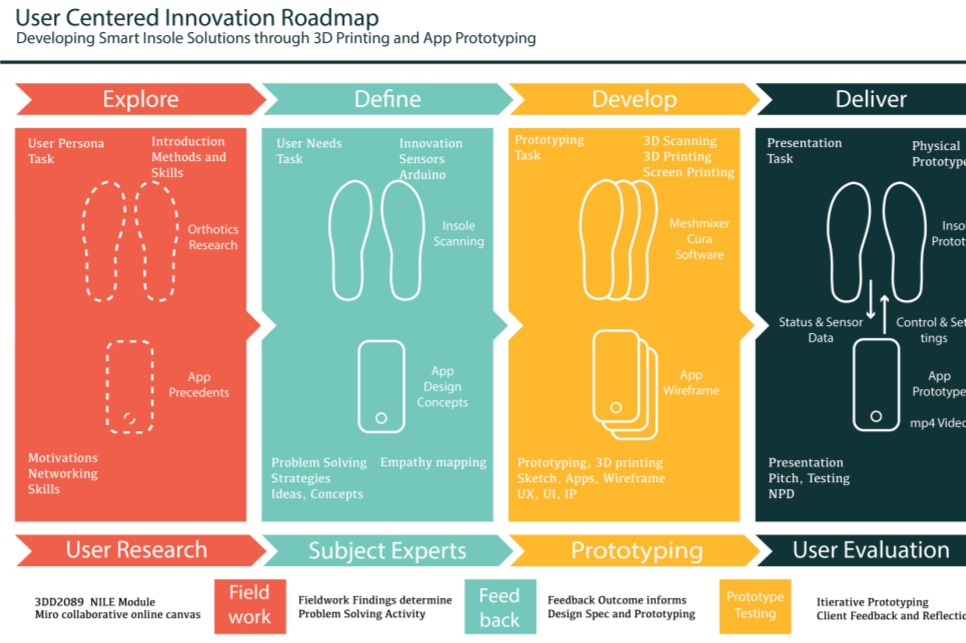
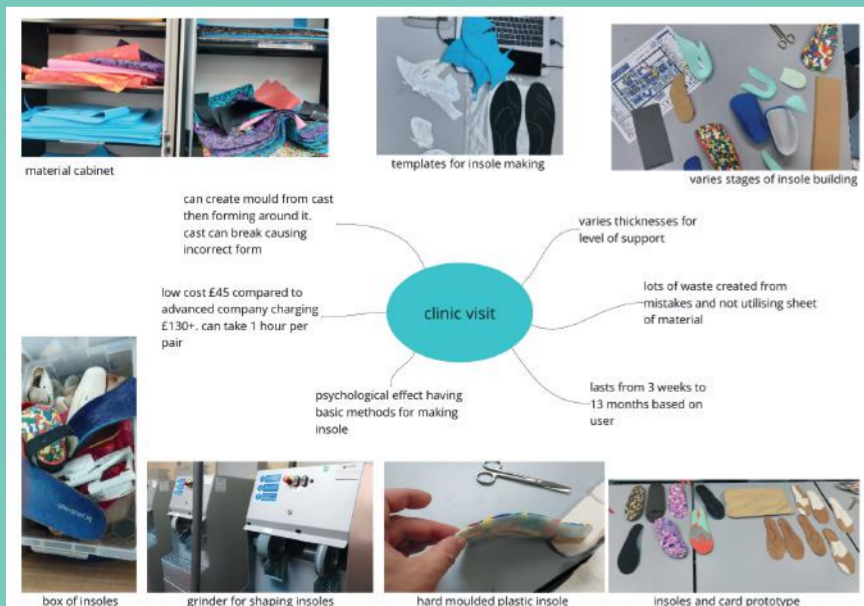
Literature

Chatzistergos Panagiotis E. and Chockalingam Nachiappan (2021) A novel concept for low-cost non-electronic detection of overloading in the foot during activities of daily living
R. Soc. open sci. 8202035. 202035
Hu, X., Luo, C., Peng, D., Qu, X. (2019). A Conductive Fabric Based Smart Insole to Measure the Foot Pressure Distribution with High Resolution. In: Carrozza, M., Micera, S., Pons, J. (eds) Wearable Robotics: Challenges and Trends. WeRob 2018. Biosystems & Birobotics, vol 22. Springer, Cham.
Mengying Xie, Kyohei Hisano, Mingzhu Zhu, Takuya Toyoshi, Min Pan, Shima Okada, Osamu Tsutsumi, Sadao Kawamura, Chris Bowen (2019) Flexible Multifunctional Sensors for Wearable and Robotic Application <https://doi.org/10.1002/admt.201800626>

Method

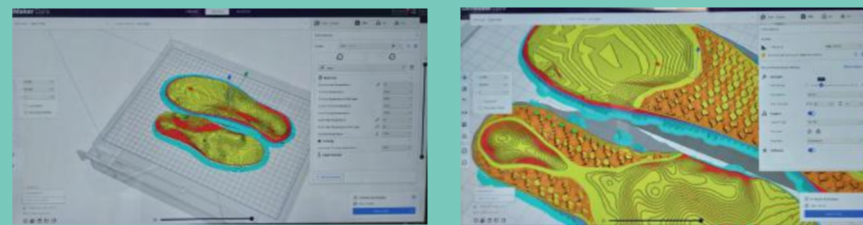
Then project provides the student with an understanding of anthropometric research and its use in ergonomic design together with the application of colour. User interface (UI) and user experience (UX) will be investigated to develop a crucial awareness and understanding of the relationship between the human factors, colour and good design. The project is an introduction to prototyping of screen-based applications using 'wireframes' and user experience design tools for mobile apps. The user centered learning for students was over one semester based on the new product development (NPD) methodology, students' networking with podiatry staff and applying their soft skills in a new context. The project team included BA Product design students, three academics and three technicians involved in the workshop facilitation.

Podiatry Clinic Visit



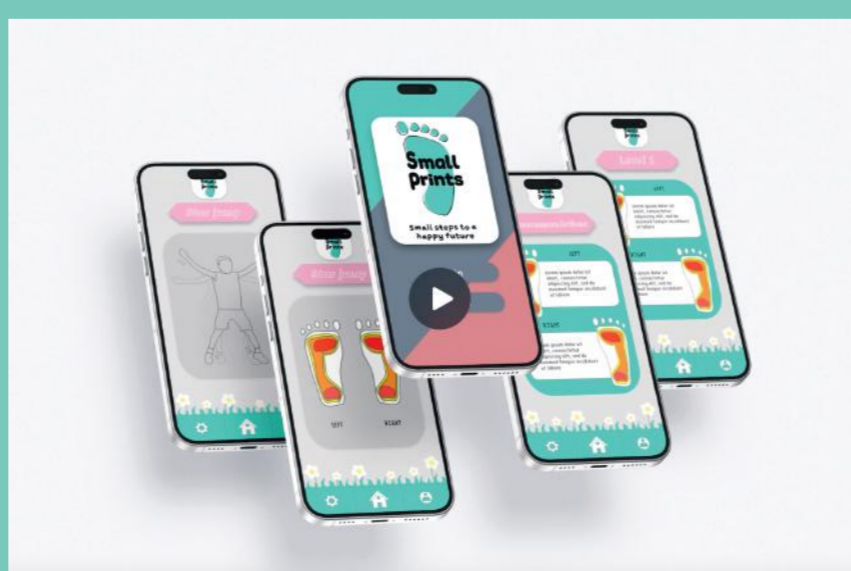
Process

User-Centred Design module with 4 students over 11 weeks
2 part Assignment supported by learning and resources on Miro collaborative platform
Field trip visit to podiatry clinic, 3D printing Suite, Physical Activity & Life Sciences Research labs
Tested suitable software tools, Meshmixer, illustrator, Adobe XD
Tested suitable prototyping tools, 3D Einscan, CURA, Ultimaker, screen printing
Output in form of PDF, XD and mp4 files with Storyboard, mindmap or wireframe sketch with proposed design direction. App Specification and Prototype of App. Competency in Adobe XD as a prototyping tool for UI/UX designers. Proposed user interaction, experience and benefits.
Testing of prototype app, podiatrist's response and user feedback
Audio-visual and graphical communication of technical and production specifications.



User / other person / podiatrist's perspective
Semi-compressed felt wears quickly, which whilst this has some benefits, it can mean the device is ineffective due to lack of persistent effect
Patients have less belief in "low tech" solution
Permanent devices are hand made and difficulty in exact replication for repeats
Scanning/casting of foot is an alternative, but does not enable the same level of specificity in modification/intervention. It also takes a snapshot of a dynamic structure that needs to change position and shape throughout gait (there is no agreed upon casting technique or position)
3D printing would provide a solution to modernise our existing practice, and create a novel solution to more effective and repeatable insole/orthotic therapy

App Prototypes

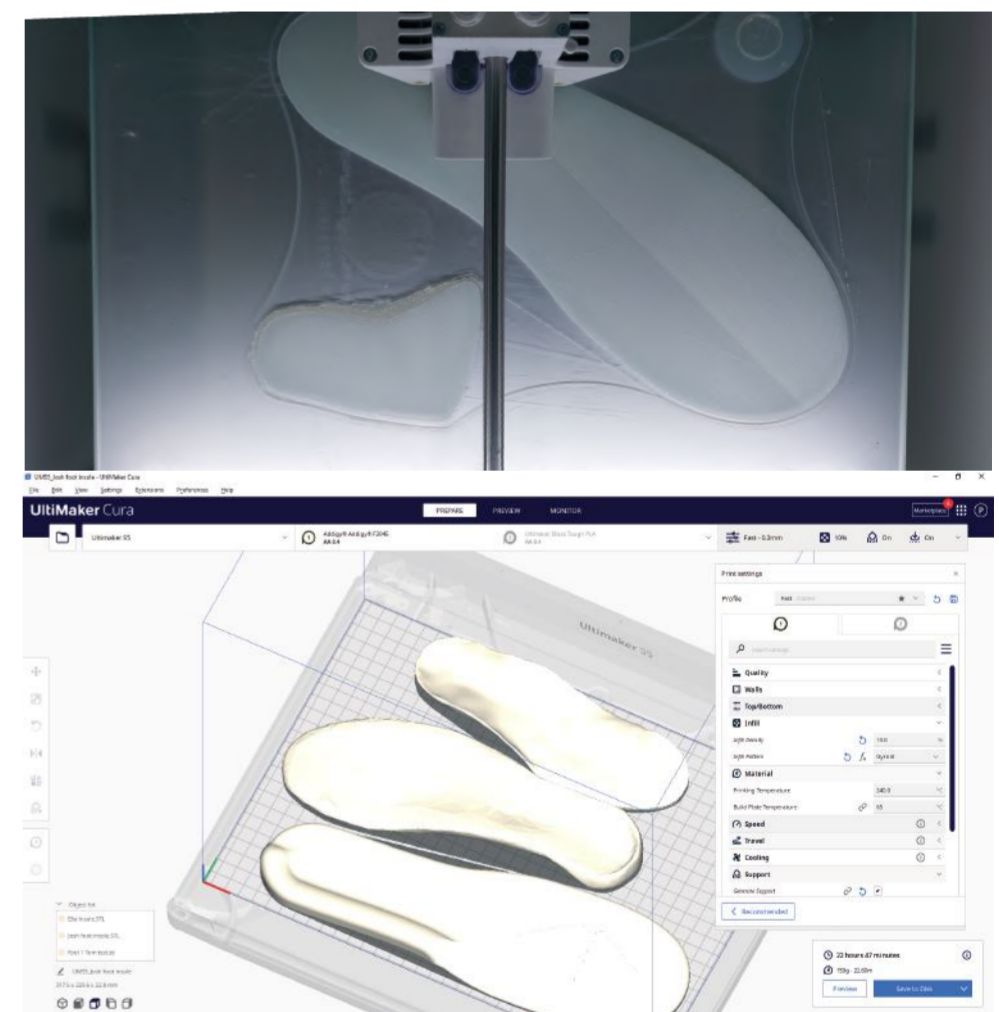
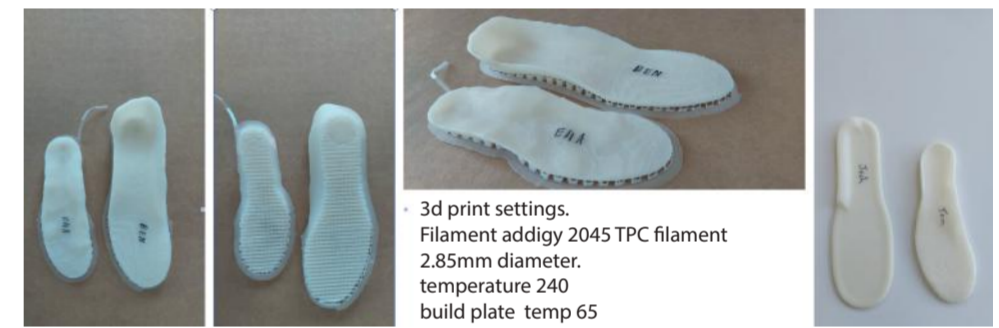


Findings

The project synthesis develops user centred prototyping practices at this university, by demonstrating an iterative model using a visual road map of user centred learning journey. Building upon two frameworks of innovation processes - i.e. the startup navigator of St Gallen University (Grichnik & Hess, 2020) and the UK Design Council's Double Diamond Design Process (Ball, 2019), the project team developed a visual way to show the differing aspects of the project, in the form of an infographic, featuring steps taken during the collaborative innovation project and the feedback loops.

What next?

Create sample pads to be scanned and digitised into STL files that can be loaded and scaled to different sizes
Utilising Product design existing work – commence printing of pads to match existing material densities and thicknesses
Outcomes from project:
Confirm printing parameters and filament type (ideally less filament types needed by modifying print parameters to change density)
Confirm cost and proof of concept to digitise and accurately reproduce on different scales/sizes
Confirm ability to make minor modifications (grind/cut) and glue to each other and base
Create a "blank" base (1 x flat, 1 x with heel cup) to add pads to as needed (to allow for a closer feeling/functioning device to a fully printed version – once pt happy with temp)
Confirm ability to scan and digitise temp for storage and subsequent accurate repeat printing



Conclusion

Capacity building and changing practice at this university, by demonstrating a model using a visual road map of collaborative innovation and of user centred prototyping. Design and modelling of a 3D printed insole and screen-printed sensors. Exploring and evaluating additive manufacturing and insole customisation through a co-design approach with Podiatrists and Technician Demonstrators. The research demonstrates the first version of a roadmap of user centred project innovation and collaboration at UON. The poster alludes to a potential supporting a future innovation pipeline and will be developed and honed to support cross collaborations. It will provide possible guidelines to support future cross-faculty collaborations and support students to develop disciplinary skills and digital prototyping in Health Professions/Podiatry and potentially Physical Activity & Life Sciences Research.