PEACOCKS The Caring Company

Additive Manufacture for Orthotics and Prosthetics

Project DIGINOVA: Biomedical Applications for Digital Fabrication, Wednesday, 6th November 2013

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Peacocks Medical Group

Established in 1903, Peacocks Medical Group has been supplying medical equipment and services for over 100 years

A family-run group based in the North East of England with clinics across the UK

Peacocks delivers both services and orthotic equipment to the NHS and the private sector

Contents

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- Why additive manufacturing
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Introduction – O&P

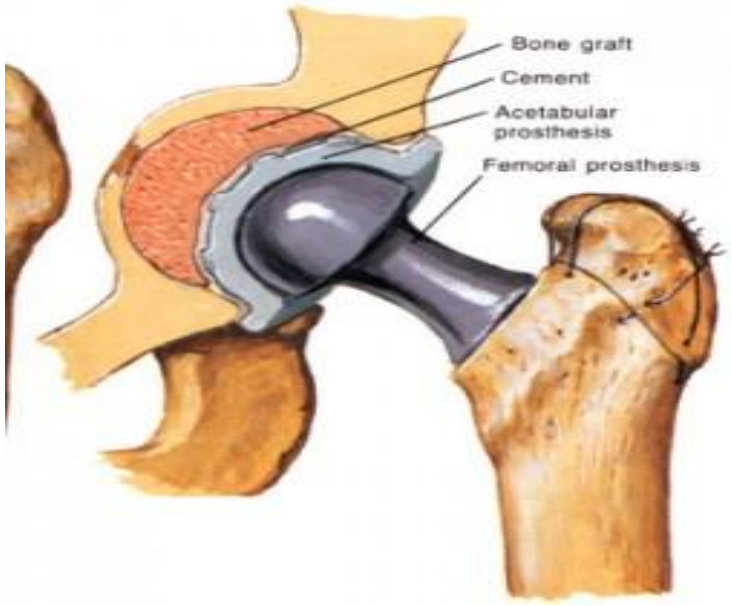
Introduction – O&P

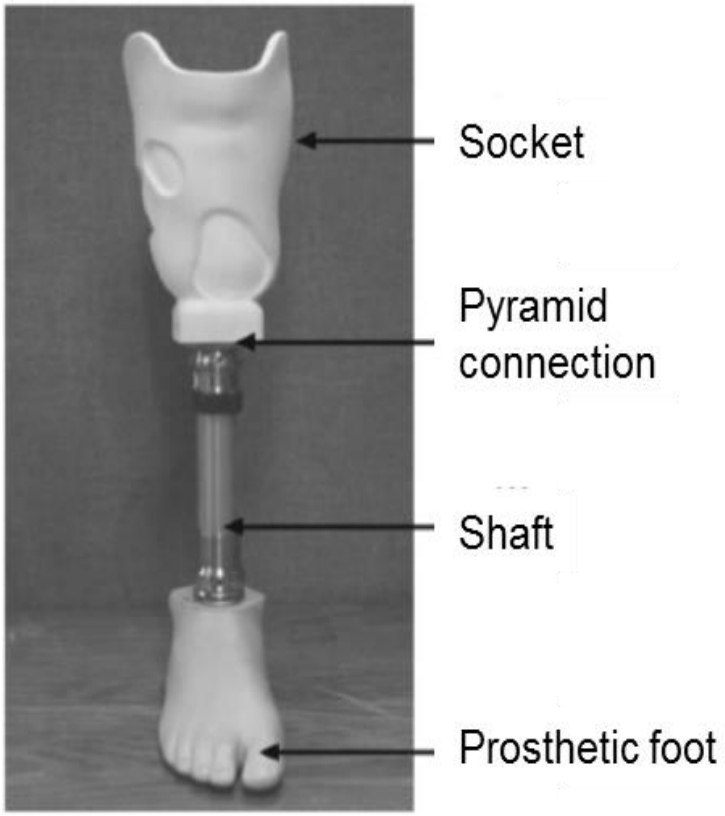
Orthotics *– External devices that support the body, realign it or redistribute pressure.*

Introduction – O&P

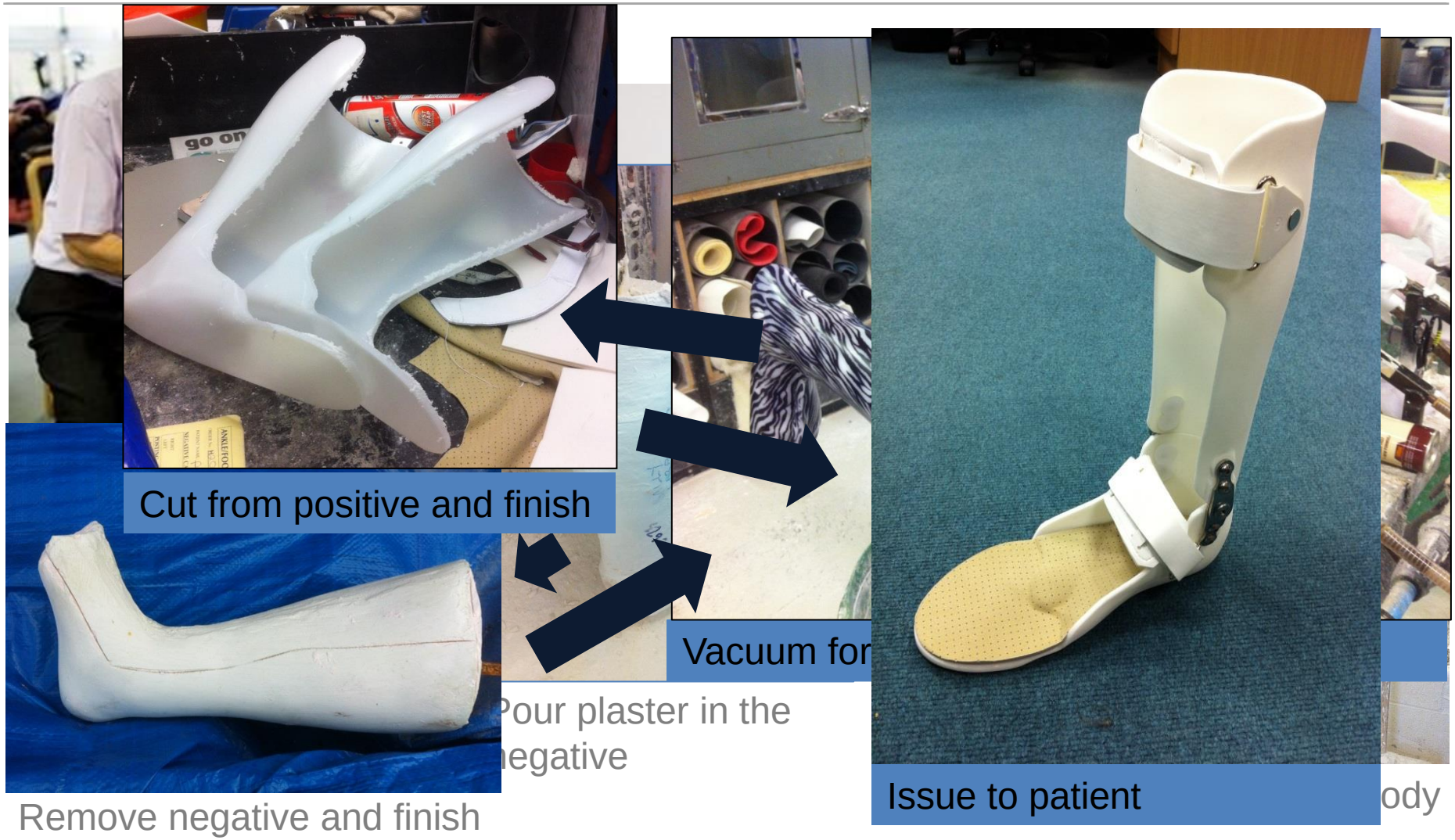
Prosthetics *– Replacements for a part of the anatomy*

- *External*
- *Internal*





Manufacturing processes



Why Additive Manufacturing

The industry needs change

Working methods have to be brought to the 21st century

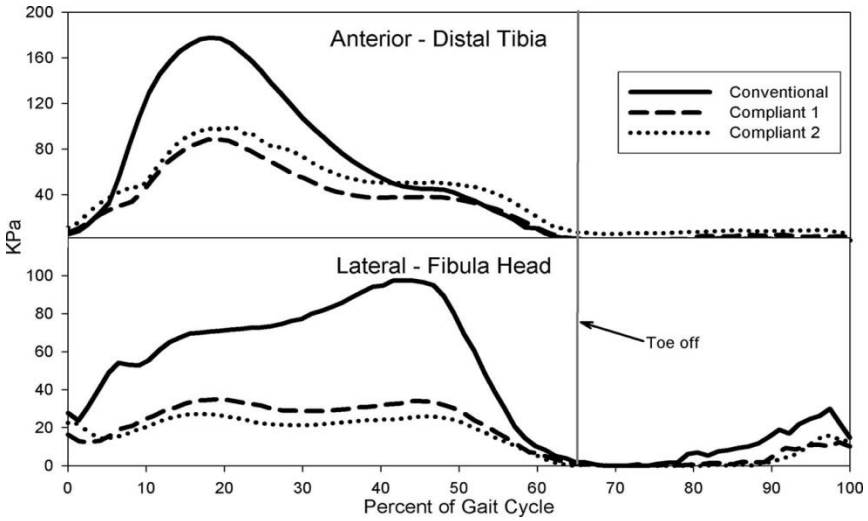
- Current technology base limits innovation and improvement
- Quality of (bespoke) products and the amount of remakes and corrections
- Speed and quality of service
- Efficiency in general
- Traceability
- Standards

Main advantages of Additive Manufacturing over traditional methods

- *Easy to manufacture bespoke parts*
- *Good fit and comfort easy to achieve – good design still needed*
- *Automatic manufacturing*

- *Digital design environment*
- *Engineering not craft*

Functional integration



Rogers B, Bosker GW, Crawford RH, Faustini MC, Neptune RR, Walden G, Gitter AJ, "Advanced trans-tibial socket fabrication using selective laser sintering", Prosthet Orthot Int. 2007 Mar;31(1):88-100.

Functional integration

- *Imitating the functionality of separate parts/ materials in a single part through "clever" design*
- *Making complex parts is not an issue…*

  …designing complex parts is

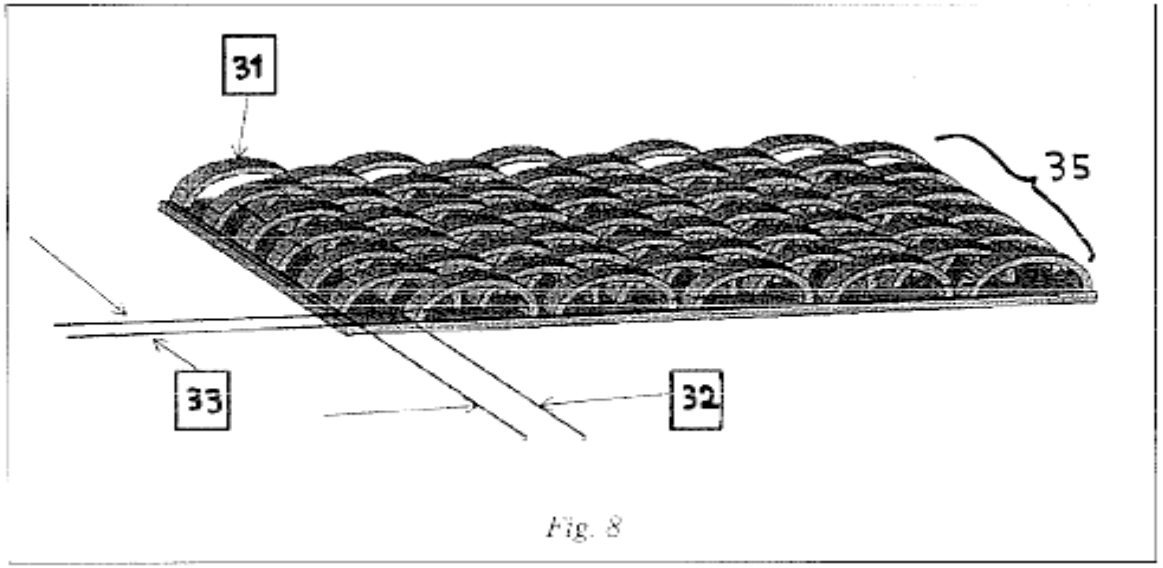


Fig. 8

Why is functional integration important?

A digital design environment:

- It can be controlled very precisely
- It can be optimised
- It can be automated and repeated

Precise placement of external components.

- Reinforcements, hinges, sensors, activity monitors…

All of this adds value and differentiates products

Go crazy with the form but keep the function

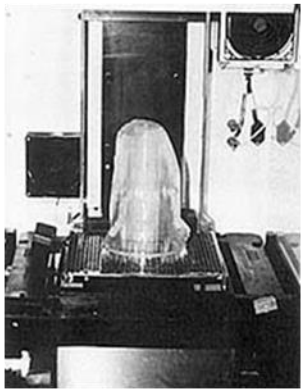
http://www.artcenter.edu/dot/spring2012/bespoke_page2.php www.bespokeinnovations.com

State of additive manufacturing in O&P

History of additive manufacturing in the O&P

O&P applications as old as the technology itself – in research

Tfem socket manufacturing 1990



FO's & outsoles 2000-2003

Knee braces 2004

AFO's 2006 (?)

History of additive manufacturing in the O&P

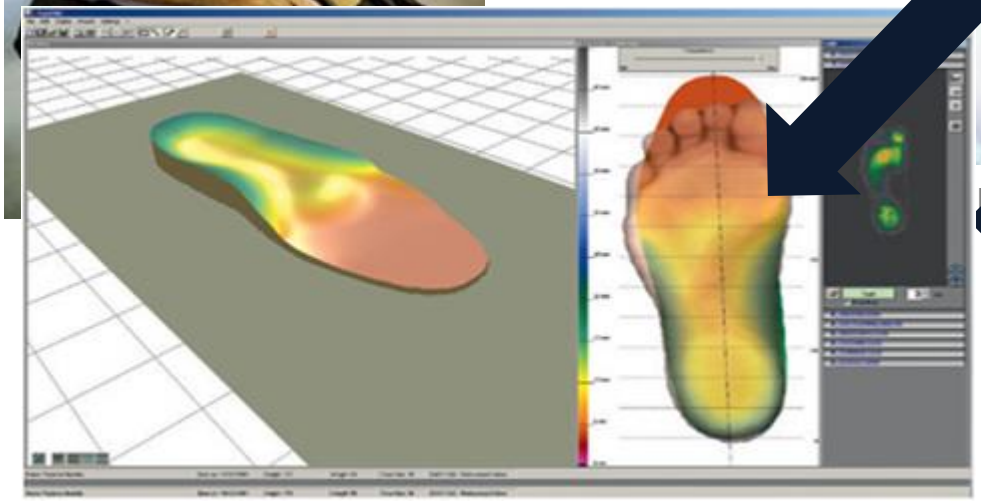
- *Main focus in transtibial socket manufacturing, AFO design and manufacturing and in foot orthoses/soles*
- *Processes SLA, SLS, FDM*
- *Only one directly manufactured end-user device in the market at this time*

State of the art today – Orthotics and Additive Manufacturing

The process

Additive Manufacturing

ct scanning*



CAD design**

*www.creaform.com **http://www.body-tech.com.au/software/easy-cad-orthotic-design-software

State of the art today – Orthotics and Additive Manufacturing

Early steps towards functional integration

And some beyond

State of the art - Prosthetics and Additive Manufacturing

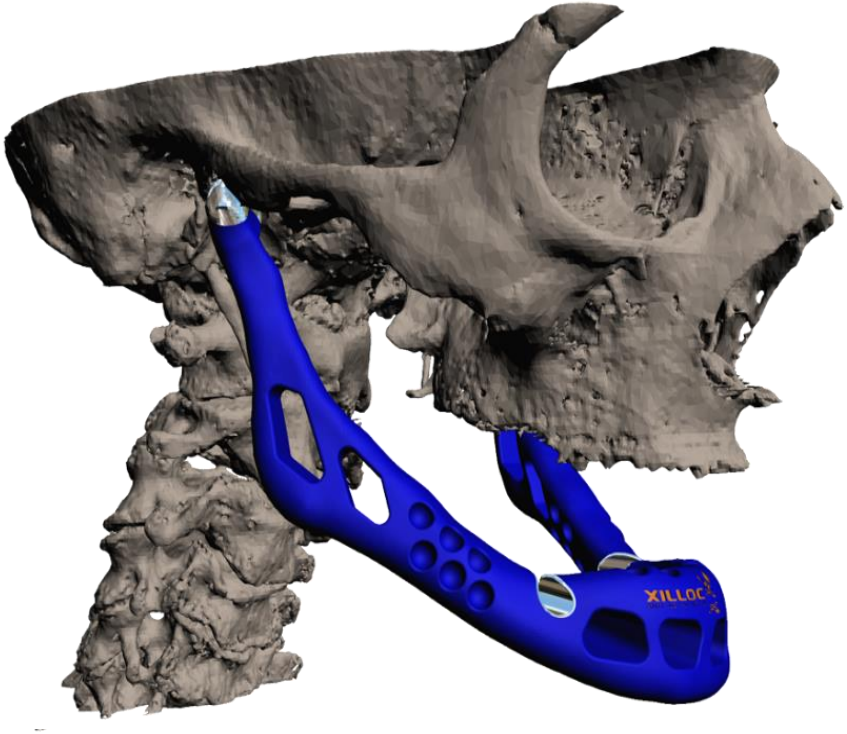
Variable impedance prosthetic socket:

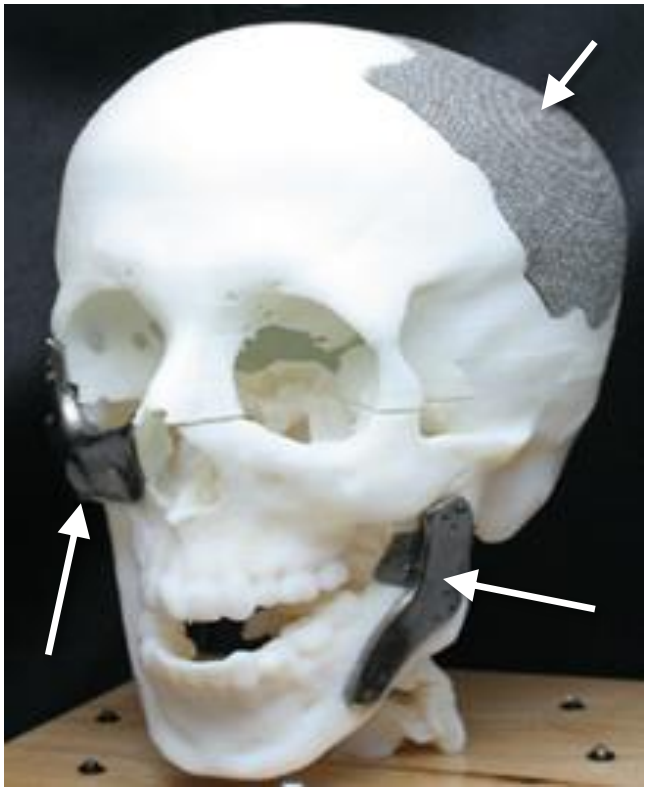
- Multimaterial socket made with Objet Connex from MRI images
- Contact pressures recorded during the stance stage of the gait cycle was measured to be 15% and 17% reduced on the fibular head when compared to a "traditional" socket.
- A 7% and 8% reduction was observed along the tibia.

http://www.deskeng.com/articles/aabjpe.htm

State of the art – Prosthetics and Additive Manufacturing

Craniomaxillofacial reconstruction





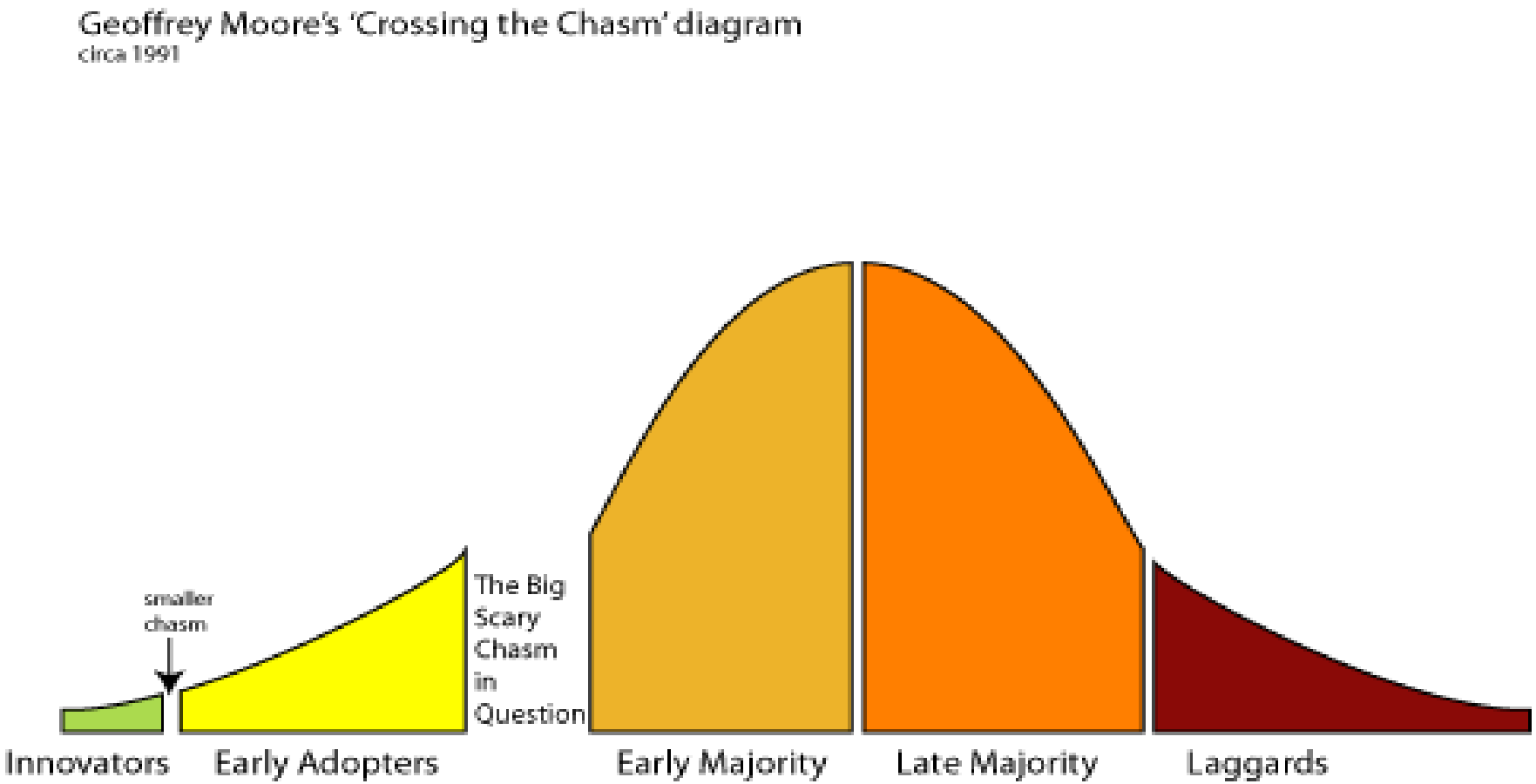
www.xilloc.com http://web.ncsu.edu/abstract/technology/3d-printing/

State of the art – Prosthetics and Additive Manufacturing

Cosmesis

http://web.ncsu.edu/abstract/technology/3d-printing/

AM vs traditional methods – main issues



a-footprint

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a-footprint

- Started SEP 2009
- 11 Partners
  - 5 universities,
  - 1 industrial organisation
  - 6 SME's
- 3.7M Euro EC contribution

FIREFLY custom made foot orthoses

Newcastle University

Junquera&Diz

KHK KATHOLIEKE HOGESCHOOL KEMPEN

MOBILAB

Materialise driving your innovations

ANYBODY™ TECHNOLOGY

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RS scan INTERNATIONAL

GCU Glasgow Caledonian University

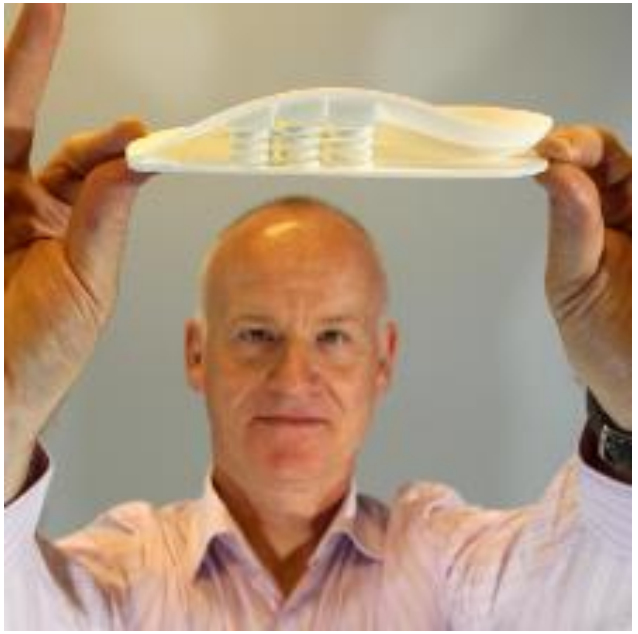
Maastricht UMC+ azM | Maastricht University

Ortho Baltic

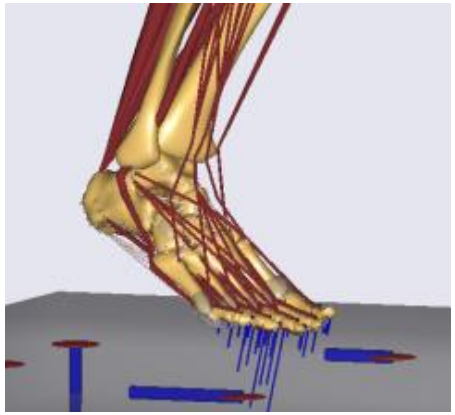
Fontys Paramedische Hogeschool

Objectives:

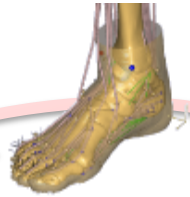
- To improve the accuracy of clinical prescriptions for customised foot and ankle orthoses
- To improve the fit and functionality
- To significantly decrease manufacture time to 48 hours
- To develop a cost-effective, fully integrated orthotic solution
- To disseminate and demonstrate the results



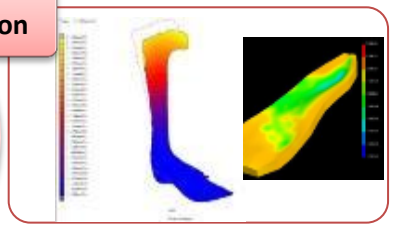
- *To utilise the potential of manufacturing*

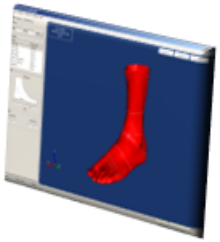


Integrated process (plan)



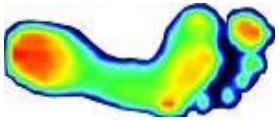
Design Optimisation





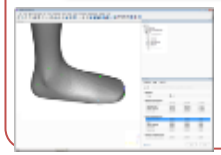
Biomechanical analysis

Clinical assessment



3D Surface scan (leg/foot)

CAD



Rapid manufactured

Supply fit and review

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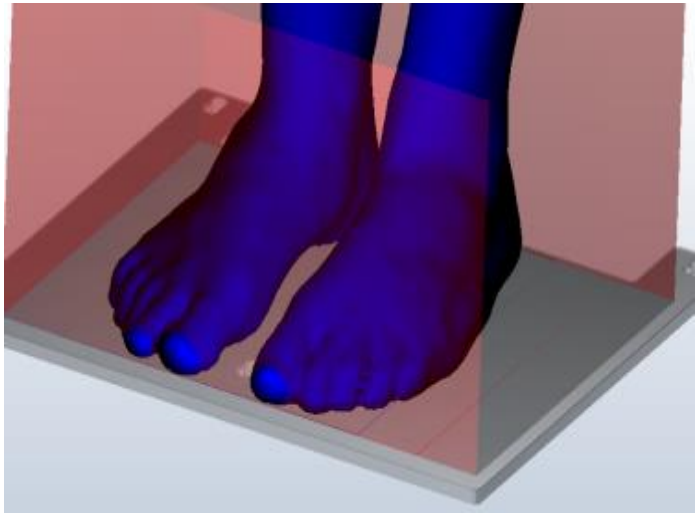
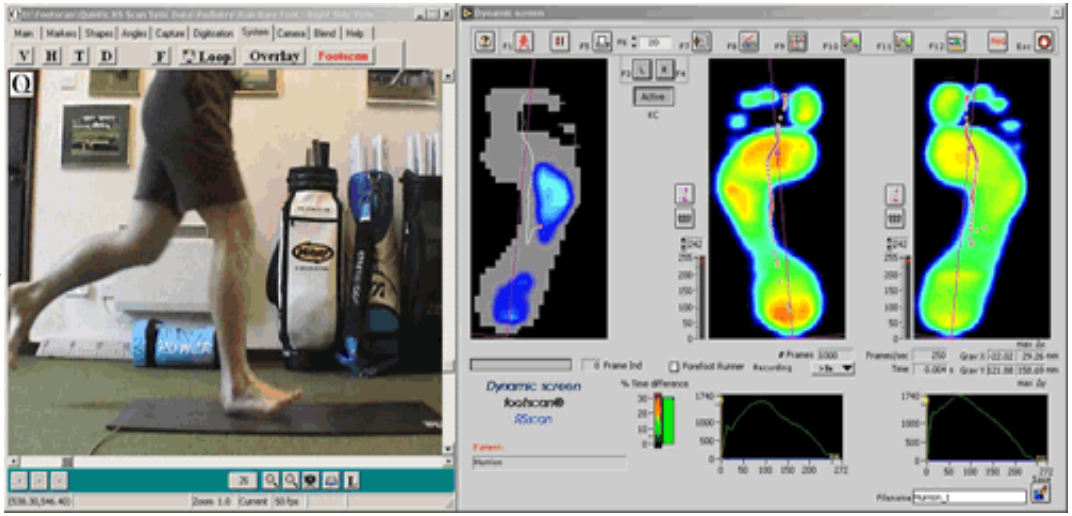
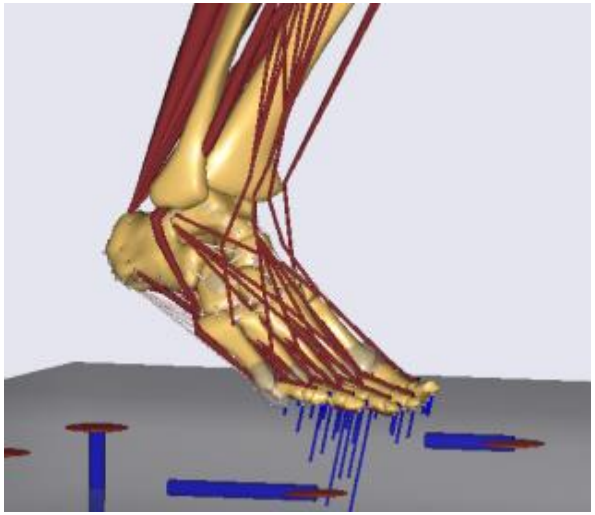
Integrated process (result)

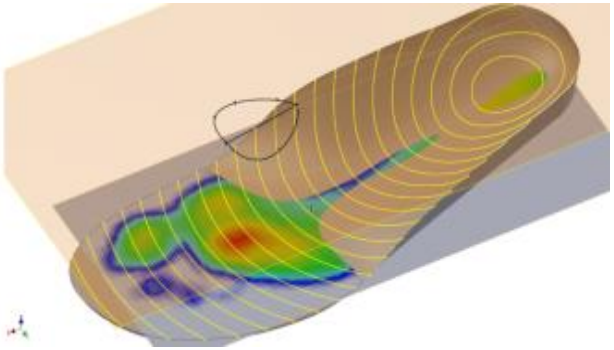


3D scan of plantar Surface

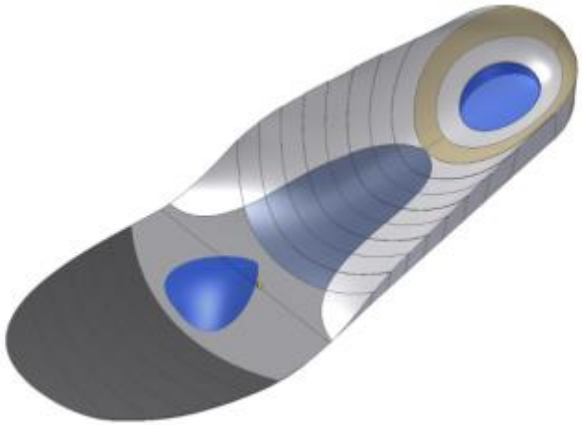


Plantar pressure measurement





Plantar pressure driven insole design

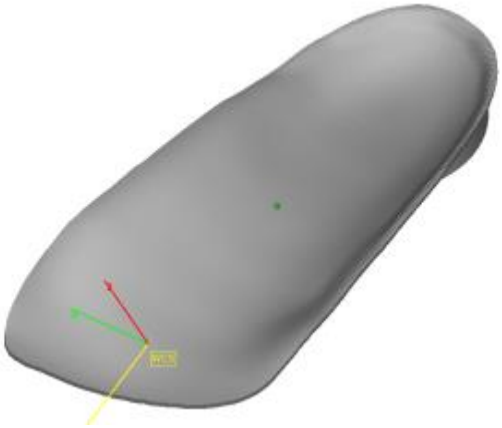


3D CAD of variable hardness insoles (UNEW)

Selected results

- Full sized insoles printed by Objet Connex with variable hardnesses ranging from Shore 25 to 95 (UNEW)

• Selected results - New orthotic concepts



3D CAD design of ¾ length foot orthotics designed with variable thickness and arch support (PCK)

SLS-made ¾ length foot orthotics in ETX Nylon powder and textured surface (PCK)

FDM-Made orthotics in PLA with CF reinforcement. a) Top carbon-fibre surface b) lower honey-comb built-time optimized structure

SLS-made AFO in Duraform PA with foot-plate and calf connected by a carbon fibre 7 spring (PCK-UNEW)

Summary

Additive manufacturing has a huge potential to change the lives of many disabled people

So far the potential is largely untapped because of the nature of the industry and costs of manufacturing

Engineering principles and methods are making their way to the O&P industry and the major change will happen through functional integration

Thank you for your attention

Any questions?

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