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Community Research

SPECIAL SHOES MOVEMENT

SSHOES

ISPO 6TH CENTRAL EUROPEAN REGIONAL CONFERENCE

25-27 AUGUST 2011

NYÍREGYHÁZA, HUNGARY

A 3D foot scanner with integrated plantar pressure measurement

Dr. Enrique Montiel, INESCOP, Spain.

SEVENTH FRAMEWORK PROGRAMME

CONTENT

- WHAT IS INESCOP?
- THE SSHOES PROJECT.
- 3D SCANNER WITH INTEGRATED PRESSURE MEASUREMENT.

What is INESCOP?

- Independent service Organisation
- Began its activities in 1971
- Non-profit making Institution
- More than 600 associated companies
- 147 staff (13 Phd)

INESCOP's services

- ✓ testing services
- ✓ technology development
- ✓ applied research
- ✓ industrial design and fashion
- ✓ environment
- ✓ training
- ✓ information

Close to the factories

- **Network of Centres**

Research to Innovate

- Materials and production processes
- Development of CAD/CAM/CAE tools:
  - Computer design programmes
  - Modelling methods
  - Measuring and testing techniques
- Technologies to traditional processes
- Adaptation of technologies developed by other sectors
- New materials or improvement of the traditional ones
- Pollution, recycling of wastes

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SPECIAL SHOES MOVEMENT

Grant Agreement NMP2-SE-2009-229261

NMP-2008-4.0-7 Integration of new technologies and materials for differentiated consumer-centred product capability

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FACTSHEET

- Project acronym**: SSHOES**
- Full title of project**: SPECIAL SHOES MOVEMENT**
- G.A. Ref**.: NMP2-SE-2009-229261**
- Start Date**: 1st July 2009**
- Duration**: 36 months**
- Total Budget**: 4,874.025€**
- EU Contribution**: 3,509.000€**
- No. of Partners**: 11**
- Website: ***www.sshoes.eu***

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Project Coordinator

INESCOP
INSTITUTO TECNOLÓGICO DEL CALZADO Y CONEXAS

Beneficiaries

University of Salford
A Greater Manchester University

Deutsche Sporthochschule Köln
German Sport University Cologne

ITIA
Istituto di Tecnologie Industriali e Automazione

A&CN
Automática y Control Numérico S.L.

TPSP
TODO PARA SUS PIES

duna®
THERAPEUTIC SHOES INDUSTRY

Soletec SYSTEMS LIMITED

KOPITARNA®
SINCE 1886

C2i2

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DIABETIC FEET

- In 2008: 50 million diabetics in Europe
- Lack of sensitivity in foot: neuropathy
- 15% of diabetics: problems with diabetic foot syndrome
- High risk of amputation
- High sanitary costs (10 million European diabetics represent 29.000 million €)

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DIABETIC FEET

- 250 million people around the world have diabetes
- more than 5% of diabetic patients will have a history of foot ulcers
- up to 85% of amputations are preceded by foot ulcers
- there is a potential new global market for personalised shoes for diabetics estimated for about 80 million users

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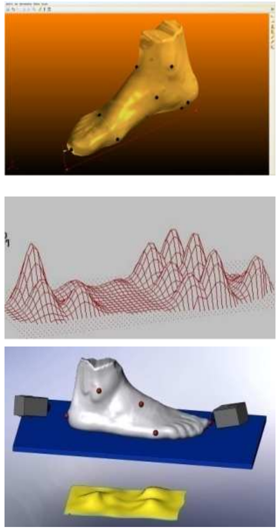
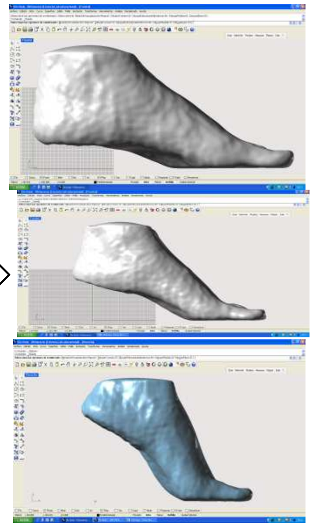
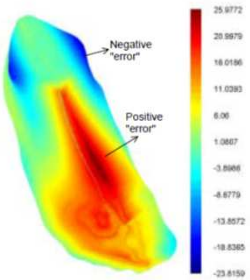
PROBLEMS ADDRESSED

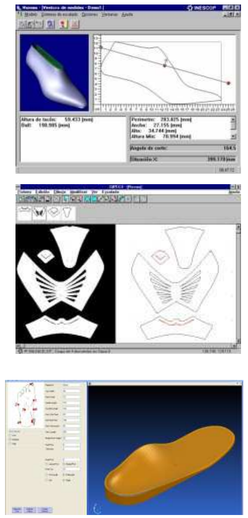
1. Health care problems (biomechanical and biomedical aspects)
2. Footwear design problems (new design technologies)
3. Footwear product problems (comfort, health welfare and service to customers)
4. Footwear components and materials problem (eco-sustainability and high performing materials)
5. Footwear manufacture problems (adaptive production processes and engineering framework)

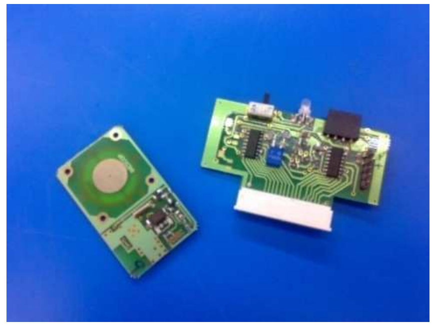
…….to virtual models

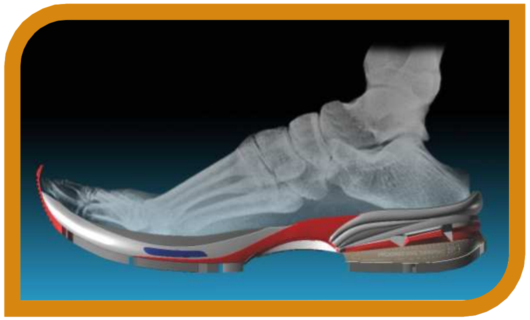








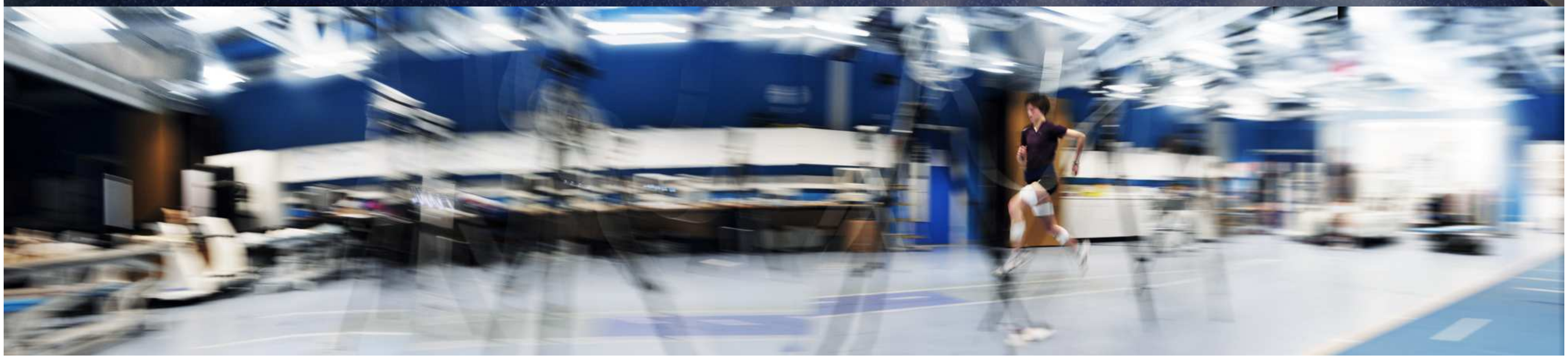




OBJECTIVES

- **Customised product concepts especially aimed at diabetic feet (notably, footwear and insoles),**
- **Engineering framework for both footwear products & processes,**
- **High-performance materials with self-adaptive properties,**
- **Full eco-sustainable product concepts;**
- **Individual consumers' requirements;**
- **Technology framework for the digital engineering of customised diabetic footwear and insole products**

Multidisciplinary approach: biomechanics, sports, health, electronics, materials, ICT, manufacturing



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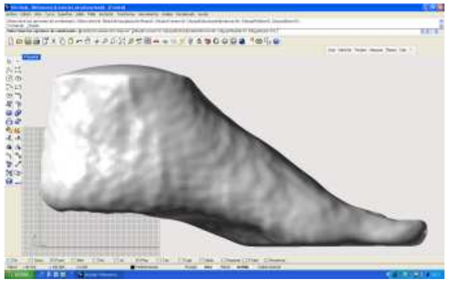
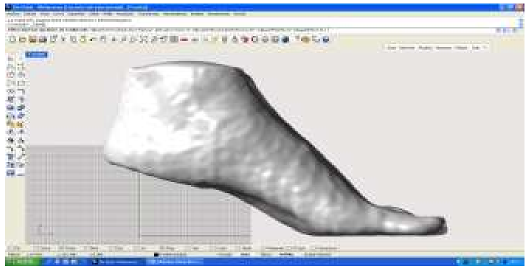
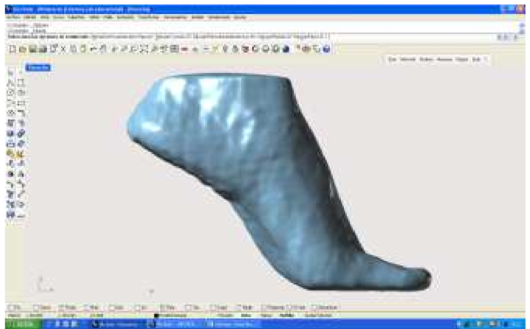
3D LASER SCANNER WITH IMPROVED WORKING AREA AND DEVICE TO FIX FEET IN THE DESIRED POSITION







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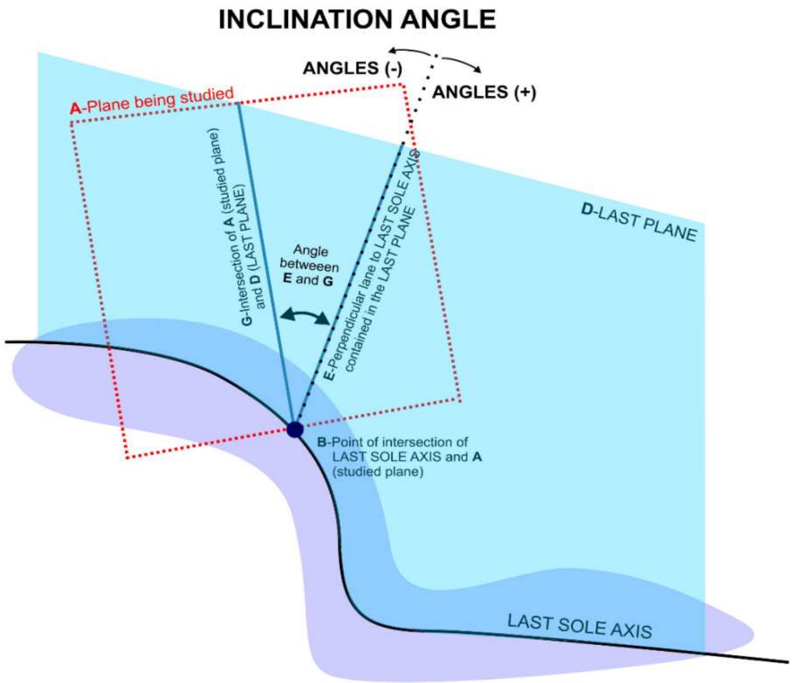
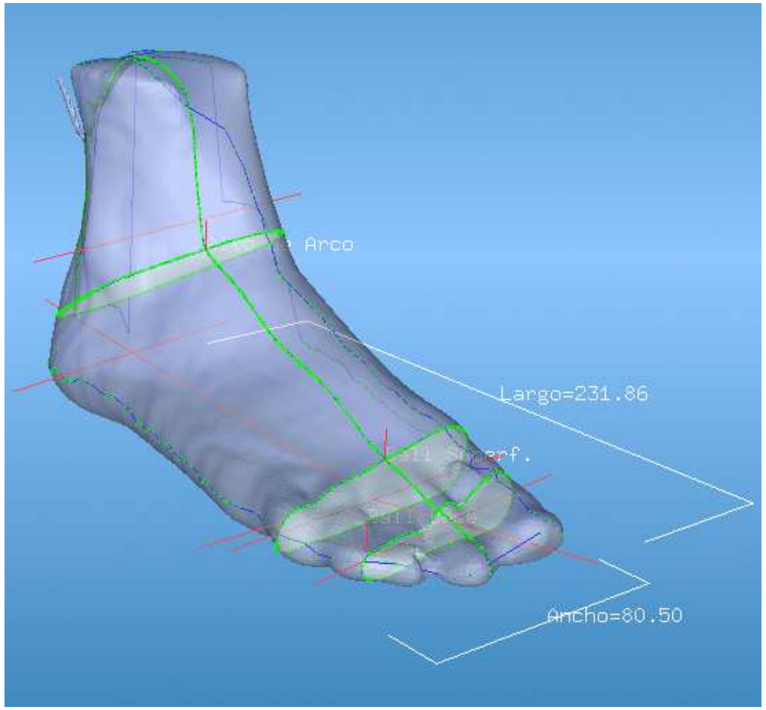
ALGORYTHM TO RISE FEET TO POSITION LIKE INSIDE THE SHOE (WITH/WITHOUT INSOLE)





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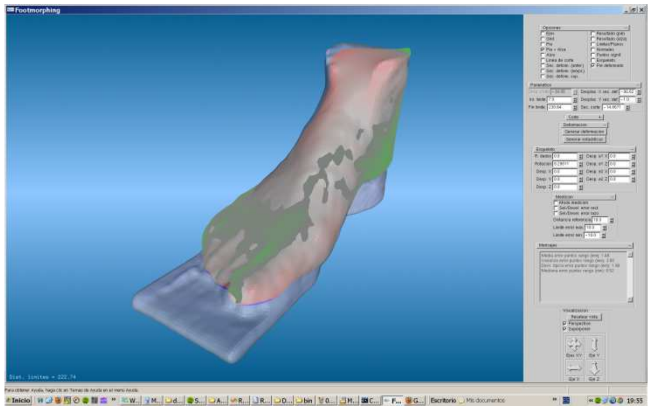
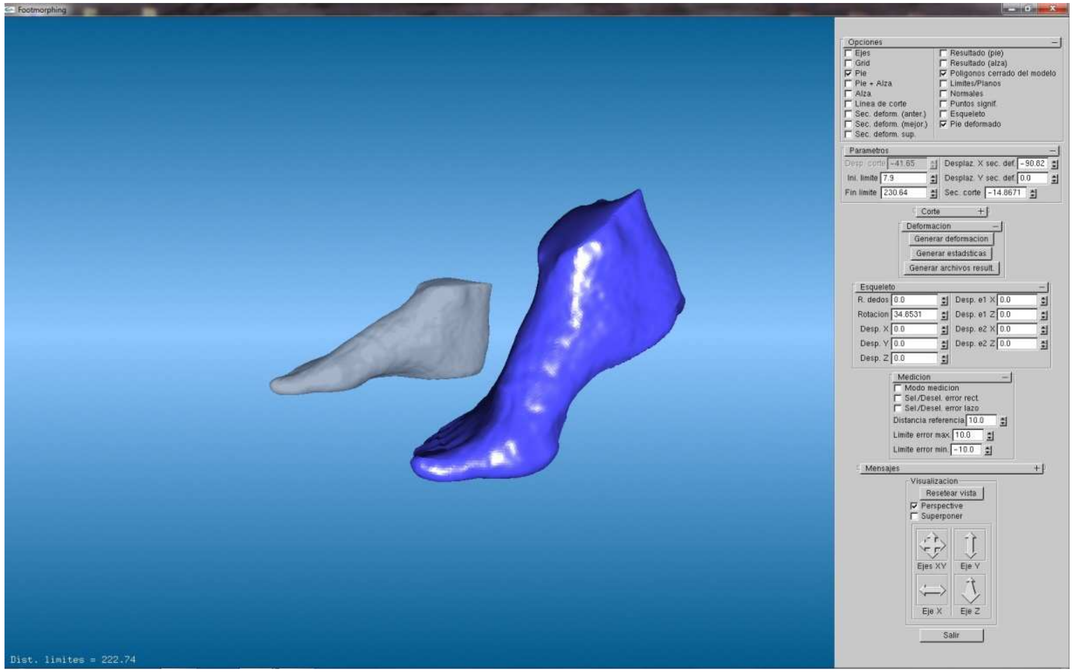
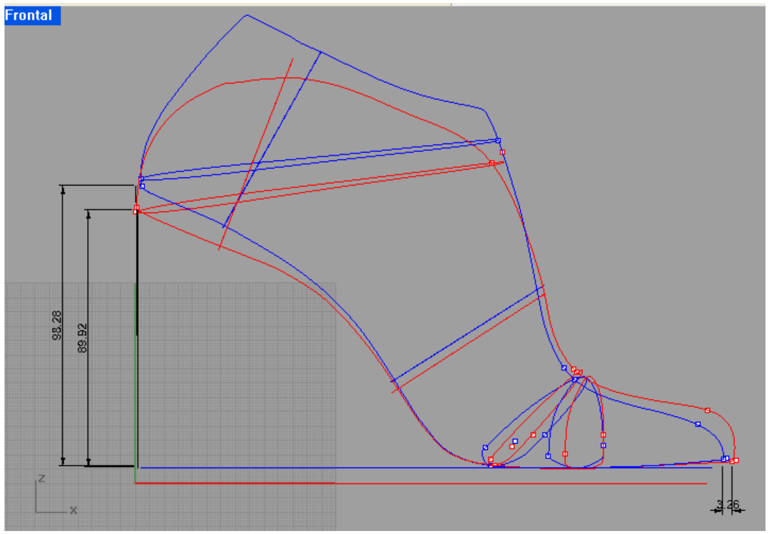
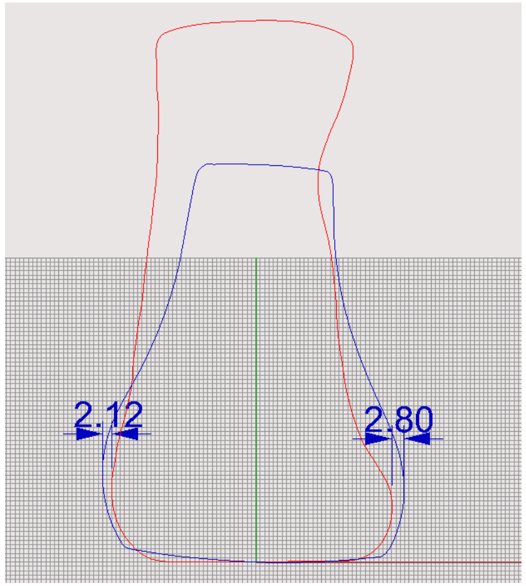
ALGORYTHM (FOOTMORPHING) TO RISE FEET TO POSITION LIKE IN THE SHOE (WITH/WITHOUT INSOLE)



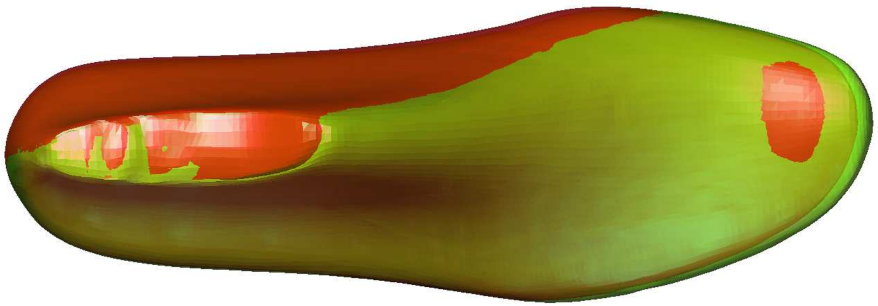


TOOLS (INFOHORMA) TO ASSESS LAST-FEET AND LAST-LAST (VIRTUAL FITTING)

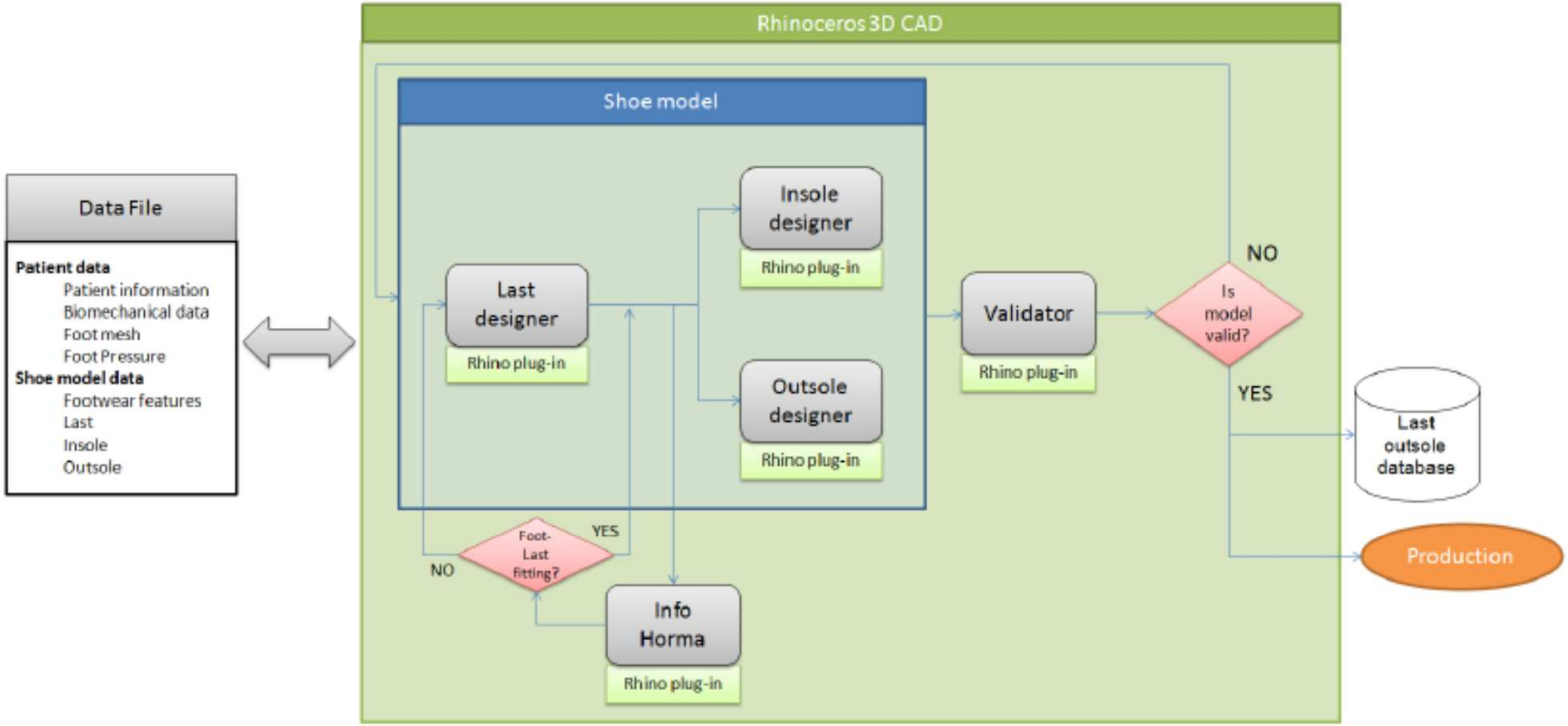




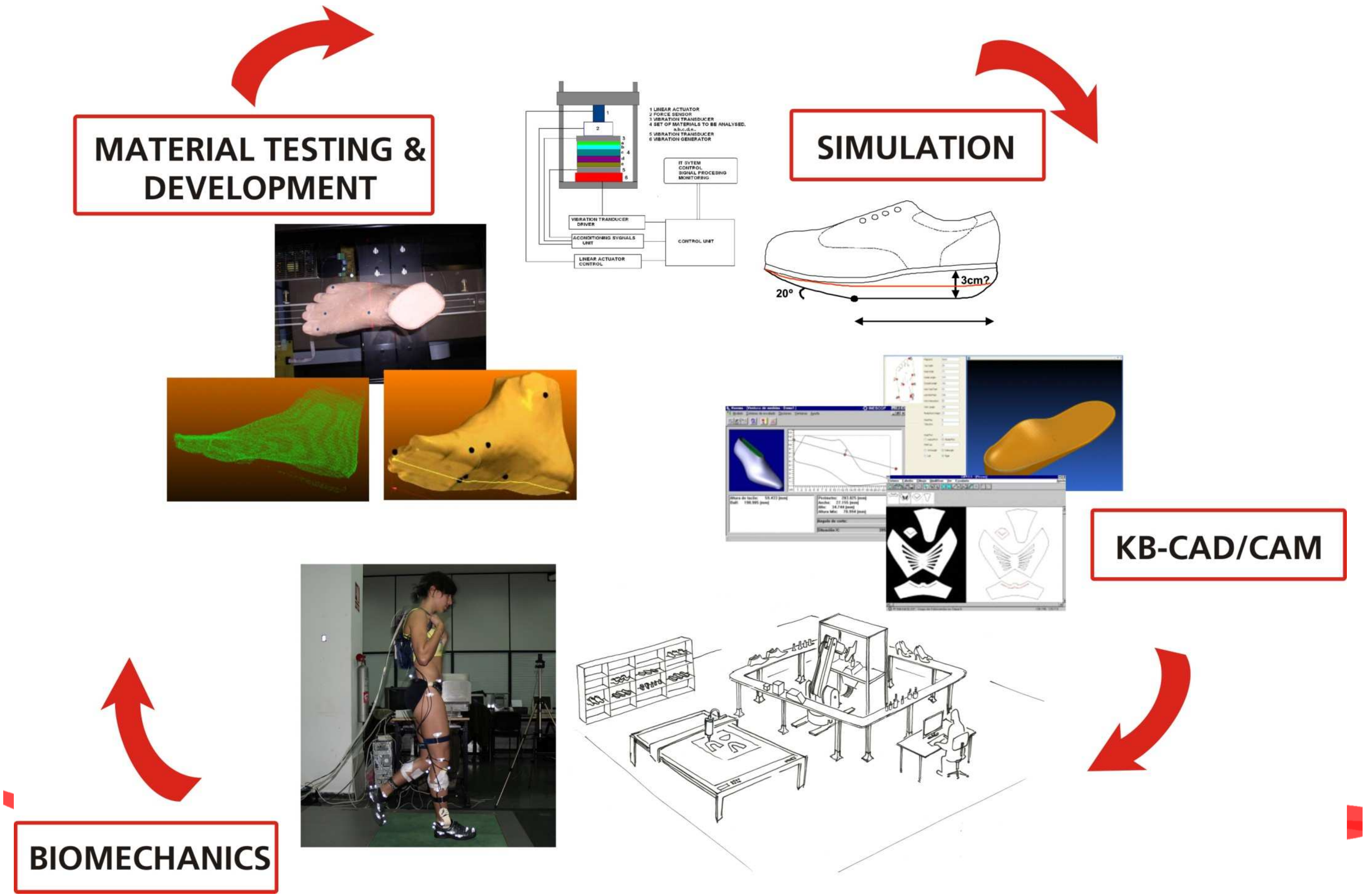
KEEPING STYLE AND MORPHING LAST TO FEET



CAD Module architecture



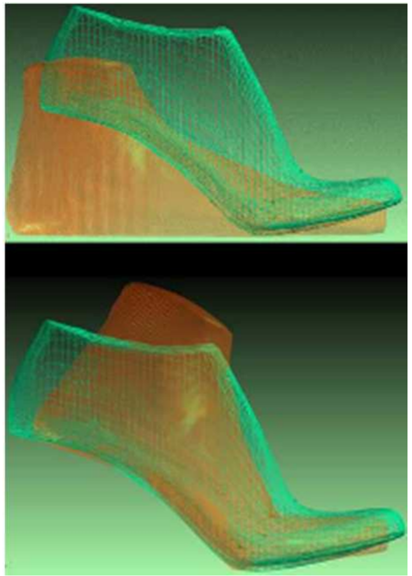
Sustainable, consumer-centred production of footwear and insoles

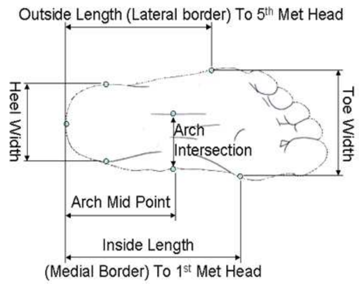


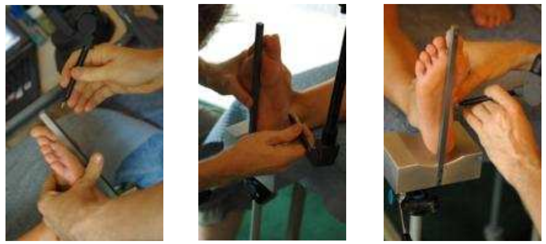
3D CAD system using biomechanical data

Rocker Shoe Design

Parametric bio-mechanical design







Last Rectification

Modelling and fitting final last

Foot Deformation

Fitting flat foot to shank last curve

Critical measures for insole design

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3D foot scanner with pressure scanning

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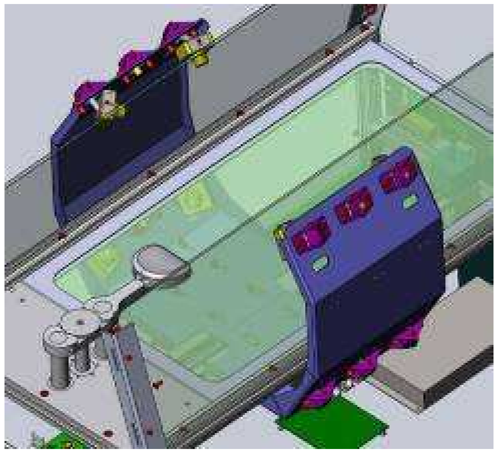
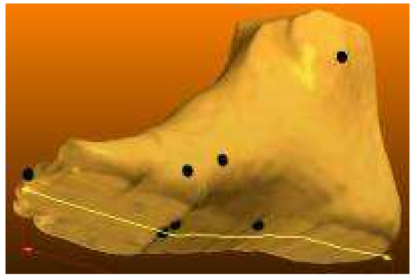
3D foot scanner with simoultaneous pressure scanning

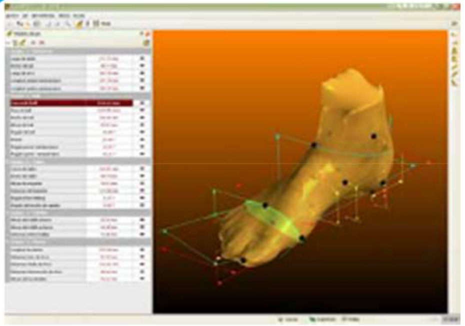
A new foot scanner with 8 cameras, increased capture volume and accuracy



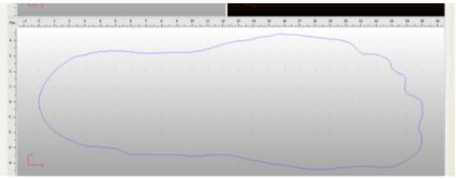
A heel lift device has been developed as well



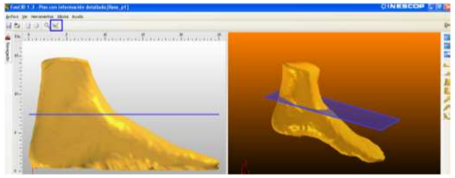
3D feet scanner getting the plantar pressure simultaneously



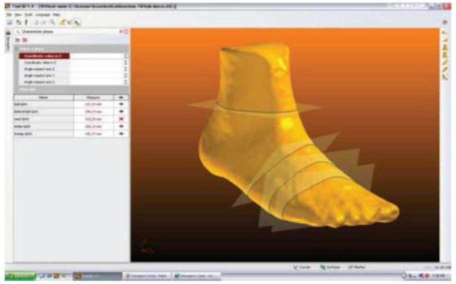
Automatic: The software obtains anatomical keypoints of the foot and provides a series of measures.



Flexible: The software allows moving those points found automatically as well as adding new ones.



It calculates additional planes and sections as defined by the user.



Integrated: Files containing the measures needed for last and shoe design are generated.

3D feet scanner getting the plantar pressure simultaneously

Two pressure plates record the plantar pressure whilst the 3D shape of the other foot is being scanned

Sensor matrix: 72 x 40
4 sensors/cm^2
2880 sensor x plate

3D feet scanner getting the plantar pressure simultaneously

Main Features:

3D Scanner specifically studied for foot scanning in orthopaedic shops
Dynamic Foot Mechanical Support
Fast data capture and processing
Customized placement of measurements
High Accuracy +/- 1mm for each single measure
User-friendly Graphical Interface
Compatibility with all major CAD/CAM Systems

Technical Data:

Scanning Volume LxHxW = 420x180x180 mm
Accuracy (max) = +/- 1 mm
Scanning rate: 15 sec
Output 3D Format : STL, ASCII
Weight supported: 120 Kg
Physical Dimensions LxHxW: 770 x 450 x 500 mm
Weight: 30 Kg
Power Supply: 220V 50 Hz 400W

3D feet scanner getting the plantar pressure simultaneously

Aim

To develop a software for visualising the plantar pressure map on the foot insole geometry, as a Rhinoceros plug-in.

Functionalities required:

- to import a geometry coming from a foot scanner as a mesh;
- to import a sequence of pressure maps in several formats (image, text, etc.);
- to select one of the pressure maps according to specific rules;
- to align pressure map with foot geometry;
- to project pressure map on the insole foot mesh;
- to calculate maximum pressure point;
- to calculate isobar curves;
- to export pressure and foot geometry data to the insole design plug-in

Foot Pressure Viewer process

Foot geometry
Pressure maps

Rhinocerso 3d plug-in

Rhinocerso 3d plug-in

Insole designer

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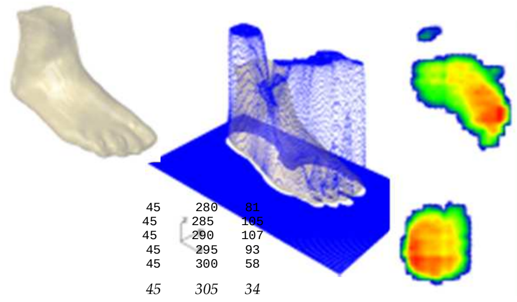
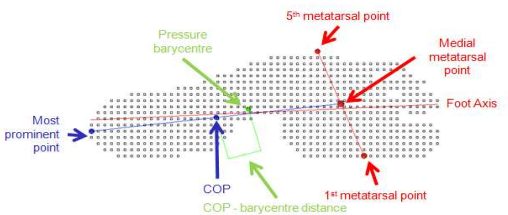
3D feet scanner getting the plantar pressure simultaneously

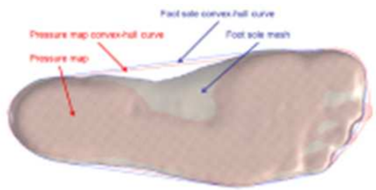
Foot Pressure Viewer use



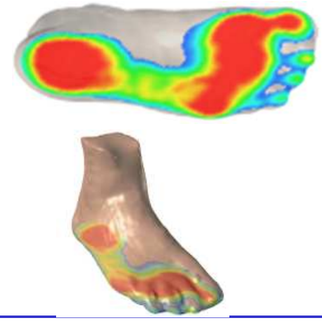
1. Input from digitiser



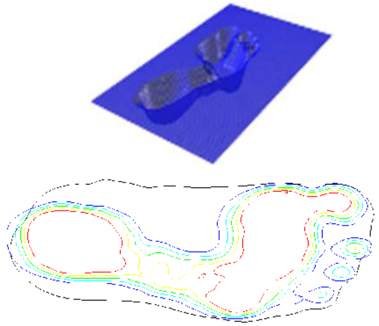
2. Pressure map selection



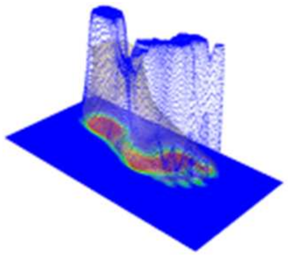
3. Pressure map – foot geometry alignment



4. Pressure map projection



5. Isobar curves calculation



6. Export data to insole plug-in

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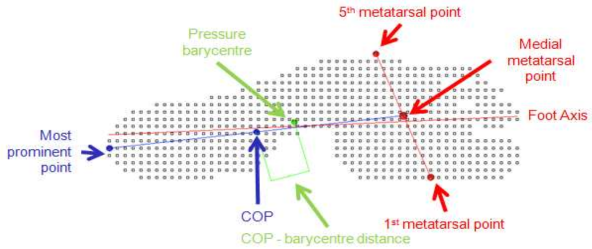
3D feet scanner getting the plantar pressure simultaneously

Pressure map selection:

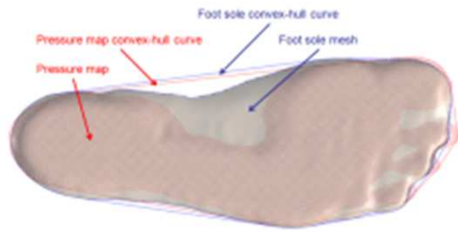
The best map is that one with the lowest distance between COP and barycentre points of pressure map.

COP (Centre of Pressure): This point is calculated as medium point between most prominent and medial metatarsal one.



Foot mesh and pressure map alignment:

Best-fit alignment between convex-hull curves of pressure map and foot sole.



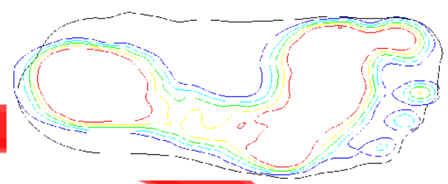
Pressure map projection:

Generating a new colored mesh overlapped to foot sole geometry.

Isobar curves:

Generating a NURBS surface elaborating pressure image.

Slicing pressure surface with parallel planes.



Foot Pressure Viewer results

Results:

- Development of a software to visualize foot pressure maps on 3d geometry;
- Calculate and elaborate data used during insole foot design process;
- Analysys of the pressure maps incoming from Minilab, in order to evaluate patient posture during scanning phase;

Advantages:

- Visualization of the pressure distribution on the foot sole geometry in order to localize exactly the maximum pressure areas. Diagnosis phase, leaded by technician, is now realized with a useful software;
- Definition of the isobar curves in order to guide insole design process, modelling insole shape in order to redistribute loads close to maximum pressure areas. Design process is now driven by objectives parameters (bio-mechanical parameters).

THANKS FOR YOUR ATTENTION

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