# CUT Product Development and 3D Printing Units supporting industry

Central University of Technology, Free State

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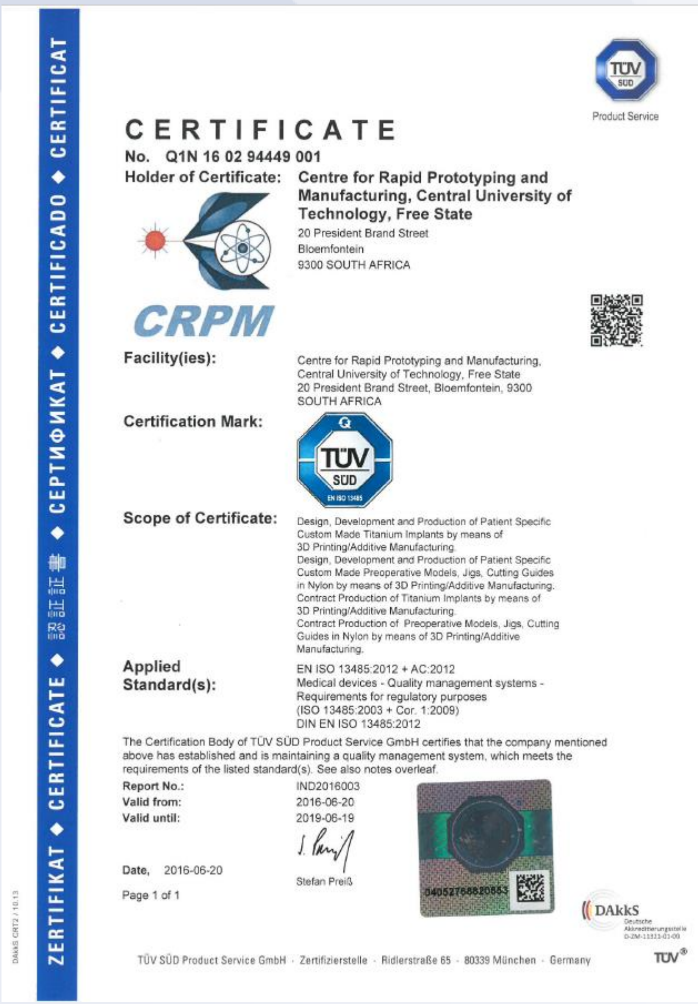
ZERTIFIKAT ◆ CERTIFICATE ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Product Service

**CERTIFICATE**

**No. Q1N 16 02 94449 001**

**Holder of Certificate:** **Centre for Rapid Prototyping and Manufacturing, Central University of Technology, Free State**
20 President Brand Street
Bloemfontein
9300 SOUTH AFRICA

CRPM

**Facility(ies):** Centre for Rapid Prototyping and Manufacturing, Central University of Technology, Free State
20 President Brand Street, Bloemfontein, 9300
SOUTH AFRICA

**Certification Mark:** TÜV SÜD EN ISO 13485

**Scope of Certificate:** Design, Development and Production of Patient Specific Custom Made Titanium Implants by means of 3D Printing/Additive Manufacturing.
Design, Development and Production of Patient Specific Custom Made Preoperative Models, Jigs, Cutting Guides in Nylon by means of 3D Printing/Additive Manufacturing.
Contract Production of Titanium Implants by means of 3D Printing/Additive Manufacturing.
Contract Production of Preoperative Models, Jigs, Cutting Guides in Nylon by means of 3D Printing/Additive Manufacturing.

**Applied Standard(s):** EN ISO 13485:2012 + AC:2012
Medical devices - Quality management systems - Requirements for regulatory purposes
(ISO 13485:2003 + Cor. 1:2009)
DIN EN ISO 13485:2012

The Certification Body of TÜV SÜD Product Service GmbH certifies that the company mentioned above has established and is maintaining a quality management system, which meets the requirements of the listed standard(s). See also notes overleaf.

**Report No.:** IND2016003
**Valid from:** 2016-06-20
**Valid until:** 2019-06-19

**Date,** 2016-06-20

Stefan Preiß

Page 1 of 1

DAkkS

TÜV SÜD Product Service GmbH · Zertifizierstelle · Ridlerstraße 65 · 80339 München · Germany


Gerrie Booysen
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# Global Picture

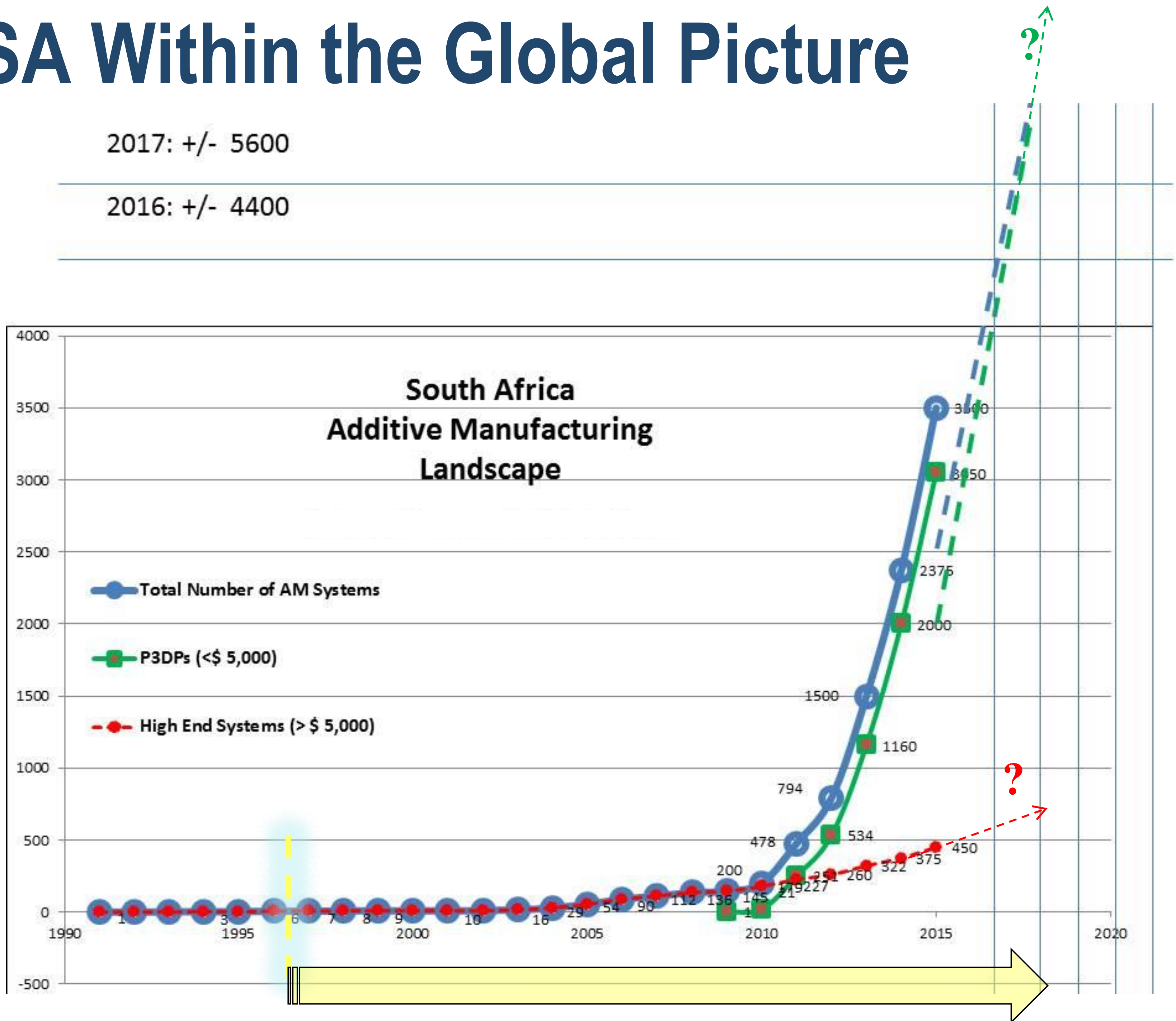
- Metal AM Growth: Wohlers Associates (2018), reports that growth is now approaching exponential.
  - 875% growth in the past five years;
  - 220% growth in the past two years alone.
- Boeing reported that they have 20 sites producing metal parts and that there are over 60,000 AM parts currently in their deployed aircraft.
- GE reported that they have over 1,200 employees operating 1,300 AM machines resulting in over 50,000 parts to date.
- Over 1,000 on-going Metal AM projects are directed at what GE believes is a $76 billion market opportunity in the next eight years.
- Stryker just finished building a state-of-the-art facility to address growing opportunities in the medical industry and already has over 100,000 Metal AM implants in patients.

# Global Picture – FoF / $4^{th}$ IR

# SA Within the Global Picture

2017: +/- 5600

2016: +/- 4400



# CENTRE FOR RAPID PROTOTYPING AND MANUFACTURING

Established in 1997

**CRPM**
- **Annually manufactures around 15 000 AM parts as part of >500 projects**
- **Have 750 commercial clients**
- **Support industries in New Product Development**
- **Going from CAD to prototypes and end-use products**

# LASER MELTING AS PART OF 3D PRINTING

Powder

Laser Melting

Part

CRPM

e-Manufacturing Solutions

Courtesy EOS

# AM TECHNOLOGIES AT CRPM

- EOS P380
- EOS P385
- EOS P396

- EOS S700


- EOS M280 200W (Ti64)
- EOS M280 400W (MS1)
- EOS M250 Extended

- OBJET CONNEX 350

PLASTIC LASER SINTERING

SAND LASER SINTERING

DIRECT METAL LASER SINTERING

# WHY AM FOR MEDICAL APPLICATIONS?

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Internationally many reports by large corporations showcase the benefits of Additive Manufacturing (AM), or better known as 3D printing, for healthcare. Aspects like ***reduced theatre time*** using 3D printed implants, cutting/drill guides and pre-operative planning models are elaborated on. The reduced theatre time has a ripple effect on ***faster patient recovery time***.

A particular report by Deloitte called “3D opportunity in medical technology - Additive manufacturing comes to life” highlights how **customization of medical devices** manufactured by 3D printing improves clinical efficacy with better fitting implants at a lower cost.

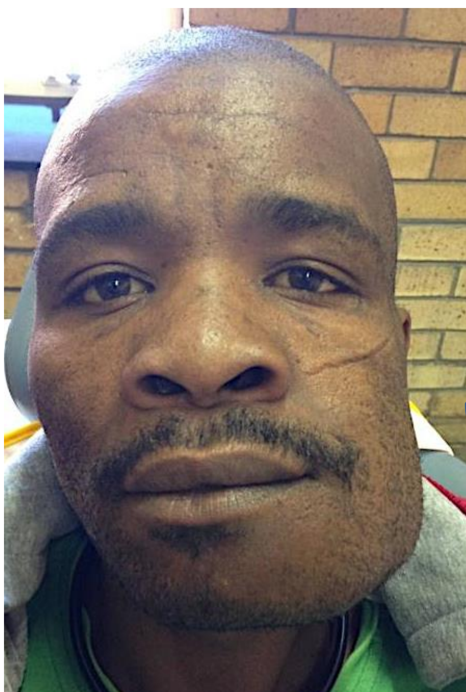
Large companies like Smith & Nephew, Lima Orthopaedics and 3D Systems realised these advantages and are setting up large 3D printing manufacturing centres that are mass-producing implants and other devices.

**Currently 95% of medical devices in South Africa are imported (SAMED 2014 report), which presents an opportunity for localisation, reduced cost and access for more patients to the benefit these provide.**

*Glenn H. Snyder, Mark Cotteleer, Ben Kotek; 3D opportunity in medical technology, published 28 April 2014 on Deloitte website: https://dupress.deloitte.com/dup-us-en/focus/3d-opportunity/additive-manufacturing-3d-opportunity-in-medtech.html*

*South African Medical Device Industry Association report on The South African Medical Device Industry – Facts. Accessed on 4 October 2017 www.samed.org.za/DynamicData/LibraryDownloads/224.pdf*

# IMPROVING LIVES




Dr. K. Hoek
Dr. W. Hoek

Central University of Technology, Free State

# 3D PRINTED IMPLANTS

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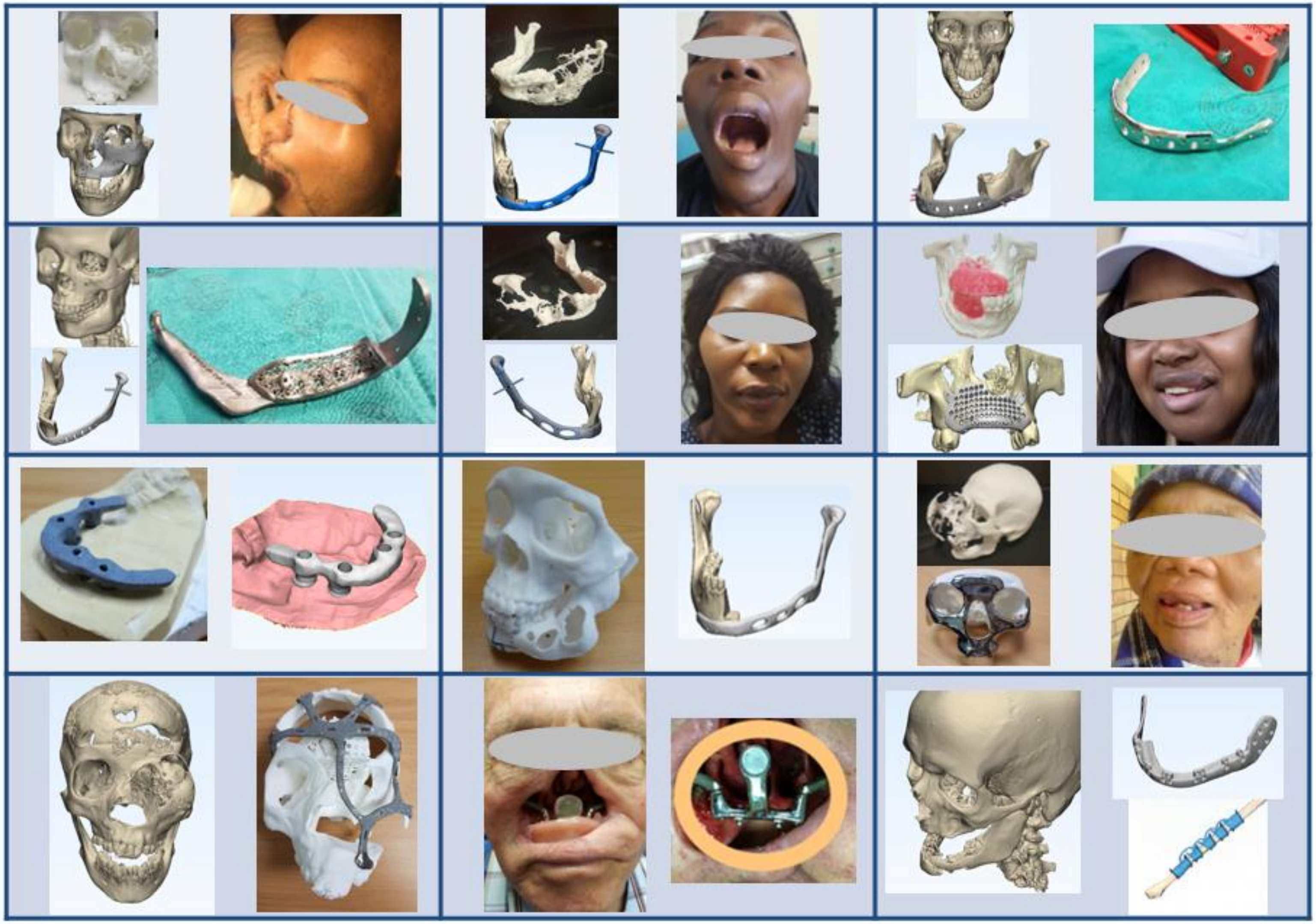

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# PRINCESS MOSHOANA

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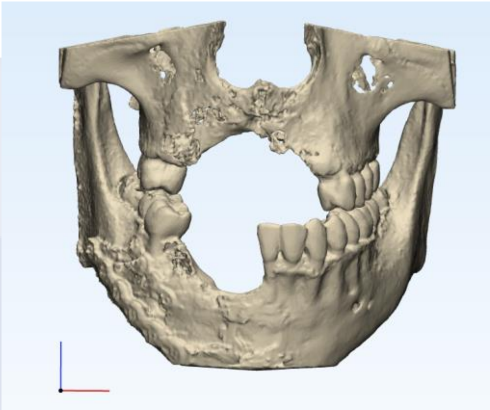

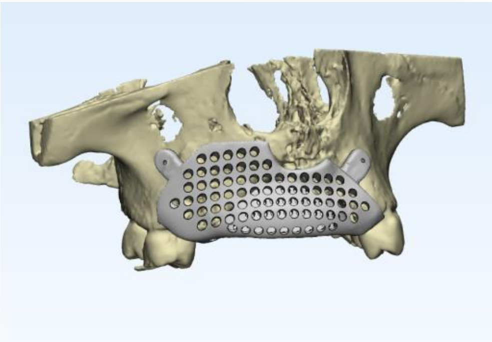

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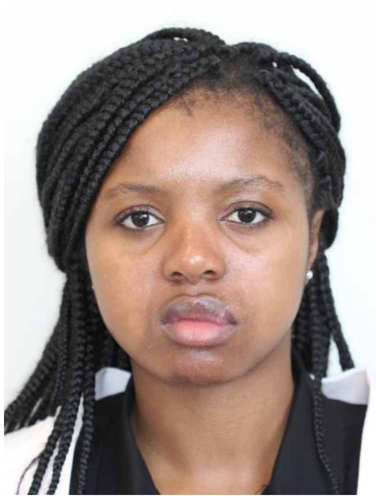
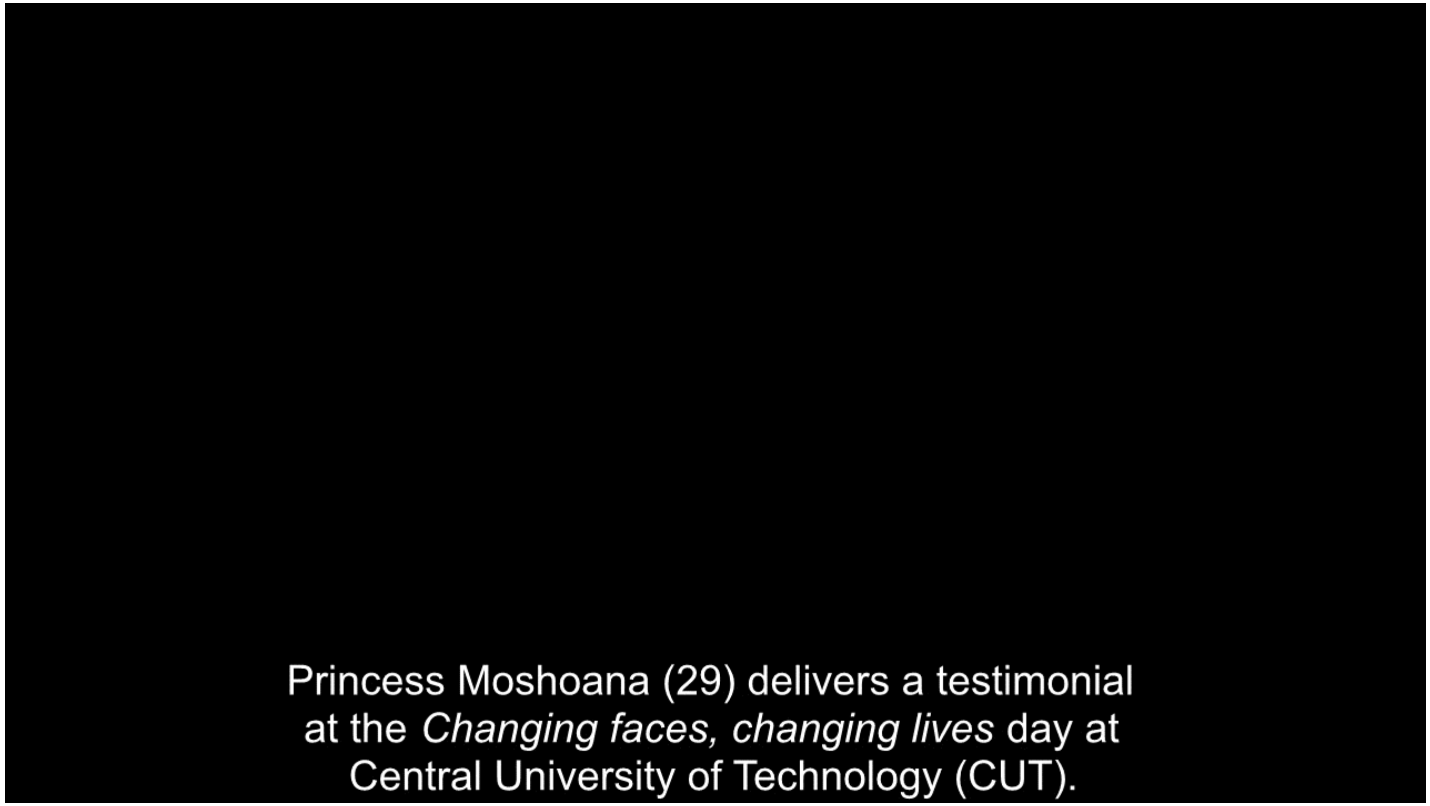
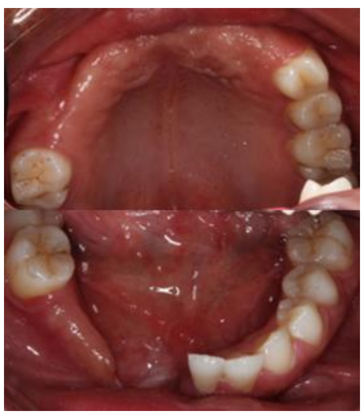
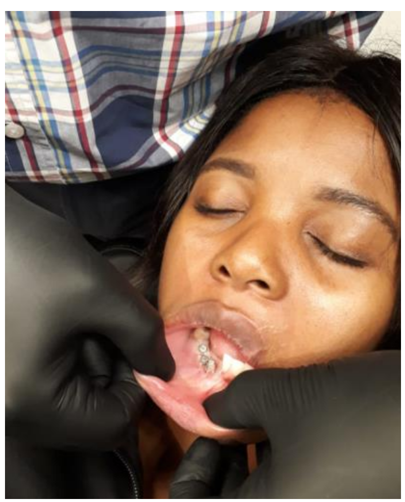
# Changing faces
# Changing lives week

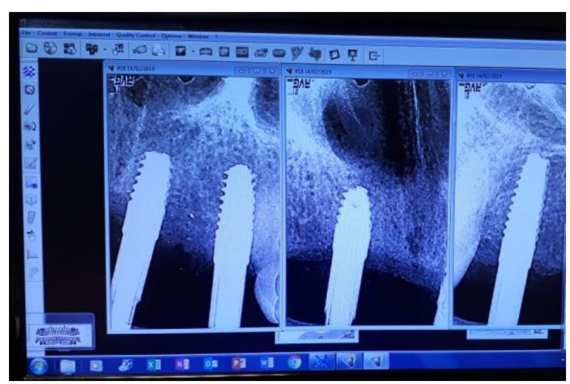
***Carl & Emily Fuchs Foundation***

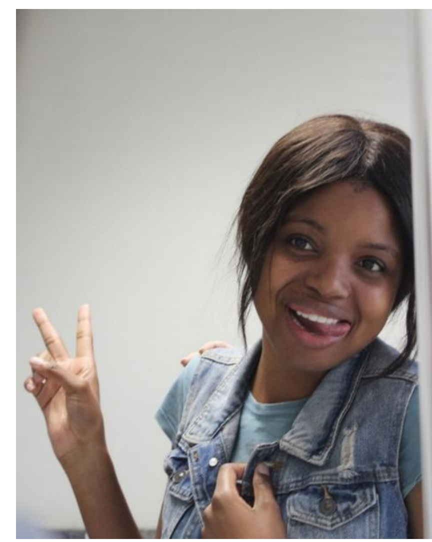



Princess Moshoana (29) delivers a testimonial
at the *Changing faces, changing lives* day at
Central University of Technology (CUT).









# WHAT DO YOU DO IF YOU DO NOT HAVE ACCESS TO GUIDED SURGERY TO REMOVE CYST BEHIND AN EYE?

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# Design and AM of patient-specific guided surgery device

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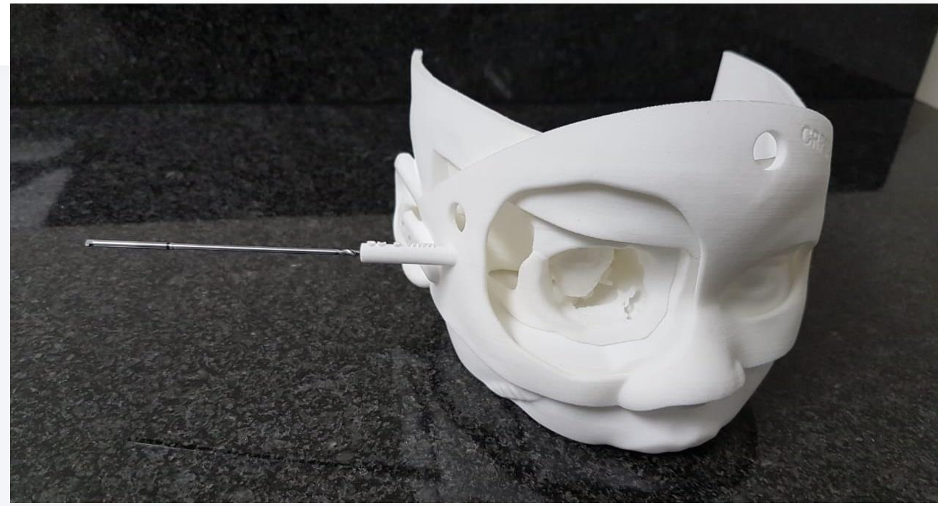
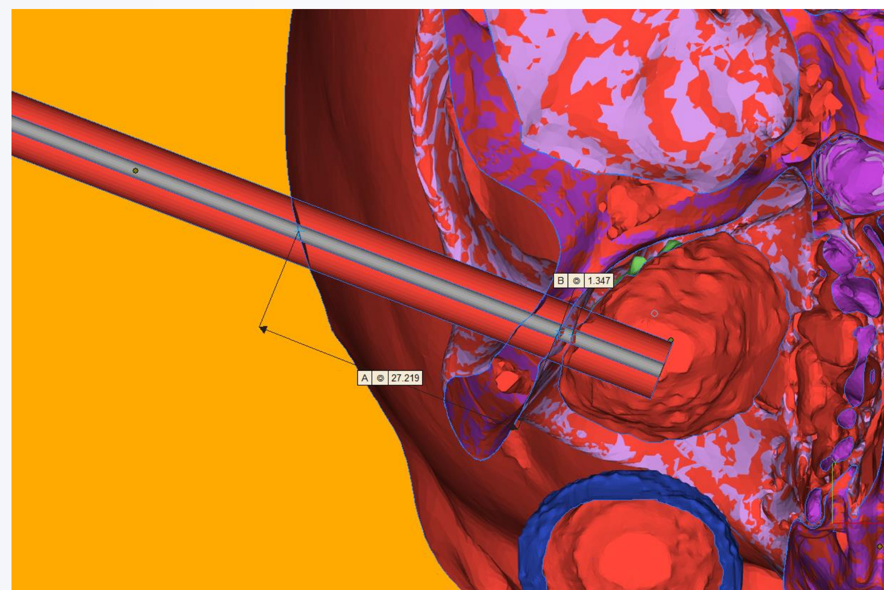
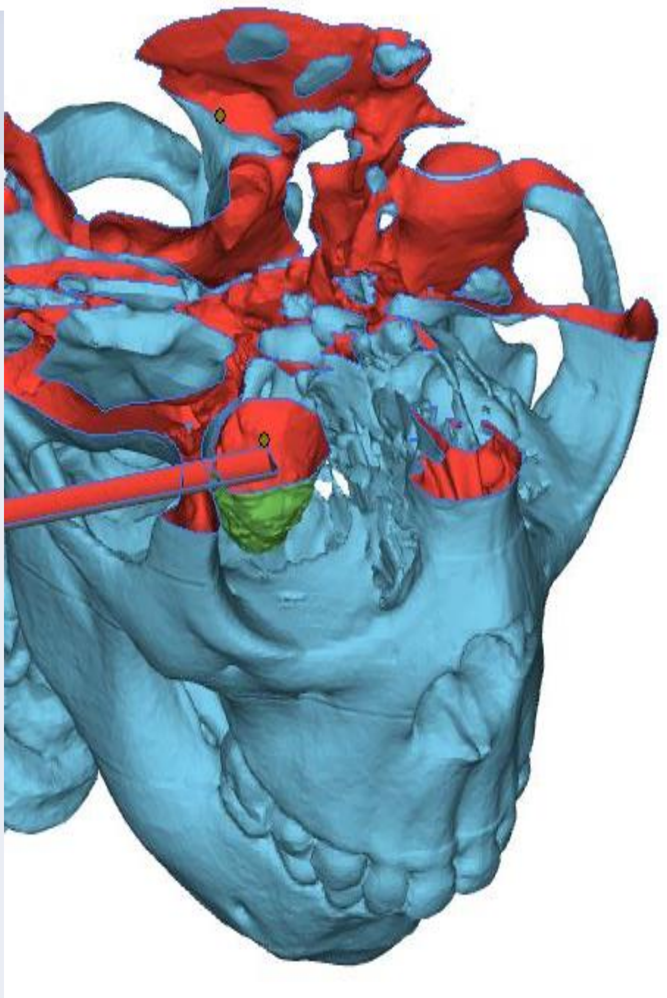
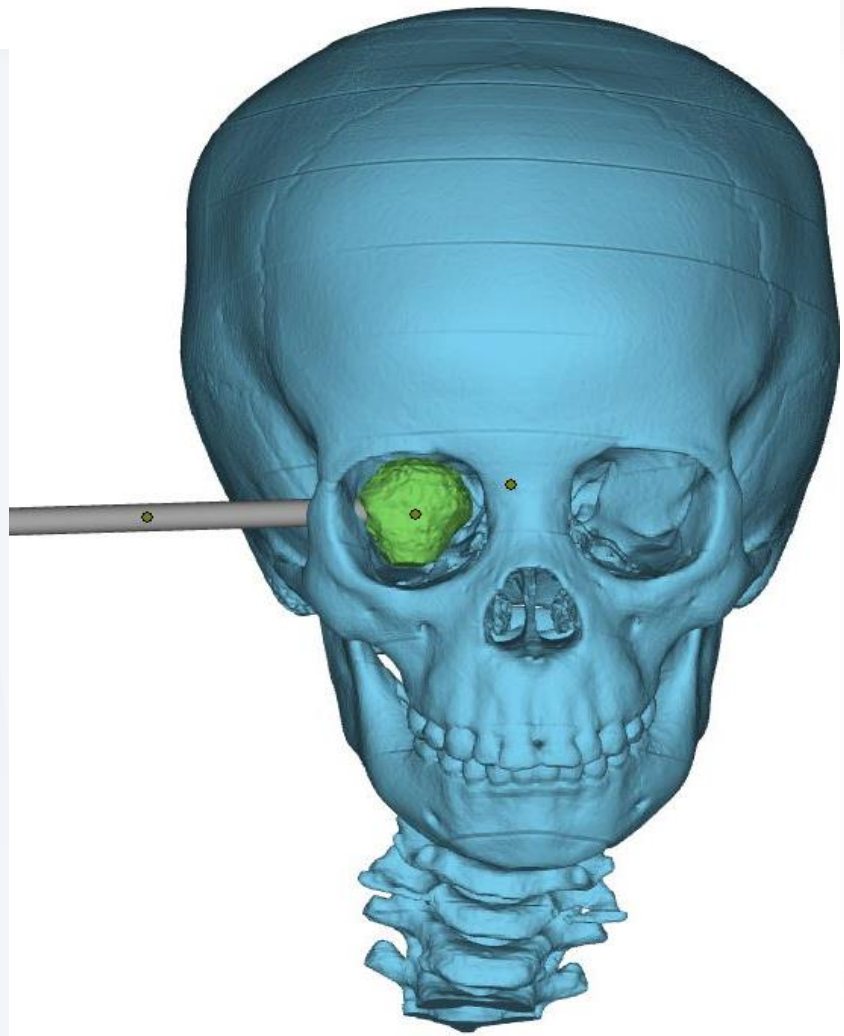





**7-year old girl with cyst behind right eye**
**Possibility of loosing sight within 14 day window**

# Design and AM of patient-specific guided surgery device





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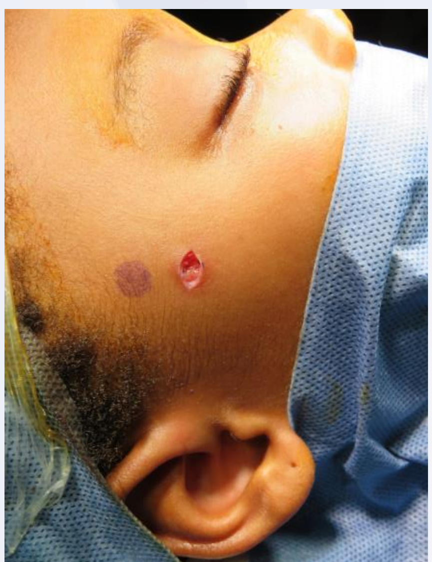

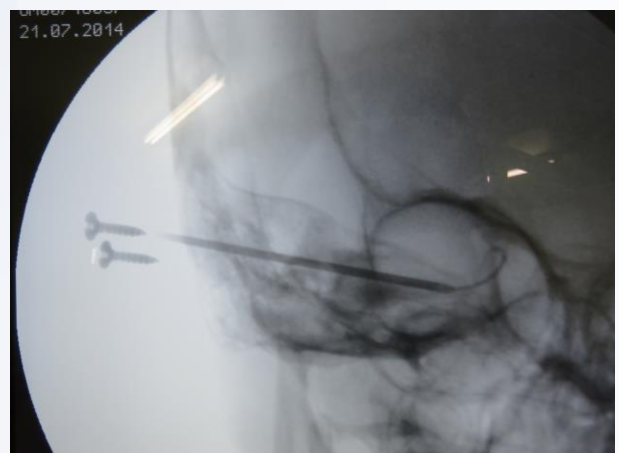


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# MAXILLARY PATIENT

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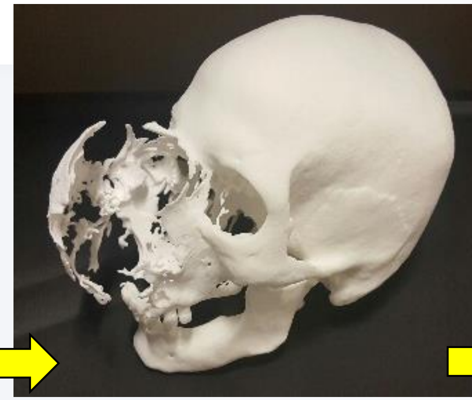

- Female patient with Myxoma of the mid-facial region (Kimberley)
- Customised mid-facial implant design – Materialise software
- Customised LS mid-facial implant in TI64 printed on EOS M280
- Maxillary frame designed to restore facial profile and symmetry
- Placement of obturator and dental bar restored mastication and speech functionality

THE CARL & EMILY FUCHS FOUNDATION

**Acknowledgements**
Dr K Hoek
Dr W Hoek

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# State patients – June 2017

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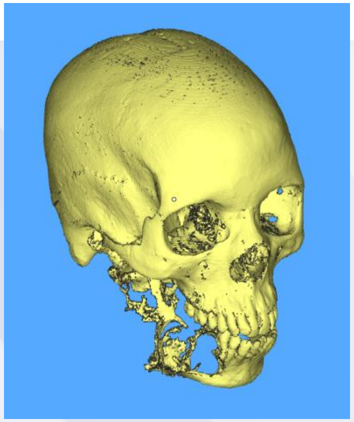
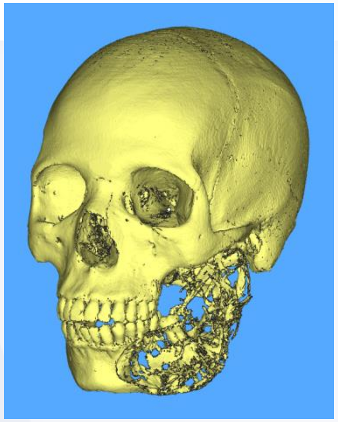
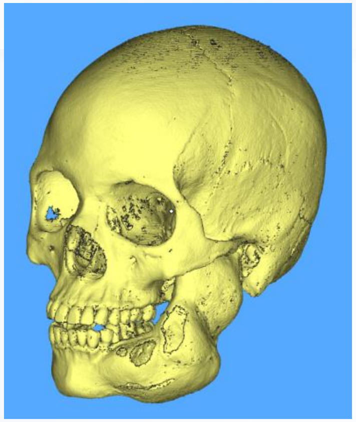
| | PATIENT 3 | PATIENT 4 | PATIENT 5 |
|---|---|---|---|
| 3D VIRTUAL MODEL |  |  |  |
| IMPLANT DESIGN |  |  |  |
| 3D PRINTED TITANIUM IMPLANT |  |  |  |


Acknowledgements

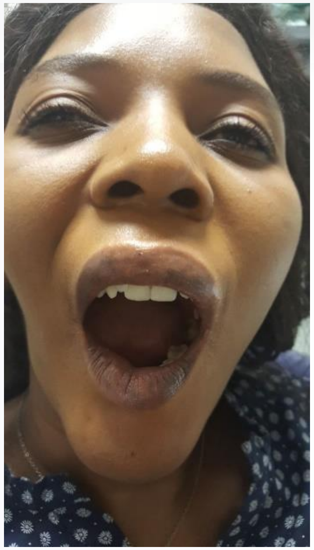
CARTE blanche
YOU HAVE THE RIGHT TO SEE IT ALL

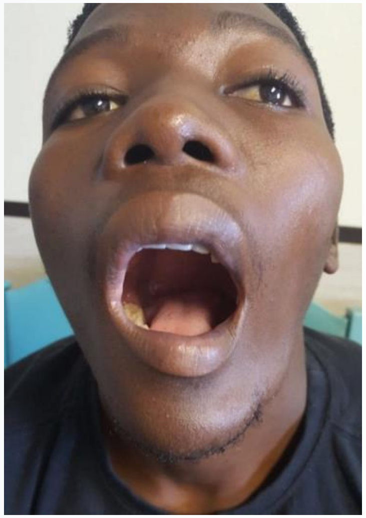
THE CARL & EMILY FUCHS FOUNDATION

Life HEALTH CARE

# FOLLOW-UP: 6 MONTHS





https://www.youtube.com/watch?v=nLKksq2ZSwM

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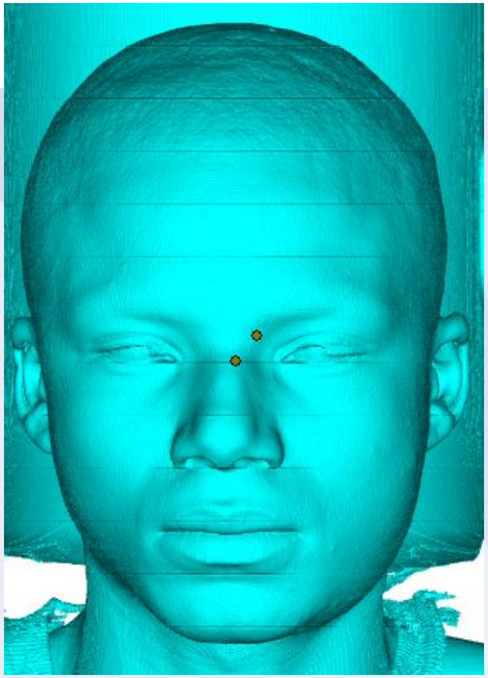

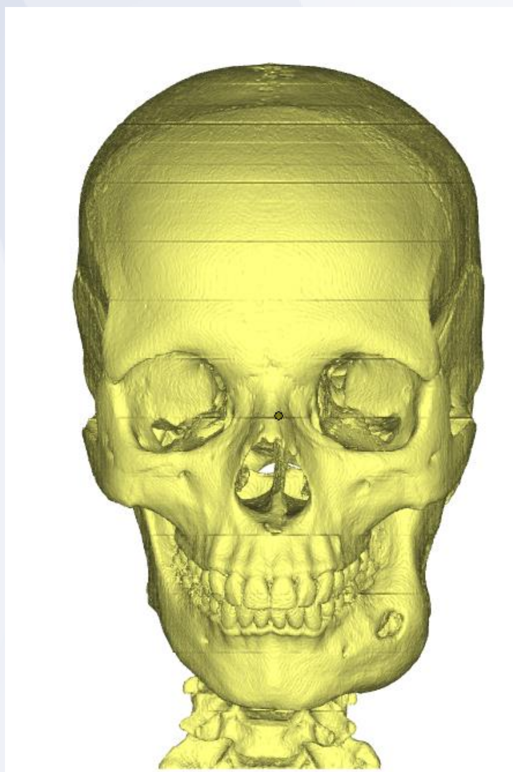

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# Customised Pelvectomy

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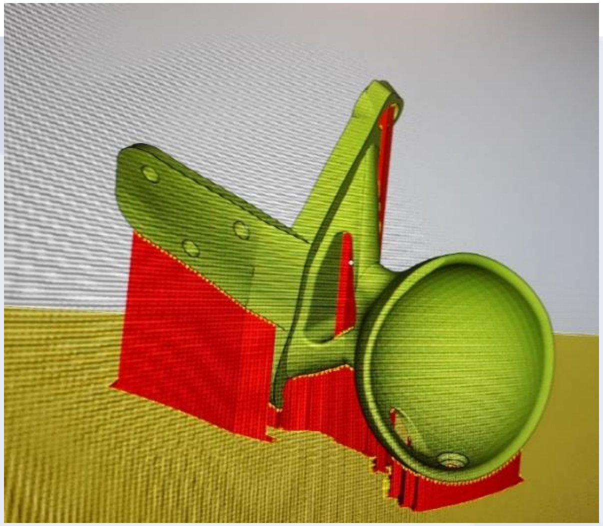

**Acknowledgement**
Prof George Vicatos (UCT)

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad
SPES BONA

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# Customised Ankle Implant

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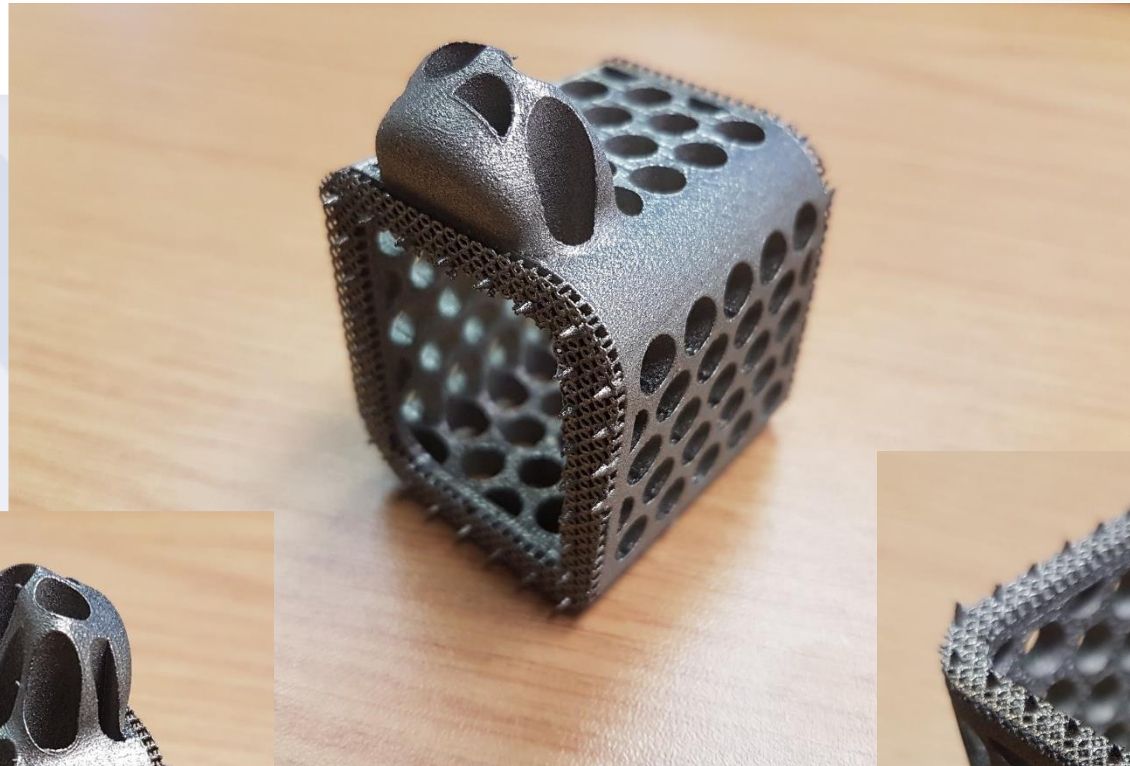

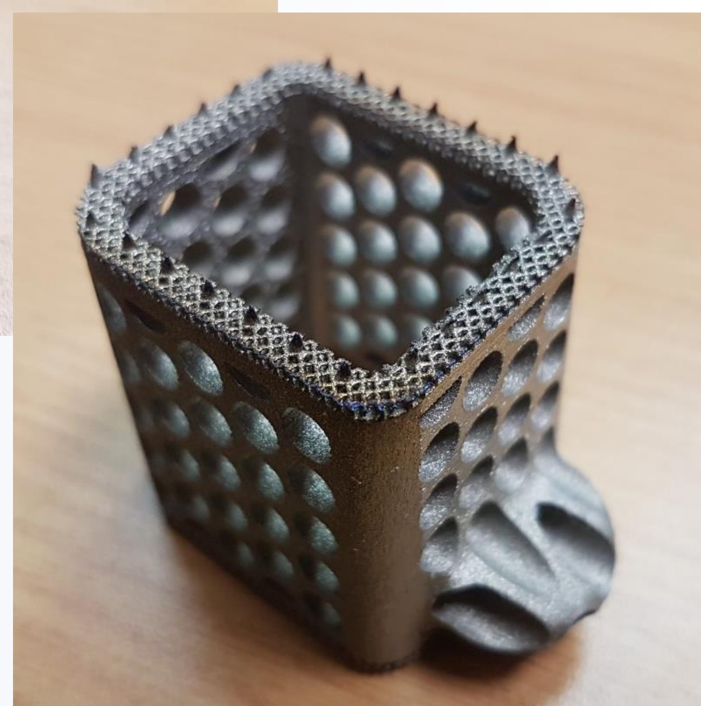

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# FACIAL PROSTHESIS

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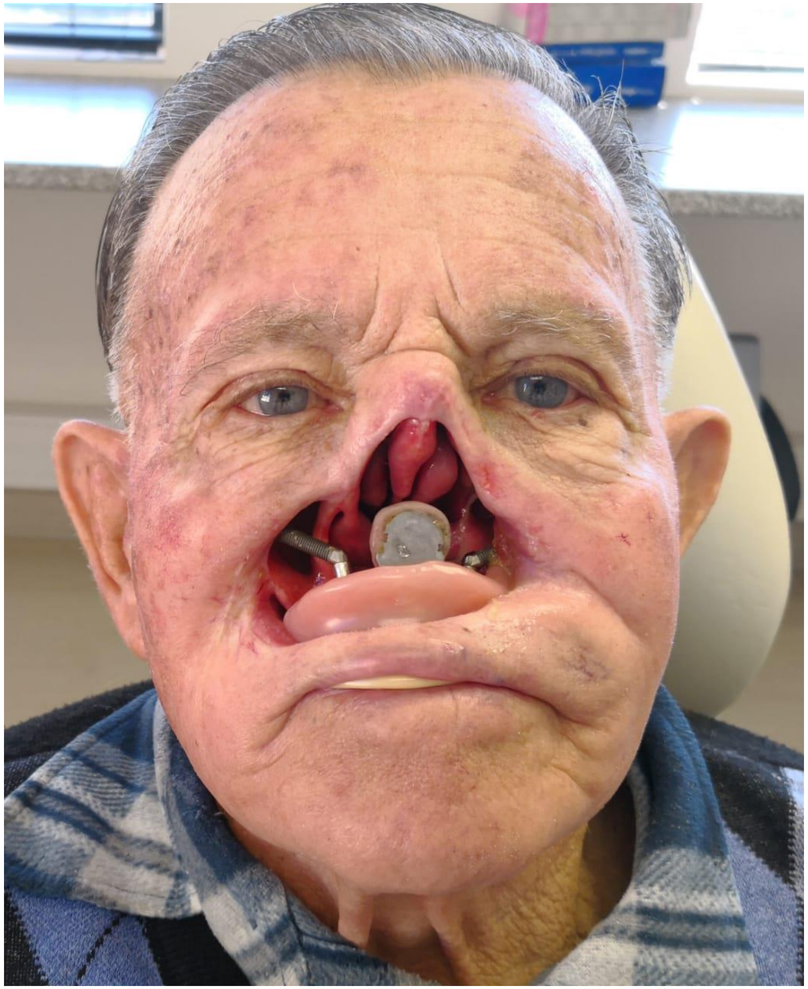

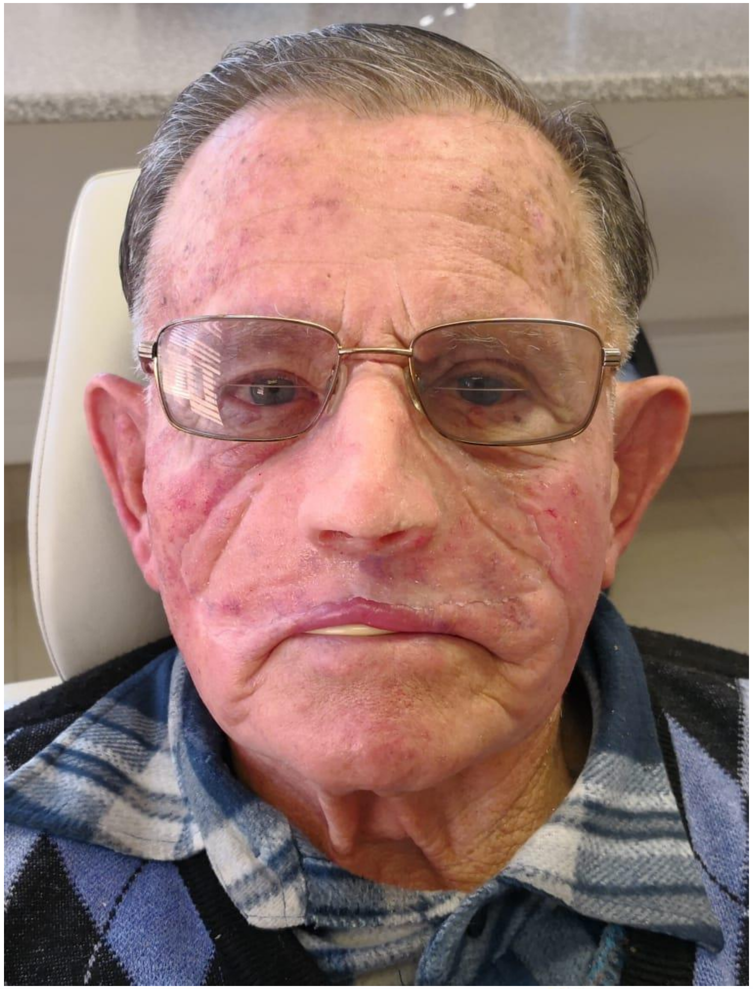

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# AURICULAR PROSTHESIS - 8

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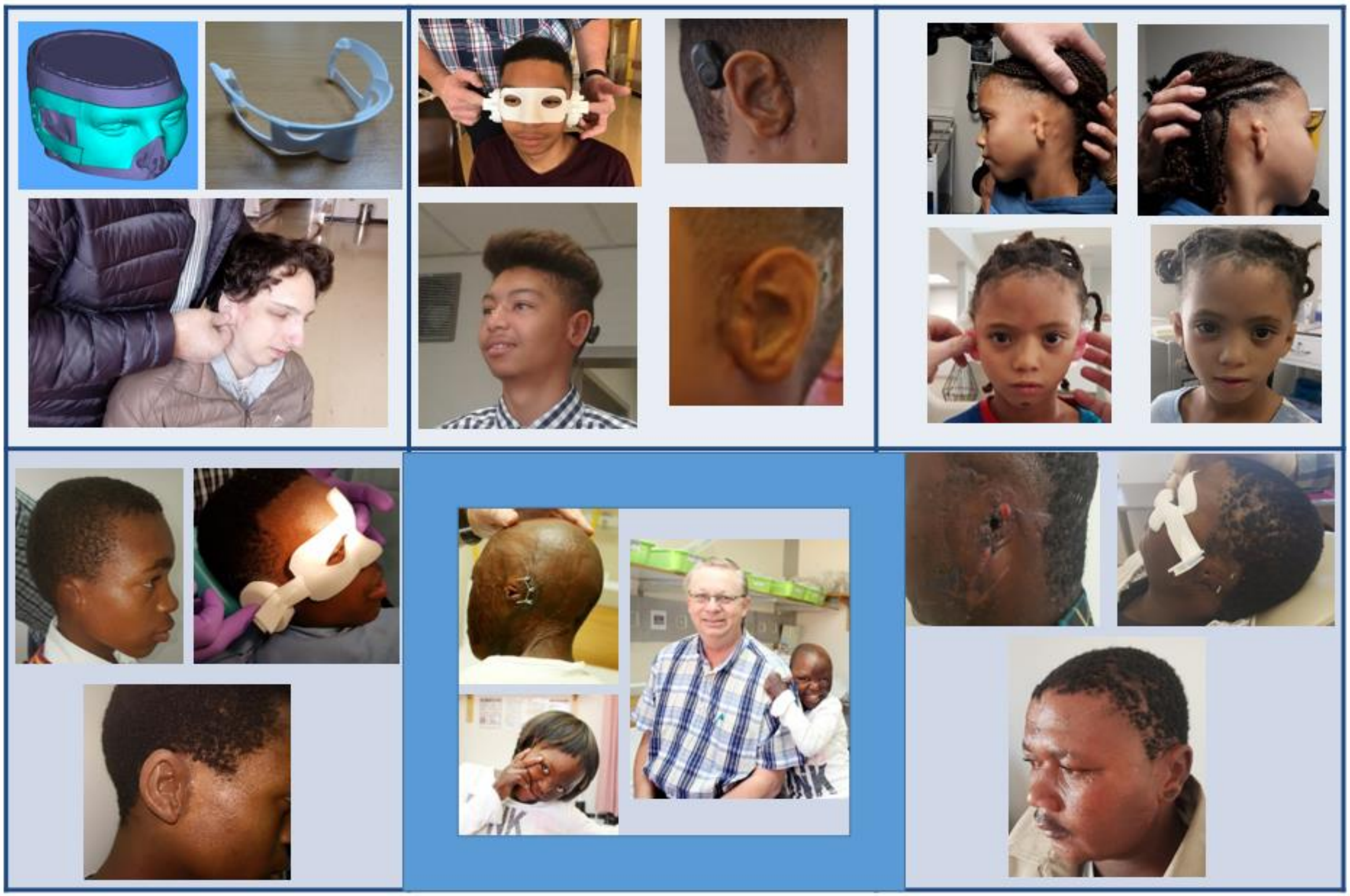

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# IMPACT OF 3D PRINTING

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# NEW INNOVATIONS

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# NEW APPLICATIONS

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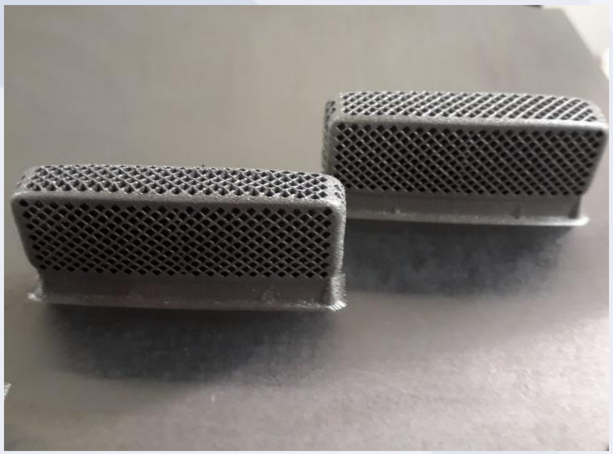

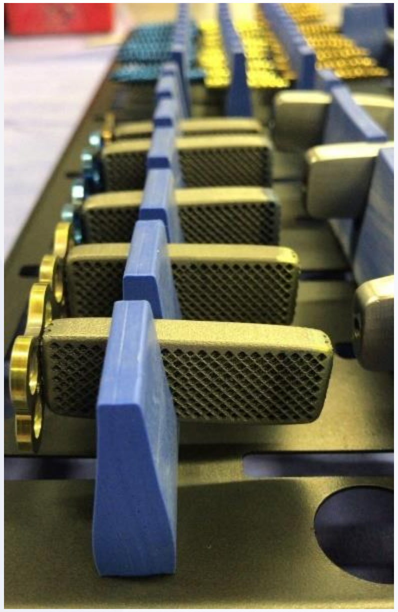

## NEW PARTNER

Saspine

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# NEW APPLICATIONS

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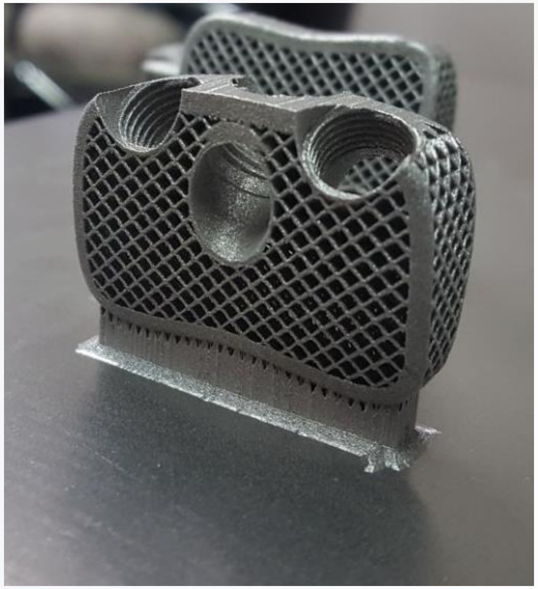

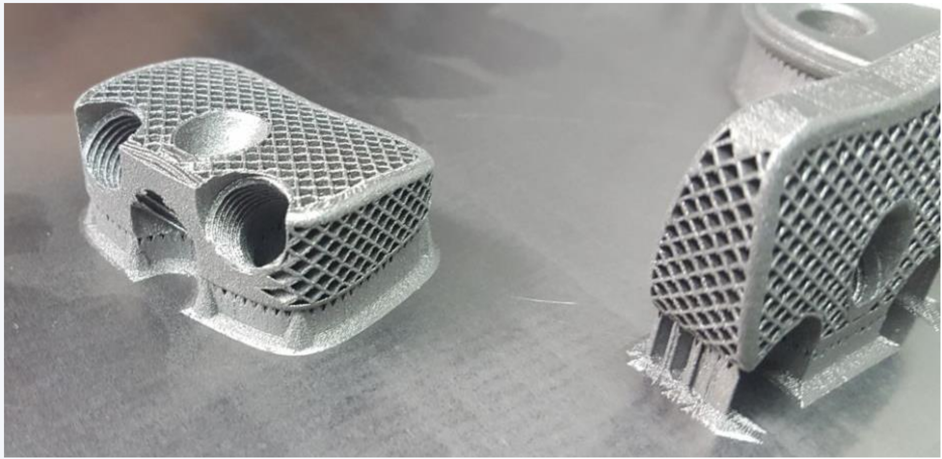

Saspine

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# 3D PRINTED SPINAL CAGES

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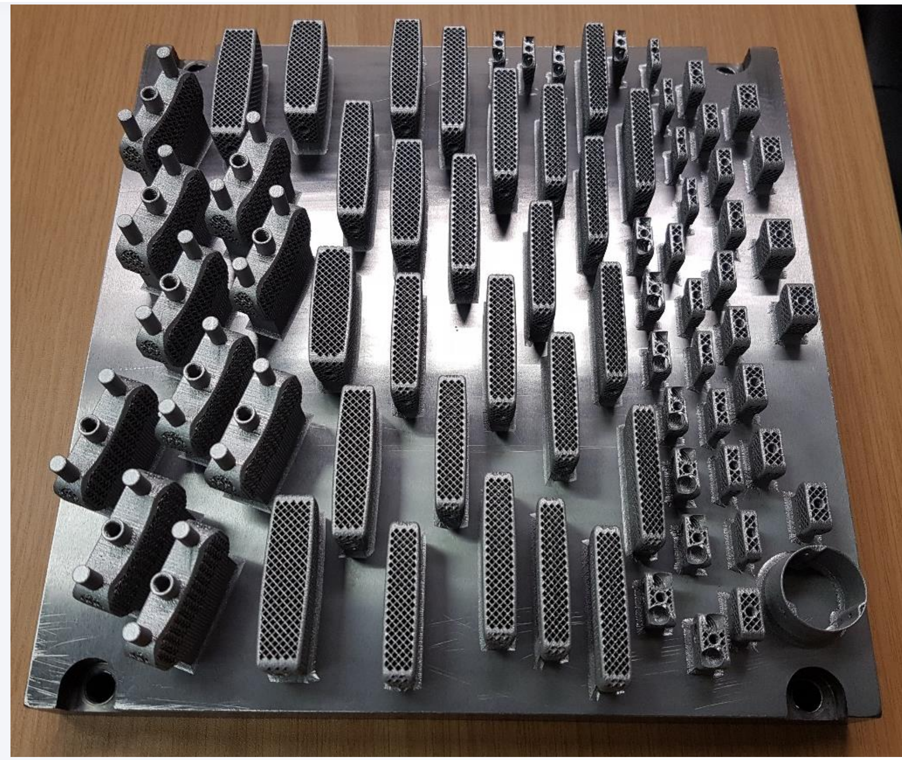

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# NEW APPLICATIONS

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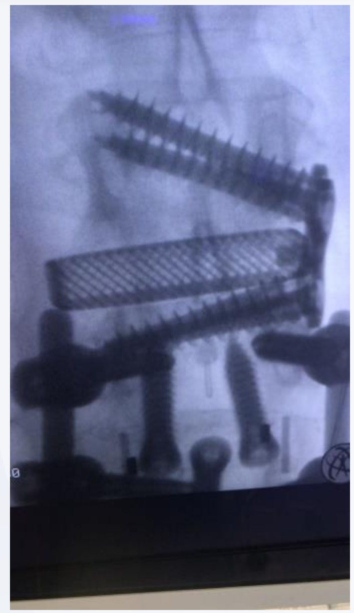

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# PATIENTS ON WAITING LIST

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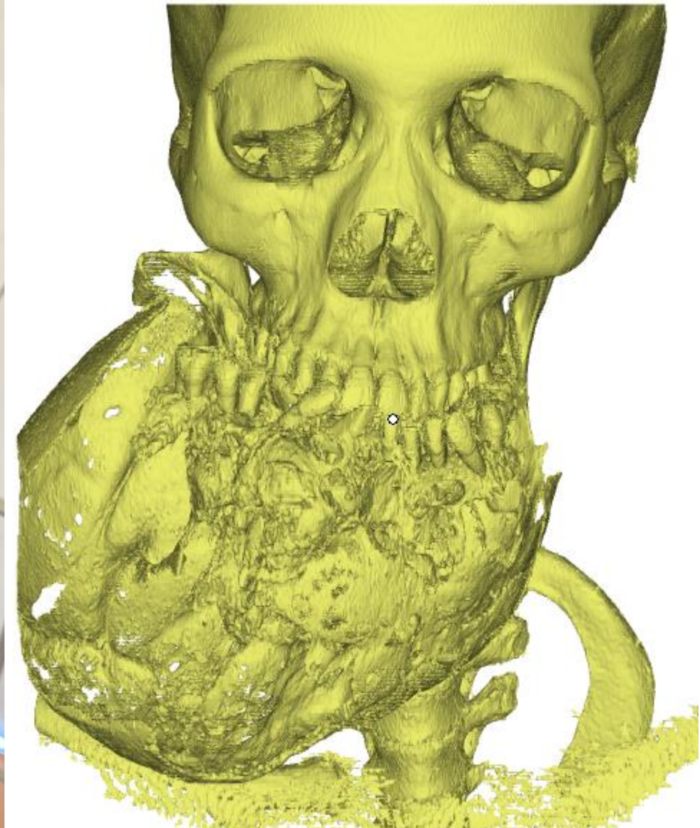

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# Qualification of Additively Manufactured Medical Implants

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# National Collaborative CPAM Resource Network

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UNIVERSITY OF JOHANNESBURG

CSIR
our future through science

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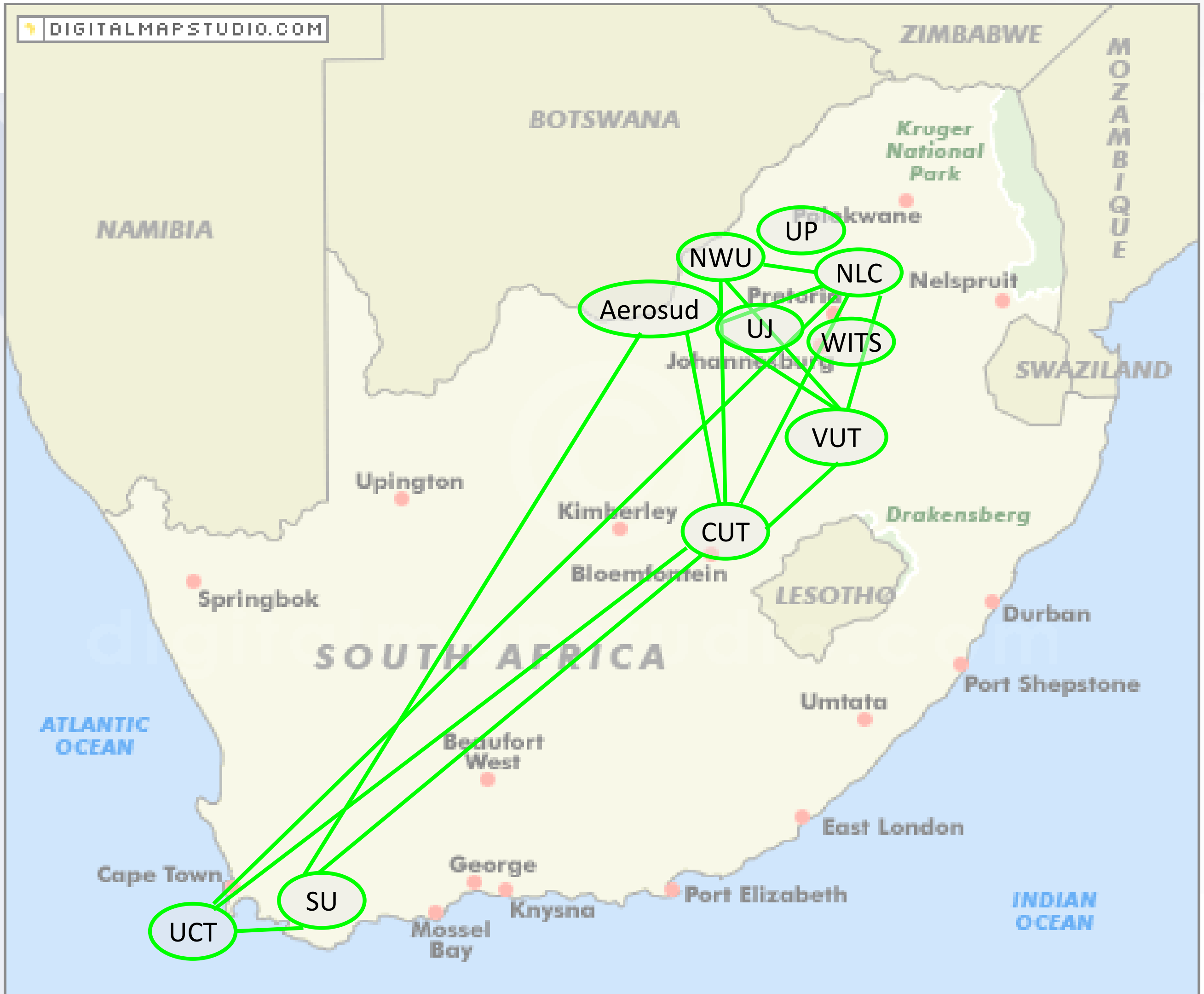
UNIVERSITEIT STELLENBOSCH UNIVERSITY




UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

University of Cape Town • Universiteit van Kaapstad • iYunivesithi yaseKapa

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

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# Qualification Process Chain

## Generating Validation Data

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Additive Manufacturing Process Optimisation

Powder Characterisation & Monitoring

Design Optimisation

Selective Laser Melting
DMLS

Part Characterisation
- Testing Witness Coupons
- Testing Components

Post-process Treatments

Non-destructive Testing

AM Health and Safety Procedures

Qualification of Medical Implants

**ISO 13485**

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# CRPM Strategic Focus within CPAM

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## Impact in the Economy of the Free State and South Africa

### Industrialisation & Commercialisation

CUT Innovation &Technology Transfer

### Technology Development

Advanced Tooling

Medical Implants & Devices

Aerospace Structures

Direct End-use (SMME focus)

Process and Product Development

Design, Simulation and Modelling

Materials Characterisation

Laboratories and Facilities

Human Capacity Development

**Supporting R&D Capabilities**

*Courtesy of Prof Willie du Preez*

# ISO 13485 CERTIFICATION

- The centre received ISO 13485 certification for 3D printing of medical devices in 2016
- This is a quality management system which is only granted after a rigorous audit of all processes. This means that the products produced at the centre conform to the International Standards and accreditation
- This will open the doors for commercial manufacturing of medical devices here in South Africa and also offer global export opportunities

# Scope of Certificate

- Design, development and production of patient specific custom made titanium implants by means of 3D Printing/Additive Manufacturing
- Design, development and production of patient specific custom made preoperative models, jigs, cutting guides in nylon by means of 3D Printing/Additive Manufacturing
- Contract production of titanium implants by means of 3D Printing/Additive Manufacturing
- Contract production of preoperative models, jigs, cutting guides in nylon by means of 3D Printing/Additive Manufacturing

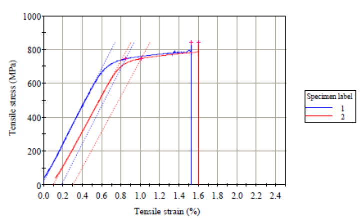
Central University of Technology, Free State

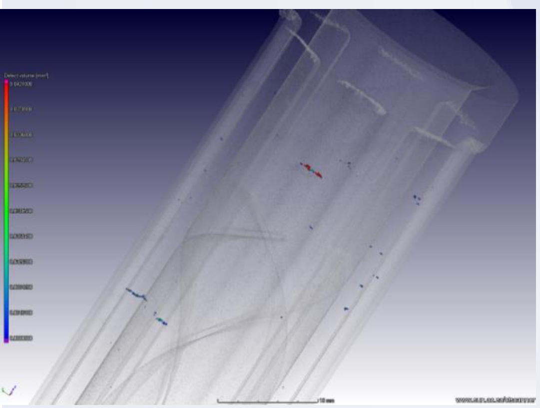
sanas Testing Laboratory T0381

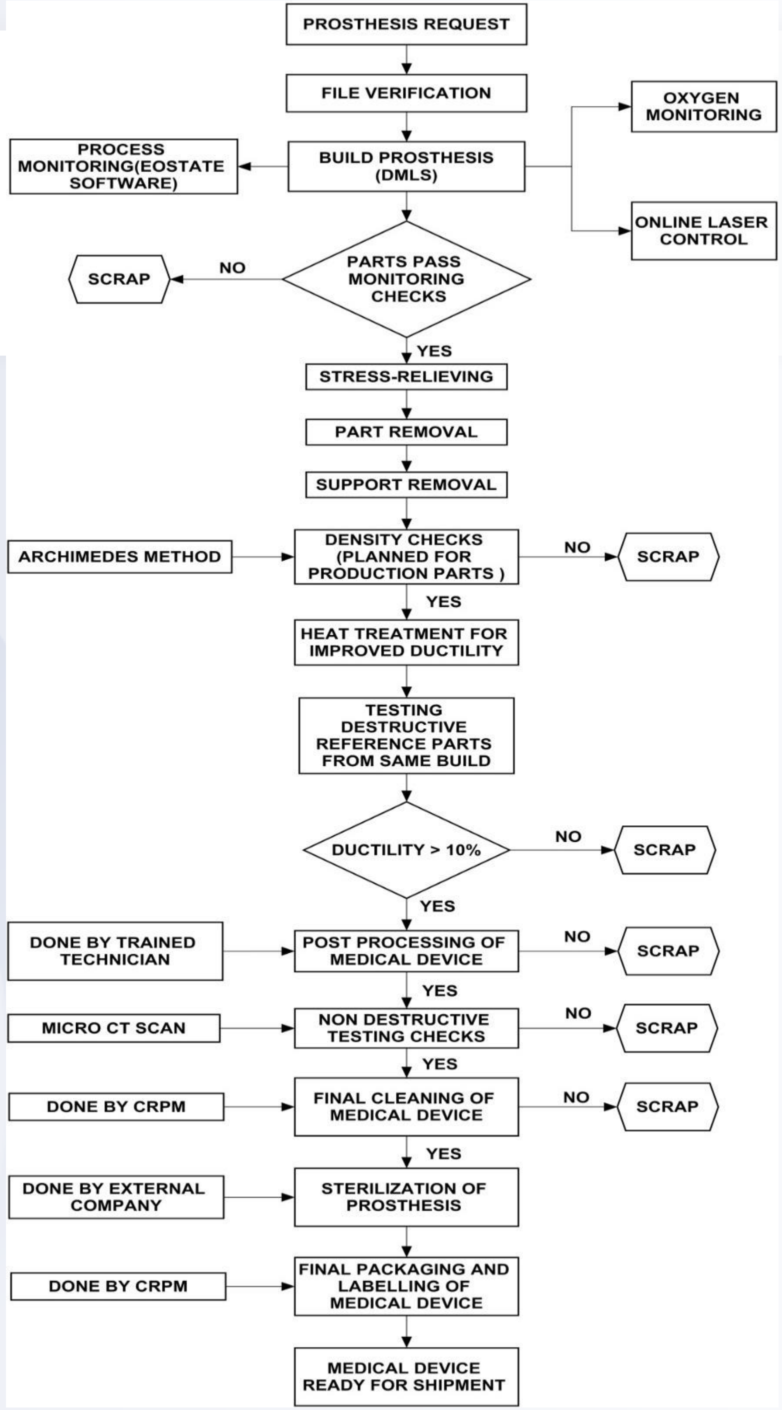
| | |
|---|---|
| Laboratory Name | CSIR Materials Testing Laboratory |
| Company | J.Els CUT |
| Operator ID | 203406 |
| Method description | LM WP 401 ASTM E8 M |
| Sample description | Titanium QH03 |
| Test Date | 01/09/2015 |

| | Specimen label | Area (mm^2) | Tensile stress at Yield (Offset 0.2 %) (MPa) | Modulus (Chord 200 MPa - 500 MPa) (GPa) | UTS (MPa) | Elongation (%) 5.D |
|---|---|---|---|---|---|---|
| 1 | 1 | 15.54 | 747.42 | 111.7 | 843.17 | 10.48 |
| 2 | 2 | 15.50 | 746.79 | 105.7 | 845.92 | 10.72 |
| Mean | | 15.52 | 747.10 | 108.7 | 844.55 | 10.60 |
| Coefficient of Variation | | 0.169 | 0.060 | 3.902 | 0.230 | 1.601 |
| Standard Deviation | | 0.026 | 0.449 | 4.240 | 1.944 | 0.170 |
| Range | | 0.04 | 0.63 | 6.0 | 2.75 | 0.24 |
| Minimum | | 15.50 | 746.79 | 105.7 | 843.17 | 10.48 |
| Maximum | | 15.54 | 747.42 | 111.7 | 845.92 | 10.72 |
| Median | | 15.52 | 747.10 | 108.7 | 844.55 | 10.60 |

Graph 1



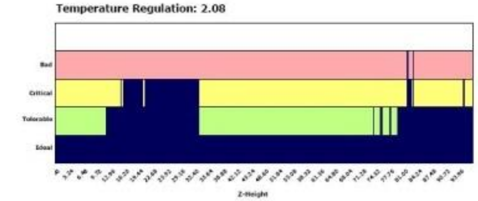



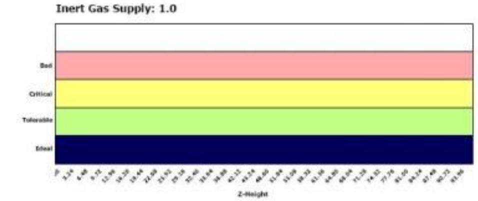



CRPM

CENTRE FOR RAPID PROTOTYPING AND MANUFACTURING

## Job Quality Report




CERTIFICATE OF IRRADIATION No H 57194 **REPRINT**

HIGH ENERGY PROCESSING CAPE (PTY) LTD

HEPRO

Established 1986

Radiation processing: Medical devices, foodstuffs, packaging, etc

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7442 CHEMPET
Tel (021) 555-8880
Fax (021) 551-1766
e-mail info@hepro.co.za

6 Ferrule Avenue
Montague Gardens
Cape Town South Africa
Reg No 1985/004695/07

*We certify that the product itemised below has been irradiated at Hepro Cape gamma irradiation facility, 6 Ferrule Avenue, Montague Gardens, in accordance with conditions specified in a clearance granted for this product by the Department of Health and Welfare.*

Company: Central University of Technology, Free State

Date: 14 January 2016 Despatch Voucher: 61897

| Ref | GRV | Batch | Quantity | Mass | Description | Dose kGy min |
|---|---|---|---|---|---|---|
| | 75710 | 97591 | 1 | 0.5 | Medical Implants: 30x21x9cm: 0.33kg | 25 |

Central University of Technology, Free State

science & innovation

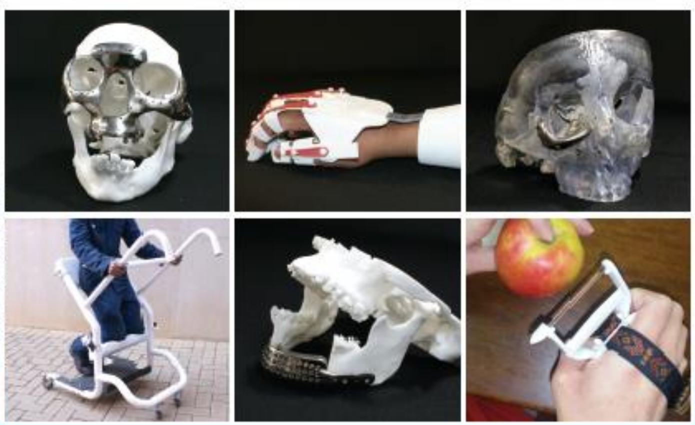
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

## THE NEWLY ESTABLISHED DSI & CUT FUNDED:

# MedAdd

## MEDICAL DEVICE ADDITIVE MANUFACTURING (MEDADD) TECHNOLOGY DEMONSTRATOR

**Bridging the Innovation Chasm in the Medical Device Industry through Additive Manufacturing**



MEDICAL DEVICE ADDITIVE MANUFACTURING TECHNOLOGY DEMONSTRATOR

# MedAdd

Central University of Technology is the leading South African university in the application of AM for the design and production of customised medical implants. For South Africa to compete internationally, the local medical device industry needs to be supplemented with the latest technology, infrastructure, expertise and skills. This can be aided by a technology demonstrator for additive manufacturing of medical devices.

**It is envisaged that MedAdd will:**

- enhance the current equipment and capabilities at CUT
- enable CUT, academic partners and local companies to demonstrate reproducibility and scale-up of innovative medical device products.
- be available for small companies to industrialise new products, de-risking their innovative development before fully-fledged commercialisation.
- enable students, researchers and industry personnel to develop the required skills for the development of this new technology and new industry.

**Success will be achieved through a comprehensive approach, using a combination of conventional and AM techniques. Initial Key Performance metrics are:**

- research, development and manufacturing of medical devices;
- training of users; and
- stakeholder engagement.

**Established Key Performance metrics are to:**

- assist companies; and
- to create new joint-venture companies.

**Engagement with other initiatives, such as the Cape Health Technology Park, South African Medical Technology Industry Association, Medical Device Manufacturers of South Africa and the National Medical Devices and Diagnostic Technology Innovation Cluster, will ensure that MedAdd can have a national impact.**

www.cut.ac.za

**Table 6: Estimated number of implants/devices to be manufactured over the next 5 years**

| Applications | Number of products/units | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Current | 2019 | | 2020 | | 2021 | | 2022 | | 2023 | | Total | |
| | | Product/Projects | Units | Product/Projects | Units | Product/Projects | Units | Product/Projects | Units | Product/Projects | Units | Product/Projects | Units |
| **Maxillofacial** | 20 | 20 | 50 | 25 | 60 | 30 | 75 | 40 | 90 | 50 | 110 | 165 | 385 |
| **Orthopaedics** | 7 | 100 | 500 | 200 | 1000 | 250 | 1250 | 300 | 1500 | 350 | 1750 | 1200 | 6000 |
| **Dental** | 0 | 10 | 20 | 25 | 50 | 50 | 100 | 75 | 150 | 100 | 200 | 260 | 520 |
| **Other (assistive devices etc.)** | 25 | 50 | 100 | 60 | 200 | 72 | 300 | 87 | 400 | 103 | 500 | 372 | 1500 |
| **Total** | 52 | 180 | 670 | 310 | 1310 | 402 | 1725 | 502 | 2140 | 603 | 2560 | 1997 | 8405 |

| Definition | Product/Project: Each instance mentioned below counts as one |
|---|---|
| Product | Development of a product |
| Product | Redesign of existing product after extensive testing (new version) |
| Project | Patient-specific case for example ***maxillofacial and dental applications*** (1 project, but consists of multiple units) |
| Product | Product that is being reproduced for commercial sales |
| Product | Contract to manufacture specific components or provide a high level service for a medical device product (tube processing for external manufacturer, CNC milling of implants or devices, 3D scanning of patients or implants, ect.) |

Table 8 shows the expected numbers of users trained for the first five years after the establishment of MedAdd. In order to estimate these numbers, the following assumptions have been made:

- Training will cover aspects such as design for AM, application (part orientation, support generation), machine operation and post processing;
- Training will be in the form of short courses, workshops and experiential learning.

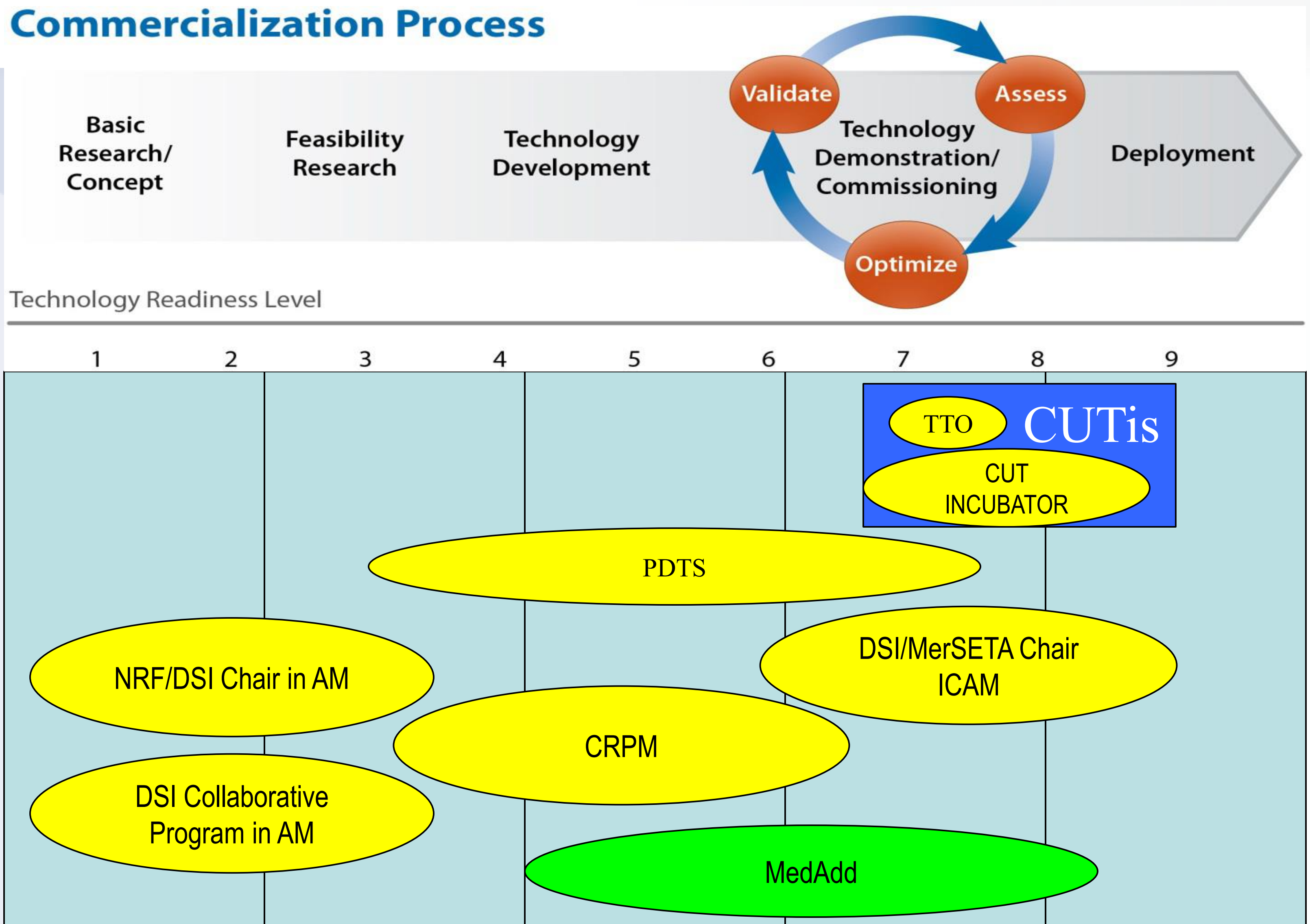
In addition, it should be noted that additive manufacturing forms part of newly developed Honours degree in Advanced Manufacturing in Mechanical Engineering. These students are not included in the numbers below.

**Table 8**: Estimate of users trained

| User | 2019 | 2020 | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|---|---|
| **Students (CUT)** | 20 | 30 | 40 | 45 | 50 | **185** |
| **Student and interns (other)** | 10 | 15 | 20 | 20 | 20 | **85** |
| **Researchers** | 20 | 25 | 25 | 25 | 25 | **120** |
| **Industry – engineers and clinicians** | 10 | 20 | 35 | 50 | 50 | **165** |
| **Total** | **60** | **90** | **120** | **140** | **145** | **555** |

The numbers of users trained is a key measure of impact for the facility. This facility will be unique in South Africa and in order to build a thriving medical device industry, students, entrepreneurs and existing industry need to understand how the equipment and the expertise at MedAdd can assist them in developing or growing their business.

# CUT AM INNOVATION CHAIN



# HOW ARE WE SUPPORTING INDUSTRY WITH PRODUCT DEVELOPMENT?

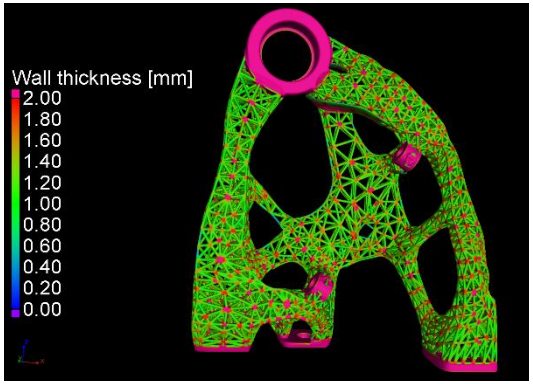
# PROTOTYPING APPLICATIONS

The DBX 3.0 All-Mountain bicycle helmet is designed to carry you safely across any terrain.

**Leatt DBX 3.0 All Mountain Helmet**

Tooling cost for three different sizes = $350 000
3D printed cost = R25 to 35k

# TOPOLOGY OPTIMIZATION AND LATTICE DESIGNS


*Courtesy: Prof Anton du Plessis*
*Stellenbosch University*

CT FACILITY
STELLENBOSCH

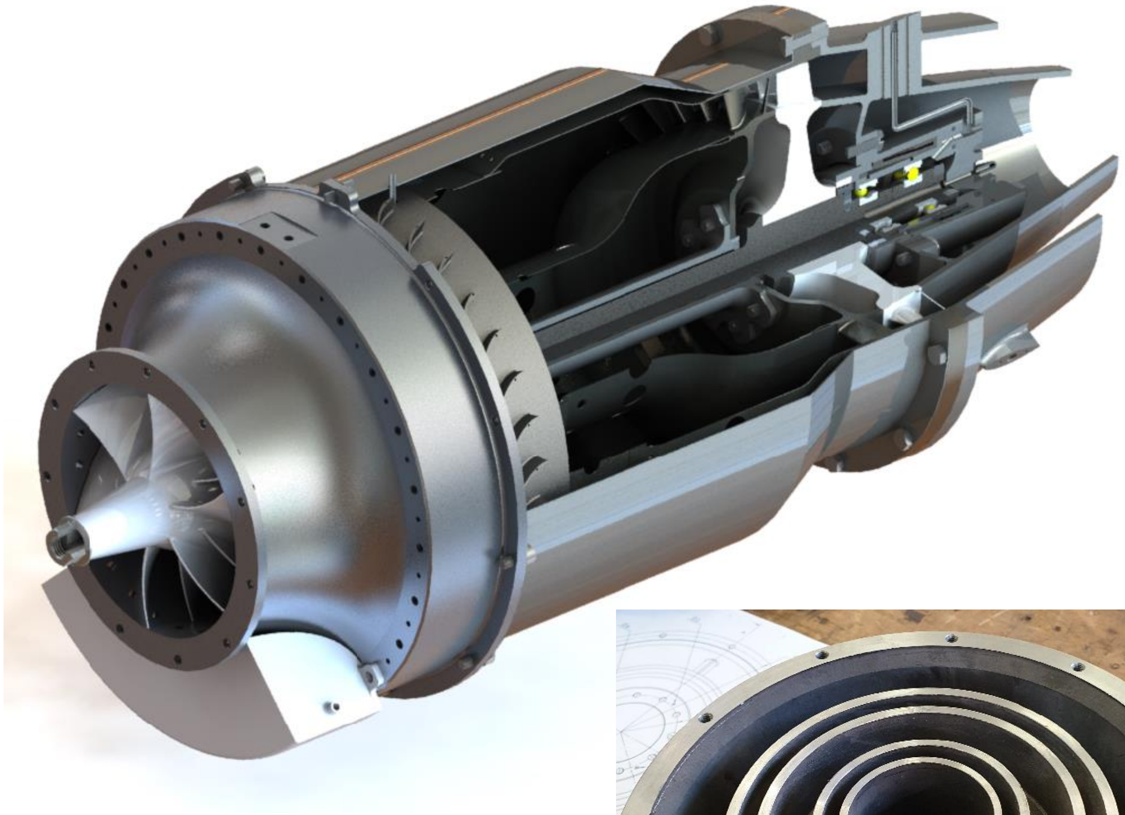
UNIVERSITEIT
iYUNIVESITHI
STELLENBOSCH
UNIVERSITY

Altair

NELSON MANDELA
UNIVERSITY

CRPM
CENTRE FOR RAPID PROTOTYPING AND MANUFACTURING

# GAS TURBINE WITH 3D PRINTED EXHAUST NOZZLE



Courtesy: Glen Snedden CSIR

CSIR
our future through science

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AIRBORNE DRONES

# 3D PRINTED DRONES


PDTS is hosted by Central University of Technology, Free State

Central University of Technology, Free State

# PDTS MEDICAL

MEDICAL DEVICE PRODUCT DEVELOPMENT

technology innovation AGENCY

PDTS

Product Development Technology Station

# Rural Mobility

**Description:**

African countries such as South Africa face a large problem concerning mobility of persons with disability in rural communities. To supply the large need of people in rural areas, the government and organizations import cheap basic folding wheelchairs. Theses wheelchairs seldom come with or have available spare parts. This is concerning as these wheelchairs are not intended for the environmental challenges faced by South African disabled persons. This rural mobility project as seen in the figures, aimed to build a sustainable reliable solution to improve mobility of persons with disability in rural areas. A wheelchair incorporates a clip on hand cycle or free wheel to help with mobility and reliability of wheelchairs in rural areas and long distance traveling. A person with disability will have a reliable wheelchair to move around indoors but has a clip on hand cycle or free wheel to improve mobility on rough rural roads and over long distances.

**Client:**

Schalk van der Merwe – Manufacture of wheelchairs and hand cycles

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# Rural Mobility

Hand cycle

Wheelchair

Free wheel

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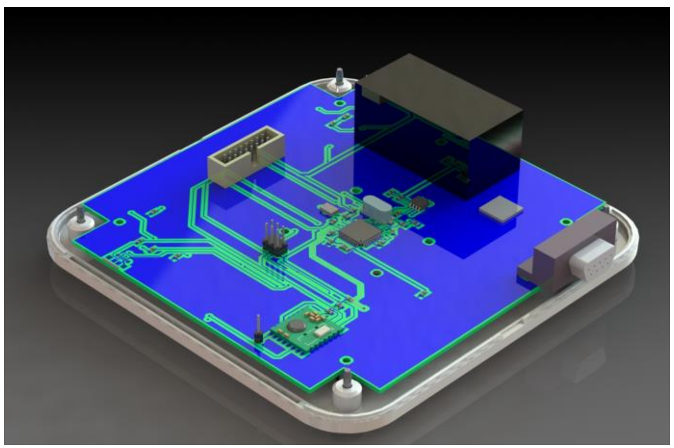
# Qbell Bed Management System

## Description:

South Africa's health care system is under enormous pressure concerning hospital bed communication and management, this problem is further highlighted in the public health care system. Qsystems in collaboration with PDTS have produced a product that is more cost effective than international competitors, while improving functionality in African environments. The first development of the Qbell was funded by Qsystems, funding received from SAB. The Qbell is a TPU soft button that can be triggered by multiple body movements (not limited to finger pressing, this is ideal for patients without hand function). The communication and reporting systems is developed by the PDTS electronic department, funded by the PDTS medical device unit through TIA funding. A wireless radio communication system was developed, this allows for a flexible bed management system and reporting system with cheap and easy installation. An RFID tag system allows for reporting of nurse productivity and response times.

## Client:

Hienrich Williams – Entrepreneur (Qsystems)

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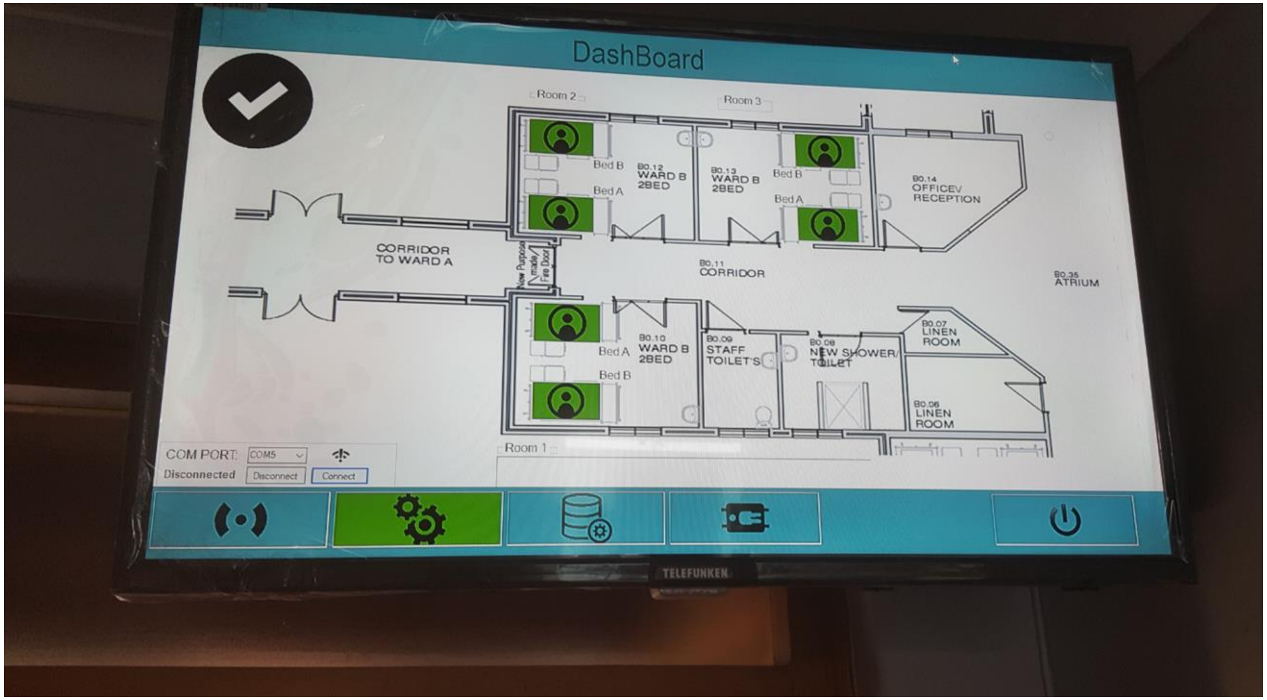
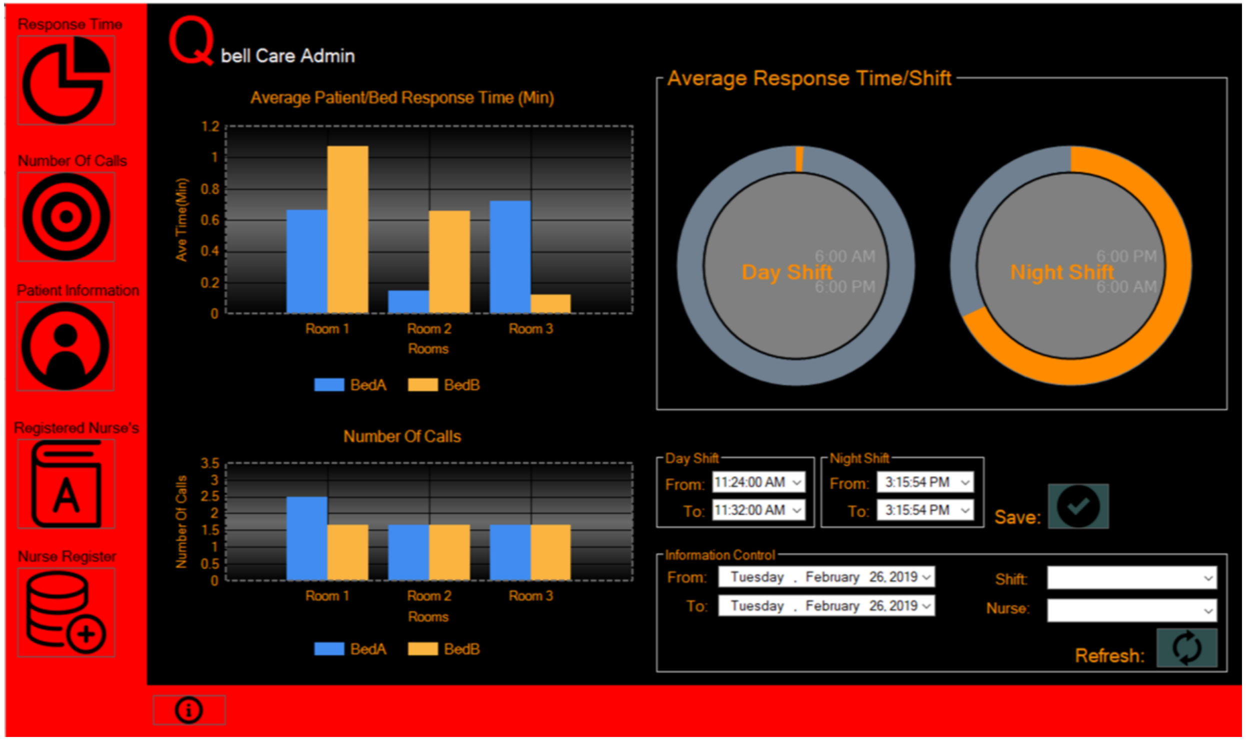
# Qbell Bed Management System




Hardware

# Qbell Bed Management System




Software and Reporting

# Non-Assisted Patient Transfer

**Description:**

Transferring from a sitting position to standing is essential for rehabilitation and daily task, often performed multiple times a day. Common transfers, including transfers from bed to chair/wheelchair, toilet or washbasin. Performed incorrectly or with out equipment, transferring can put both patient and caregiver at risk of injury. The patient transfer device ensures that sit-to-stand transfers can be carried out safely, quickly and with ease. Reducing the load on both therapists and care givers. The PDTS patient transfer device allows patients of all sizes to be safely transferred. The seat paddles are able to adjust forward and backwards to accommodate a variety of people. The paddles easily swing away to help with a quick and safe transfer. Medical grade caster wheels also ensure smooth movement in a home and hospital environment. The width of the device is specifically designed to accommodate standard wheelchair sizes in transfer, while a non-slip standing surface further improves the transfer.

**Client:**

Nurture Health Hillandale Physical Rehabilitation Hospital

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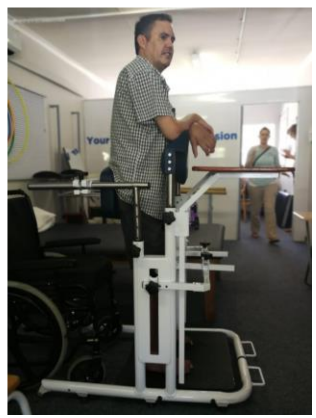
# Adult Standing Frame



## Description:

Standing frames are used by persons who rely on a wheelchair for mobility. A standing frame provides alternative positioning to sitting, by supporting the person in the standing position. Standing promotes healthy bone maintenance, leg muscle stretching, spasticity reduction, improved internal organ functions, improved posture, and overall range of motion improvement. These benefits are not just physical, but also psychological. The PDTS standing frame comes with a host of adjustable features that accommodate a wide range of body types. Localised manufacturing dramatically improves the retail price.

## Client:

GreyMil Physical Rehabilitation Hospital

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# Multi Functional Walking Frame

**Description:**
A major problem faces by retirement homes and care centres is older patients falling at night on their way to the toilet. Conventionally a commode is used to solve this problem. Currently patients cannot buy a walking frame and commode on medical aids together. Commodes are usually priced at R1300 – R3200. The proposed device, clip on commode, is an add on to a standard walking frame. The device will retail for R350 –R450 and is seen as a walking frame accessory.

**Client:**
Nurture Hillandale Physical Rehabilitation Hospital

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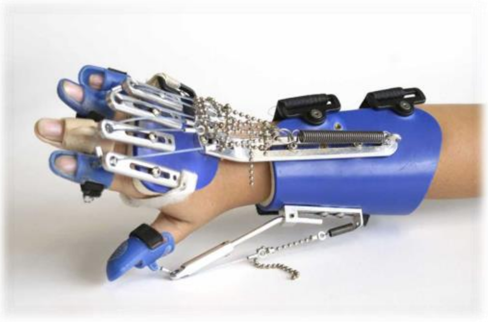
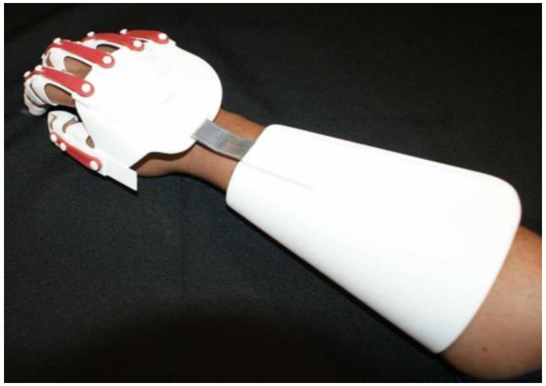
# Patient Specific Dynamic Hand Splint





## Description:

This project aims to develop a patient specific dynamic hand splint that will enable persons with tendon injuries or spasticity of the hand caused by a stroke to achieve appropriate hand rehabilitation. One of the major drivers of this project is to produce dynamic hand splints through the use of additive manufacturing (AM), specifically selective laser sintering (SLS). AM allows for a dimension driven CAD file to be manufactured that exhibits biomechanical function and appropriate fit. Insuring cost effective local production of complex hand splints that will be custom fitted to the client's specific needs.

## Client:

Frans Klienhans Orthotics & Prosthetics

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Central University of Technology, Free State

# ACKNOWLEDGEMENTS

- CUT and CRPM staff
- Surgeons
- Pelonomi Hospital colleagues
- National Science and Technology Forum
- CUT Innovation Services (CUTis)
- EOS
- Materialise
- Department of Science and Innovation (MedAdd project)
- Department of Science and Innovation (CPAM project)
- Department of Science and Innovation (CICAM project)
- Wohlers Associates
- National Research Foundation (SARChi Chair)
- Technology Innovation Agency (TIA)
- The Carl & Emily Fuchs Foundation
- PDTS
- MerSETA
- CSIR

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Department:
Science and Innovation
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National Science and Technology Forum

The Carl & Emily Fuchs Foundation

CUTis
Central University of Technology Free State Innovation Services

merSETA
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