SPS Pilot

Pilot Case 3: Prothesis Adapter

CIRCULATION
all

VERSION

DATE
27-05-2021

AUTHORS
SPS

LEAD PARTNERS
Jotne, CloudBroker, Additive Industries, TNO

CONTRIBUTING PARTNERS
SPS, Jotne, CloudBroker, Additive Industries, TNO

QUALITY CONTROLLER
SPS

HORIZON 2020

Agenda

- SPS Pilot Outline
- Digitalization : Assessment
- SPS Product Development Cycle
- Main Challenges and Solution Providers
- Pilot Schedule
- Pilot Execution Steps
- Enabling Technologies Used
- Current Status

Pilot : Prosthesis Adapter Design

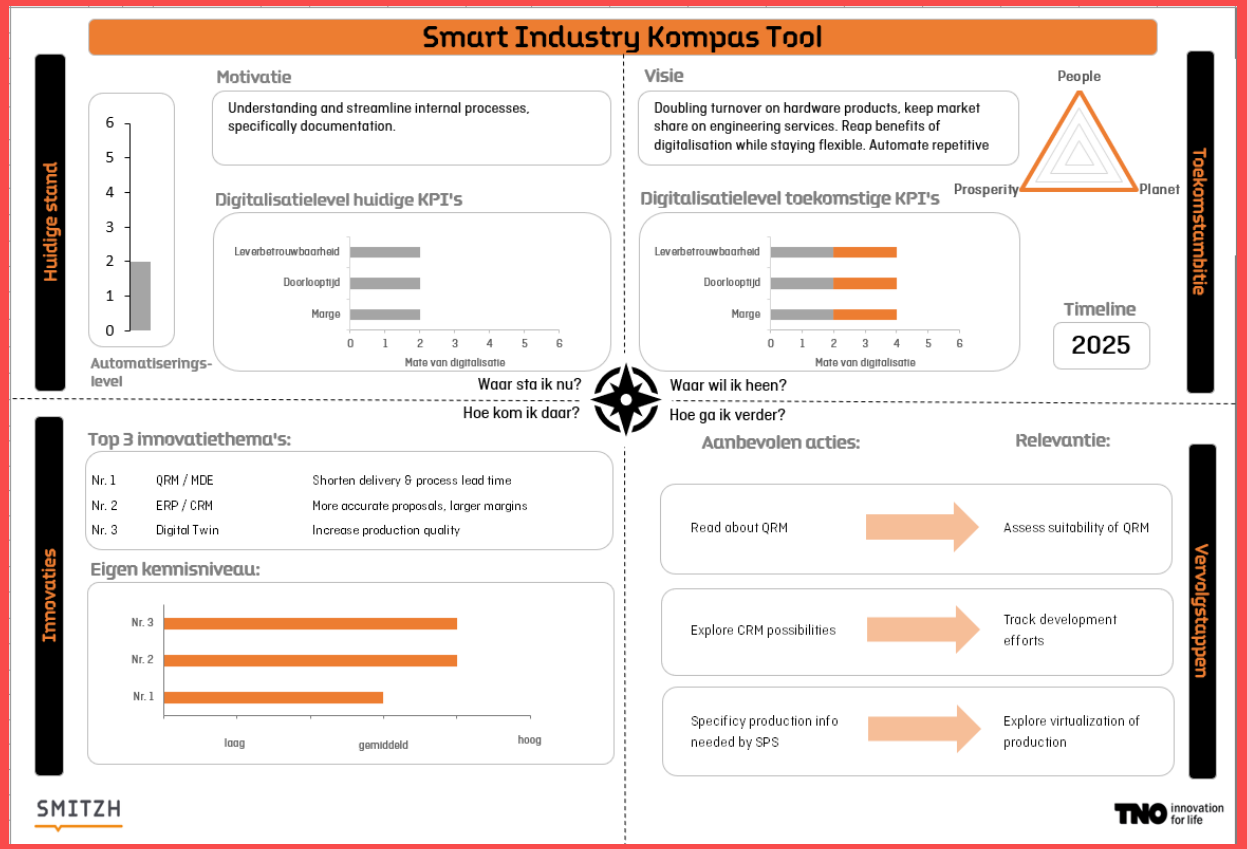
Main aim:

- Lighter adapter
- Improved design and analysis loop
- Production through additive manufacturing
- Proper tracking of changes in requirements and design during development

SPS Assessment: Results

The main technologies identified to be implemented are:

- QRM / MDE
- ERP / CRM
- Digital Twin



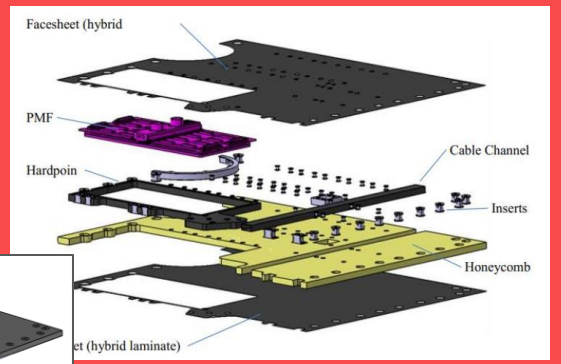
Asset Selection

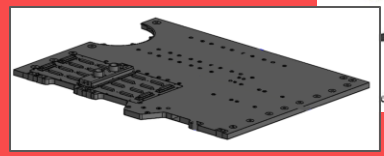
Main Digital Twin Application Product:

Prothesis Adapter

Enhancing the digital twin to map the vibration / thermal test data => Improve Digital Twin:

Sandwich Panel





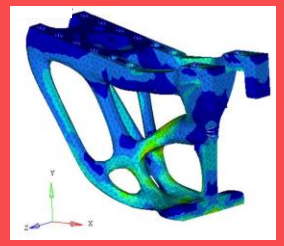
HORIZON 2020

SPACE STRUCTURES

Prothesis Adapter: Product Development

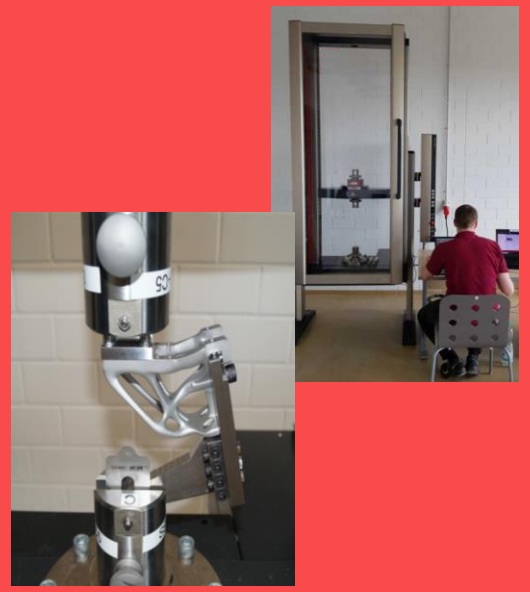
Requirements → Design and Analysis → Production → Testing and Release

Initial SPS Design



Digital / Virtual Twin

Product



Digital Twin: Challenges

Requirements → Design → Analysis → Production → Testing and Release

Main Challenges to be considered:

- Computing Time
- Data Interoperability of 3D models with Complex Geometries
- Rework time : Consideration of Product Manufacturing Information during Design Phase
- Reliability : Enrichment of the Digital Twin with Test Data
- Faster Data Exchange, Common Data Exchange formats
- Improve Reaction Time to Requirements Change
- Data Storage and Archiving
- Product Development : First Time Right

CHANGE2TWIN

Solution Providers and Pilot Application

Solution Providers

Jotne

- Data Exchange
- Data Storage and Archiving
- Multidisciplinary data management

CloudBroker

- Computing Performance on Demand

TNO innovation for life

- Enrichment of the Digital Twin with Test Data: Photogrammetry

Solutions Providers

- Product Manufacturing Information, Design checking for manufacturing

- Production: 3D Metal printing

HORIZON 2020

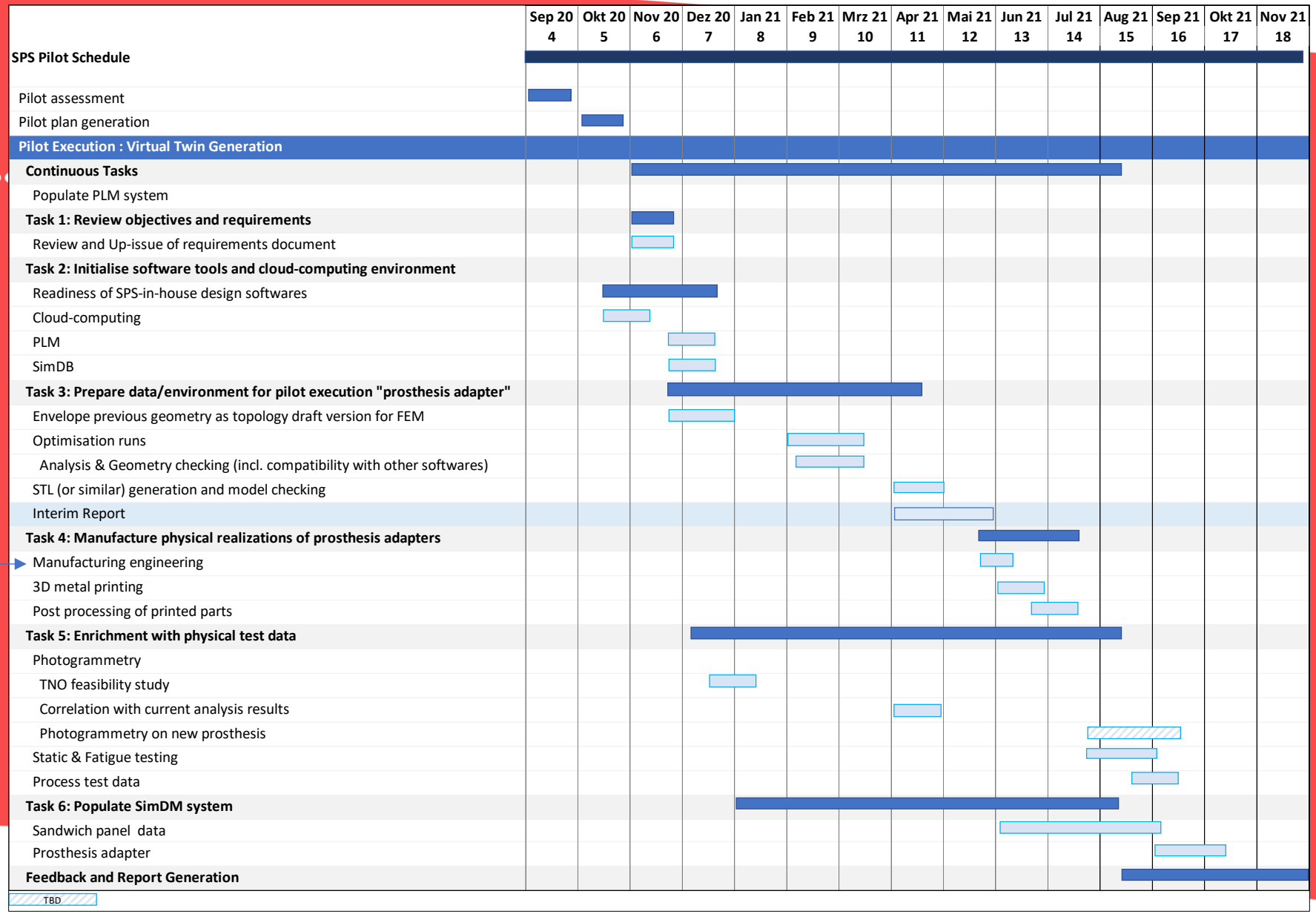
SPACE STRUCTURES

SPS Pilot: KPIs

Process / Topic	KPI
Data exchange	• Time of the data exchange operation • Number of iterations required until exchange is successful
Computing performance on demand	• Time from job submit until the results are received • Infrastructure costs
Product manufacturing information	• Number of documents and revisions • Non-recurring setup cost • Machine parameters and behaviour
Enrichment of the digital twin with test data	• Non-recurring installation cost • Correlation time • Accuracy increase
Data storage and archiving	• File size • Access time • Long-term accessibility

Pilot Schedule

- Model Update – Done
- Manufacturing engineering - Ongoing



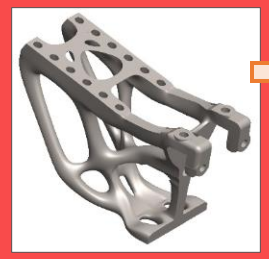
Twin Building : Steps

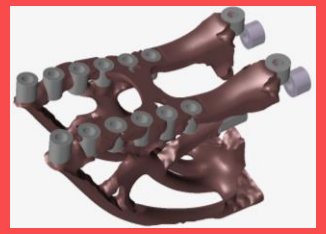
1. Review Objective and Requirements
   - Main Requirements for Design Update
   - Review current design
   - Identify software requirements
2. Initialise software tools and cloud computing
   - Deploy required softwares
   - Employ cloud computing environment
3. Optimization of prosthesis design and model analyses
   - Recalculation of load environments
   - Design optimization and analysis update of the prosthesis adapter
   - Model checking for data interoperability
4. Manufacturing of prosthesis adapter
   - 3D Metal printing
   - Post processing of the product
5. Enrichment of the test data with photogrammetry
   - Feasibility study for using photogrammetry to enrich prosthesis test data
   - Employment of the technology during test phase (TBD)
6. SimDM and Test data correlation
   - Correlation of prosthesis mechanical test data with the analysis model
   - Correlation of mechanical and thermal test data of sandwich panel

PLM Implementation and Use

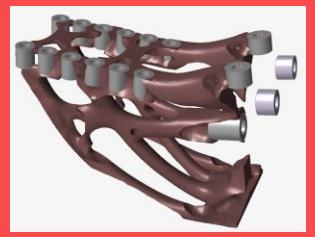
Design Optimization and Analysis

Optimization Loops → Design Update → Mechanical Analysis

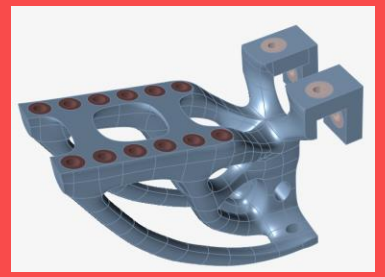


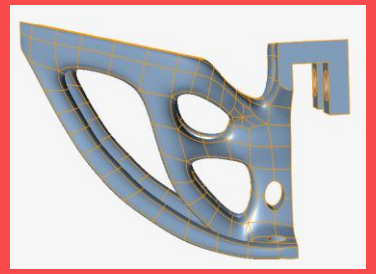


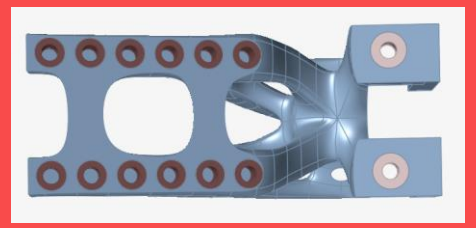
Minimum Mass

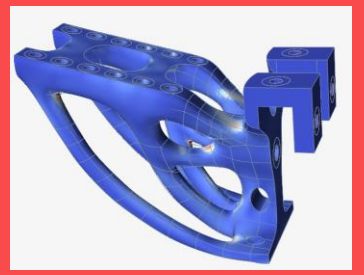


Maximum Stiffness

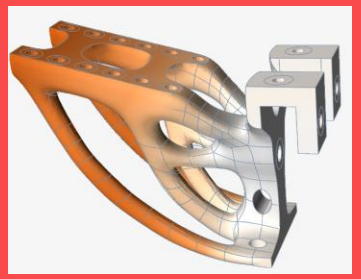








Maximum Stress



Maximum Displacement

HORIZON 2020

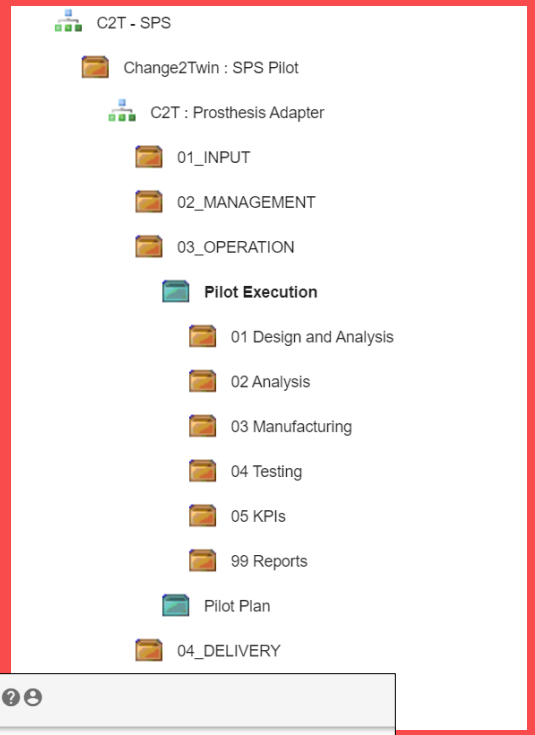
SPACE STRUCTURES

Enabling Technology – PLM Software

truePLM – Jotne

- End-user application for standards based (ISO 10303-239) Product Lifecycle Management (PLM).
- Structures a product or project by breakdown elements.
- A Reference Data Library (RDL) enables extensive adaptation to use cases by the end user herself (the application semantics are not hard-coded).
- Interoperability with other engineering tools is provided via ISO 10303, STEP, that is, data exchange by AP239 and AP242

➢ Implemented to efficiently store data and to track changes at all phases of the product development



HORIZON 2020

https://jotneit.no/edmtrueplm

Enabling Technology – Cloud Computing

CloudBroker

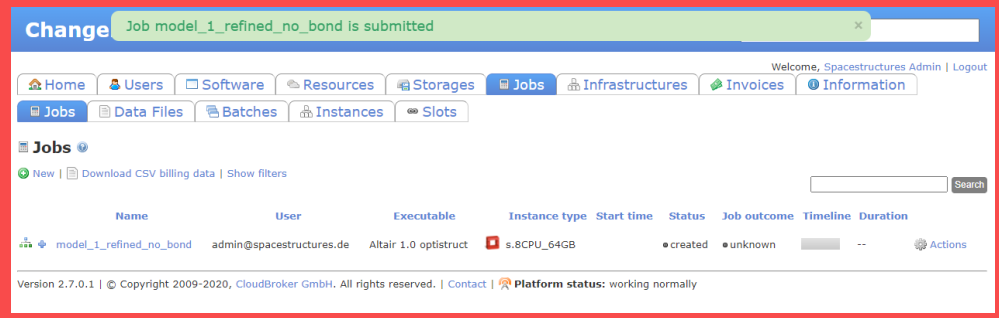
- High performance cloud space access for computing

➢ Deployment of Altair software on cloud and access for model analyses

➢ truePLM access through Windows based virtual machine on the cloud

Home page

Job Overview



HORIZON 2020

SPACE STRUCTURES

https://c2t.cloudbroker.com/

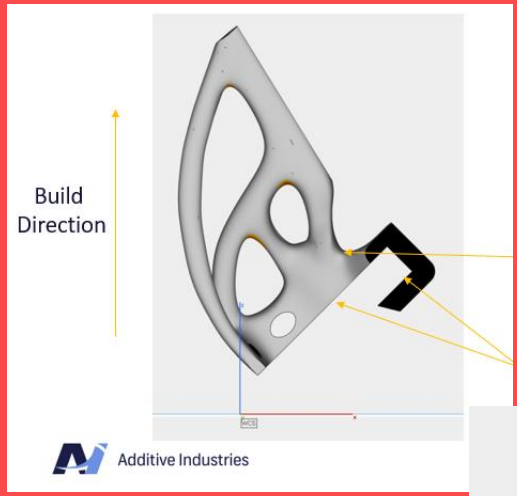
Enabling Technology- Design for Manufacturing

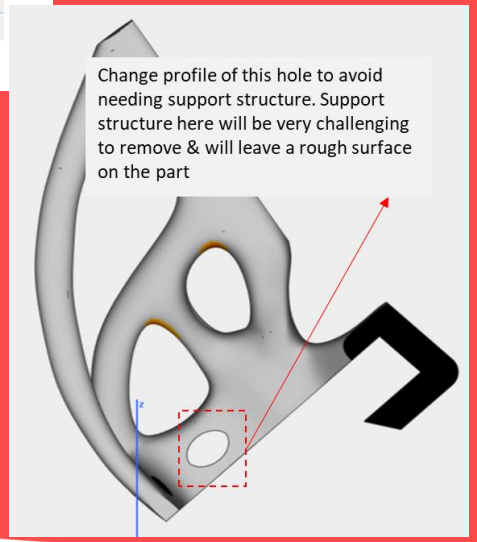
Additive Industries

- Best practices for additive manufacturing

➢ Design checking using commercially available Build Manager Software

➢ Assessment of the printability of the geometry and suggestions for build orientation





Enabling Technology- Data Management

SimDM - Jotne

- ISO 10303-209 (AP209) repository and application for managing multidisciplinary analysis, design and test data
- Imports data by AP209, AP242, NASTRAN, Abaqus, Ansys and csv-formats (test data) and combined into a federated model via cross domain correlations
- Possible extension of the application by a 3D viewer (VCollab)

➢ Enables correlation of the test data with the analysis models, thus improve the analysis models (vitual twins)

Enabling Technology – 3D Metal Printing

3D printing and post processing - Additive Industries

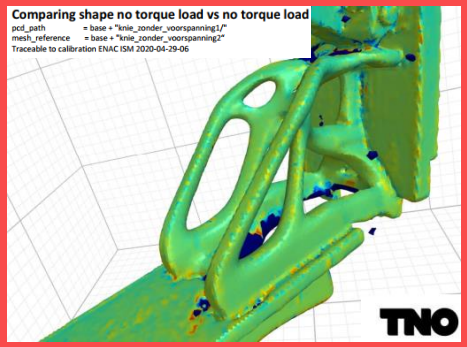
- Prosthesis adapter manufacturing using Metal Fab 1
- Post-production heat treatment
- Post processing of the component

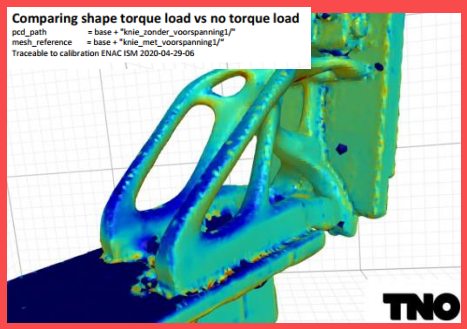
https://www.additiveindustries.com/systems/metalfab1

Enabling Technology – Photogrammetry

Optical fringe projection scanner - TNO

- 3D imaging technique to analyse the adapter and store data as Stanford Triangle Format for 3D point clouds
- Prosthesis adapter scanned without stress and with applied stress
- Geometry of both states are registered with respect to the M10-interface plane and deformation can be established by estimating shift of the surface
- The component geometry (STEP AP214) is split into components and registered individually to establish internal deformation of the component under stress





Current Status

1. Review Objective and Requirements

2. Initialise software tools and cloud computing

3. Optimization of prosthesis design and model analyses
- Design update completed
- Final checks ongoing

4. Manufacturing of prosthesis adapter
- 3D Metal printing
- Post processing of the product

5. Enrichment of the test data with photogrammetry
- Feasibility study for using photogrammetry completed => **Positive results**
- Employment of the technology during test phase (TBD)

6. SimDM and Test data correlation
- Correlation of prosthesis mechanical test data with the analysis model
- Correlation of mechanical and thermal test data of sandwich panel

PLM Implementation and Use

CHANGE2TWIN

SPACE STRUCTURES