



POZNAN UNIVERSITY OF TECHNOLOGY



FACULTY
OF MECHANICAL
ENGINEERING

AutoMedPrint

AUTOMATED DESIGN AND RAPID
MANUFACTURING OF INDIVIDUALIZED
MECHANICAL AND BIOMECHATRONIC
PROSTHETIC AND ORTHOTIC DEVICES



TEAM AT POZNAN UNIVERSITY OF TECHNOLOGY



FILIP GÓRSKI PhD, DSc, BEng, Assoc. Prof.

UNIVERSITY: Poznań University of Technology

EDUCATION: Mechanical Engineering
(Master's & Doctoral studies and habilitation)

OCCUPATION: Professor at Poznań University of Technology

ROLE: Head of Division of Additive Manufacturing and Virtual Reality
Vice-dean for science of the Faculty of Mechanical Engineering

INTEREST: 3D Printing in in Medicine / VR & AR for Medicine / CAD design
automation in medicine / reverse engineering

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Faculty of Mechanical Engineering

Institute of Materials Technology
PUT Cluster of Excellence
in Biomedical Engineering



PRODUCTION OF CUSTOMIZED MEDICAL DEVICES

Transition from a traditional process of manufacturing medical devices

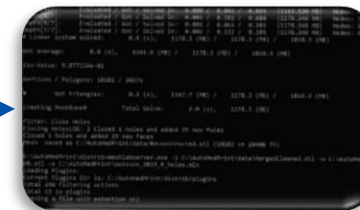
TRADITIONAL PROCESS
*Manual manufacturing
Piece production*



MODERN PROCESS
*CAD, Reverse Engineering, 3D Printing
Small series production*



AUTOMATED PROCESS
*Design automation
MASS CUSTOMIZATION*



FOR WHOM ARE WE DOING IT?



Biologically disabled people constitute over 10% of the population (e.g. in Poland)

The total number of disabled people is decreasing (2002 vs. 2011) BUT the number of biologically disabled people is increasing!

Causes: aging society, civilization diseases, accidents

NEW IS COMING!

DAY 1



DAY 2



DAY 3

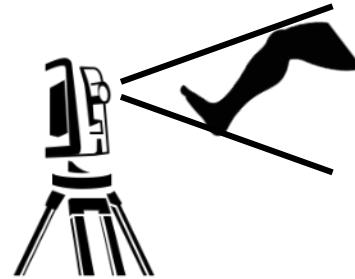


- the modern digital process and 3D printing is replacing the traditional molding of prostheses and orthoses for people with physical disabilities
- 3D printing = completely new technical possibilities + potentially low cost
- problem -> an engineer is needed to design products!

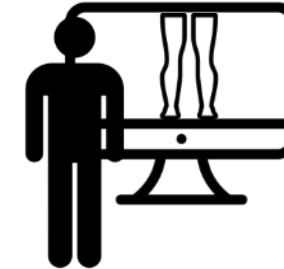
AUTOMEDPRINT SYSTEM



M.D.consultation
diagnosis



limb 3D scanning



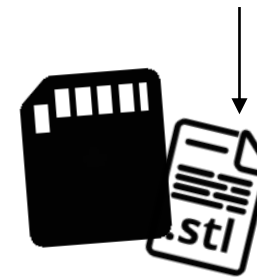
automated design
visualization



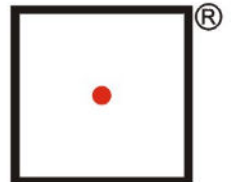
post processing
assembly, try-on, use



3D printing



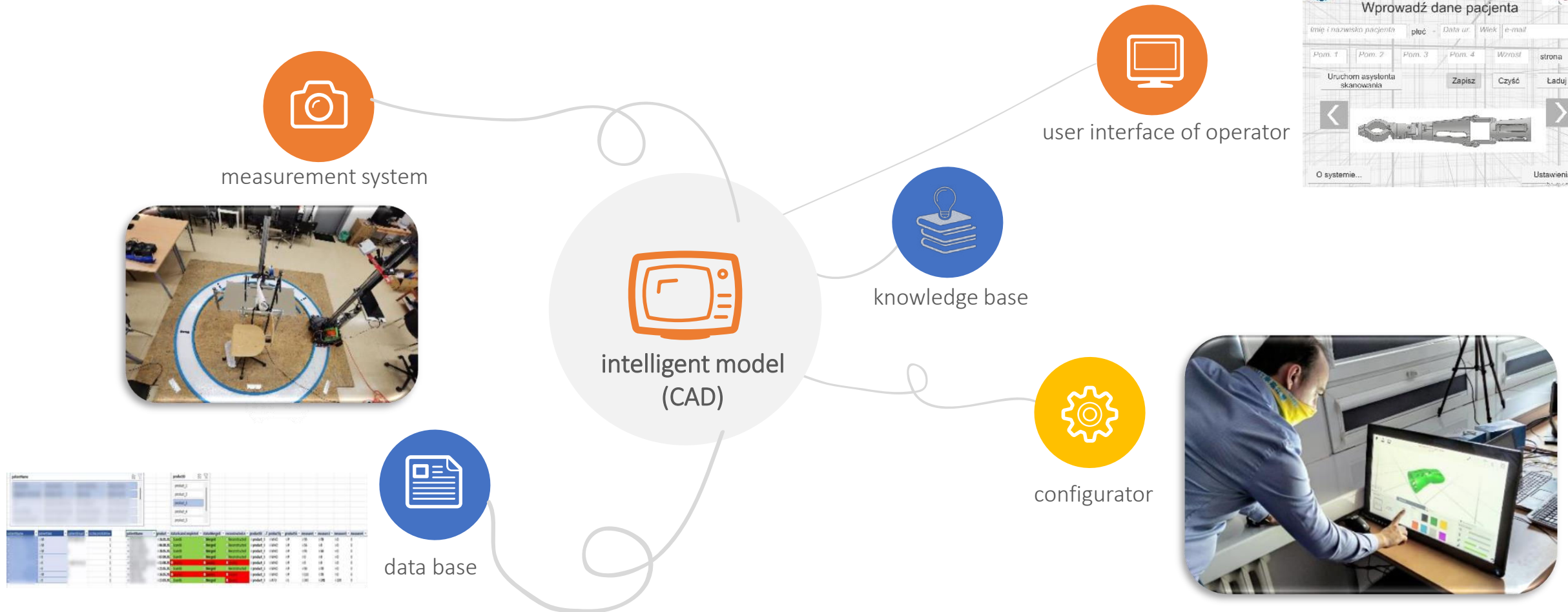
automated 3D printing
preparation



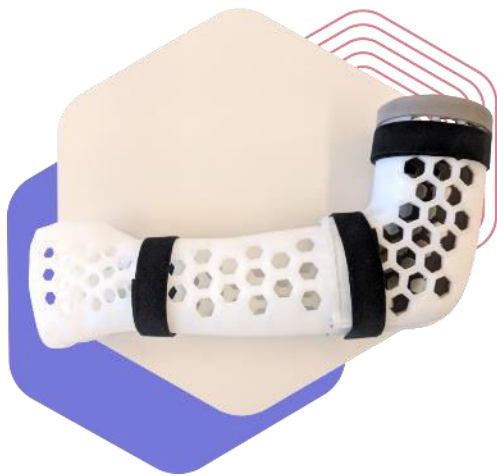
Polski
Produkt
Przyszłości

AUTOMEDPRINT: Automation of design and rapid manufacturing of individualized orthopedic and prosthetic supplies based on data from anthropometric measurements

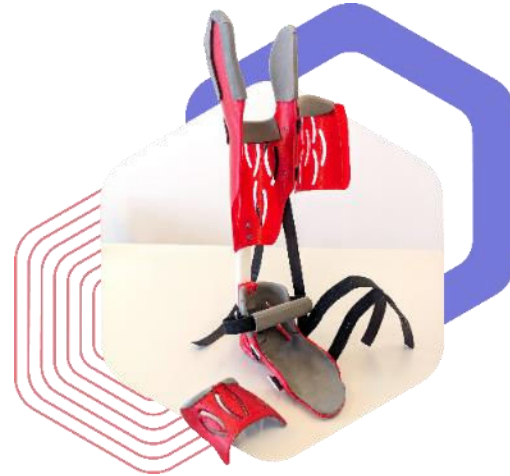
AUTOMEDPRINT – EXAMPLE OF AUTOMATED DESIGN SYSTEM



ORTHOPEDICAL PRODUCTS IN THE AUTOMEDPRINT SYSTEM



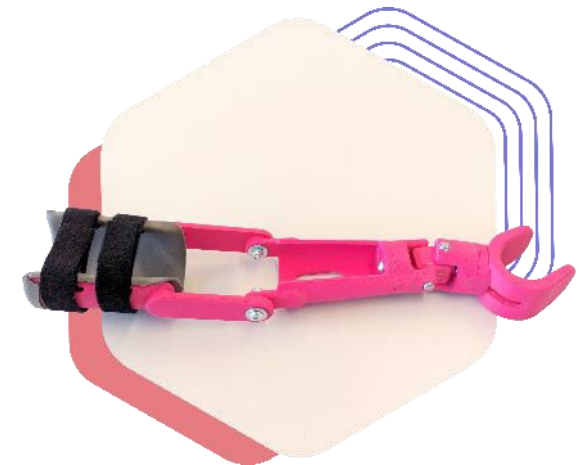
HAND
ORTHOSIS



LEG
ORTHOSIS

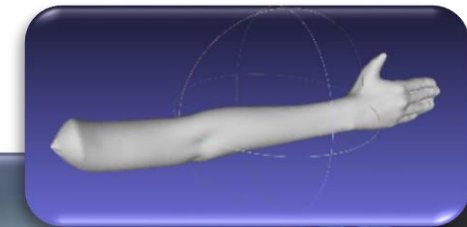
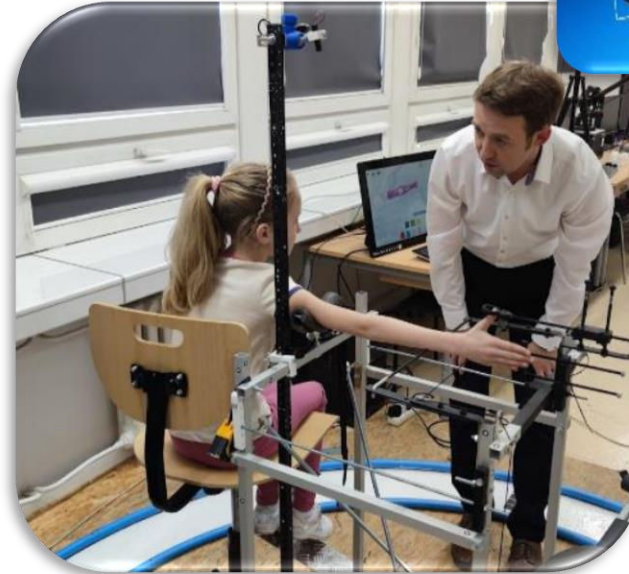
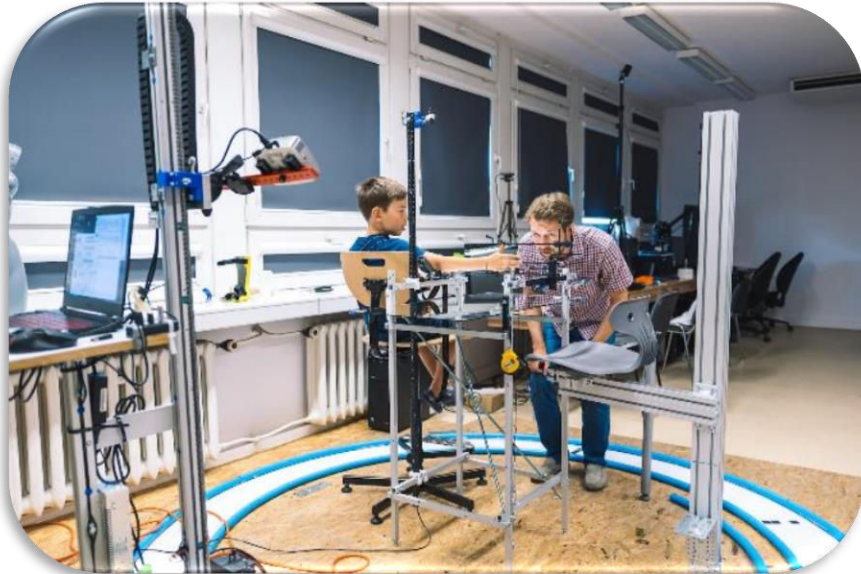


COSMETIC
PROSTHESES



MECHANICAL
PROSTHESES

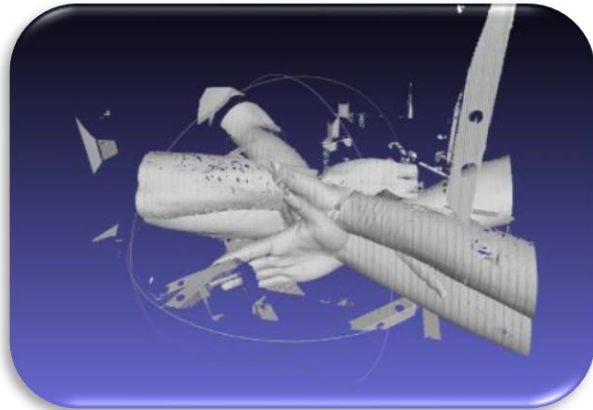
3D SCANNING



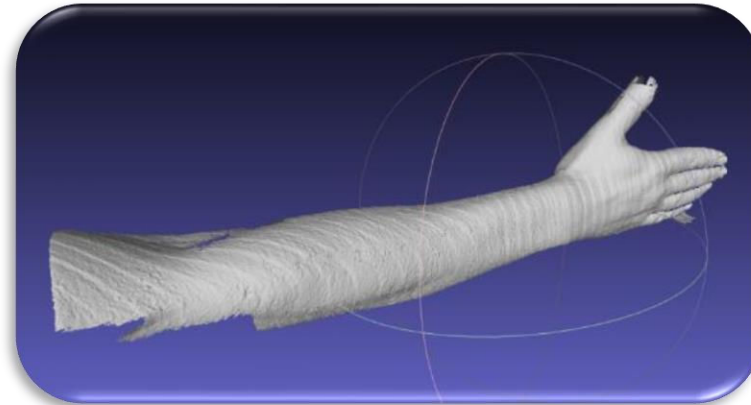
3D scanning + automated data processing

Virtual laboratory available at
<https://my.matterport.com/show/?m=NXHcatKcdW7>

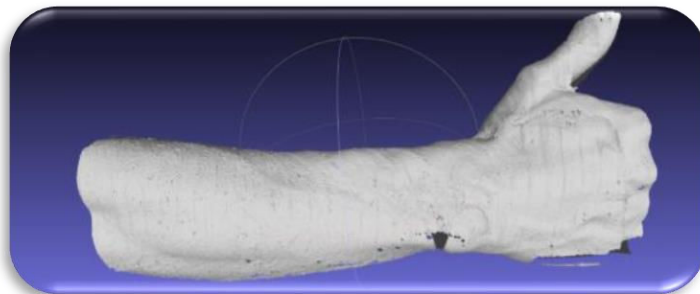
3D SCANNING - DATA PROCESSING



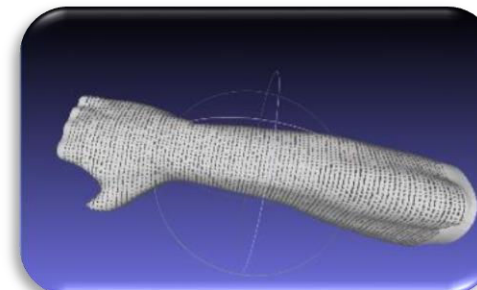
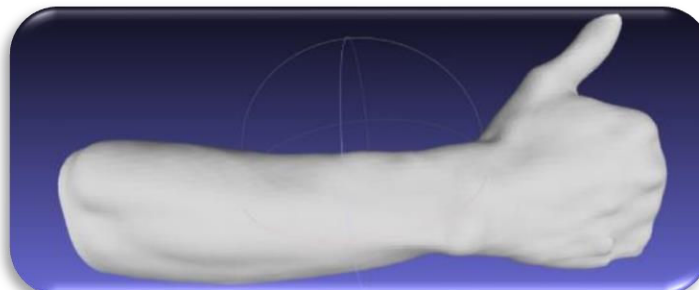
1. Raw scans



2. Transformation, initial cleaning



3. Reconstruction

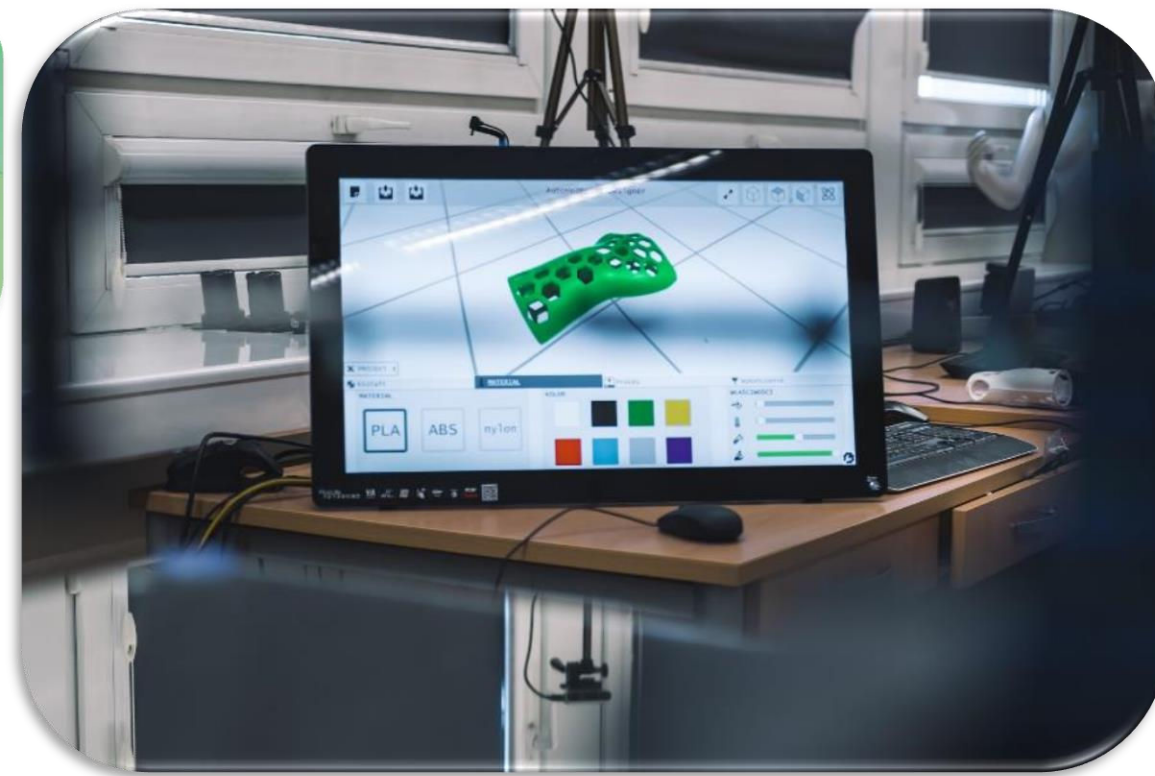
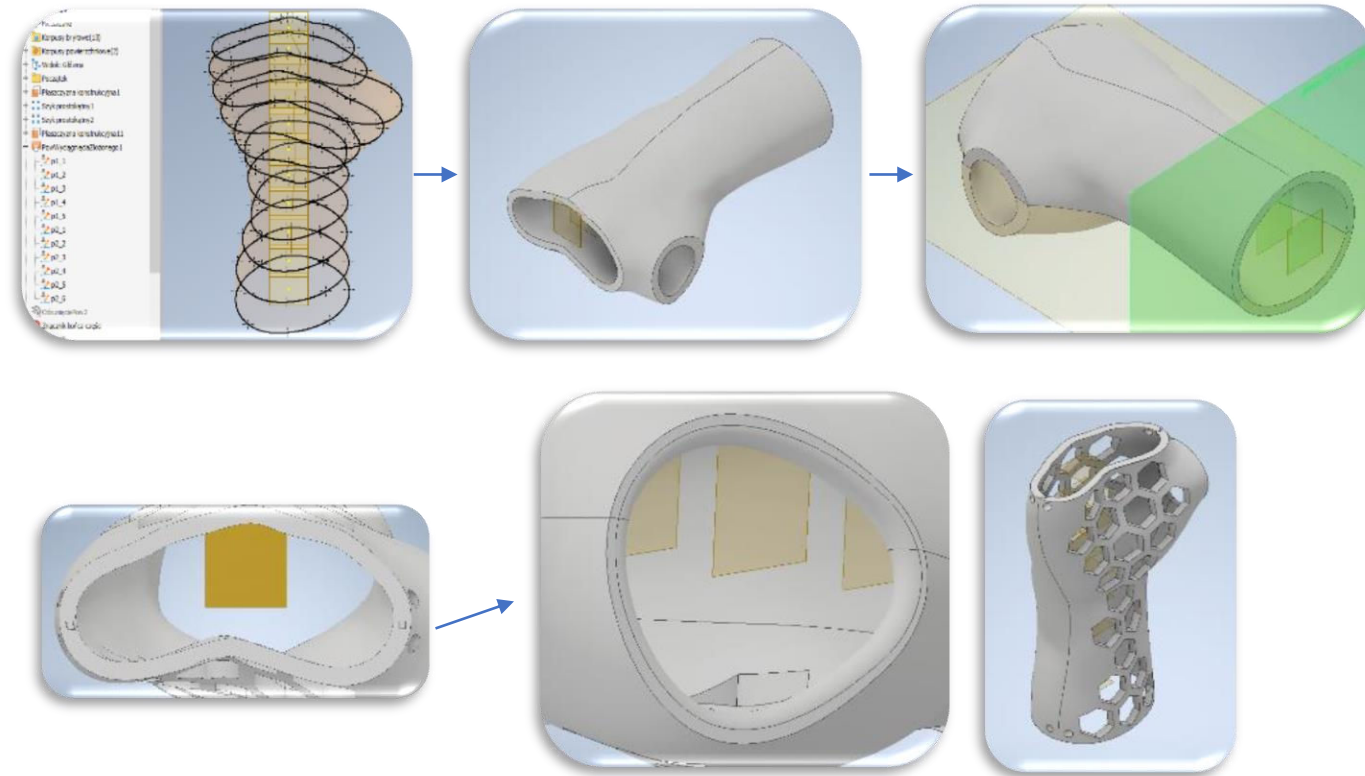


4. Data extraction

x1_12	32,541
x1_13	41,769
x1_14	34,588
x1_15	0
x1_16	29,888
x1_17	39,448
x1_18	29,263
y1_11	53,474
y1_12	32,541
y1_13	0
y1_14	34,588
y1_15	48,3
y1_16	29,888
y1_17	0
y1_18	29,263



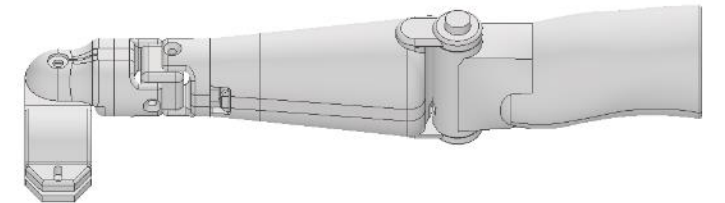
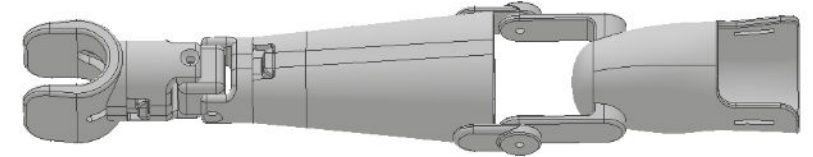
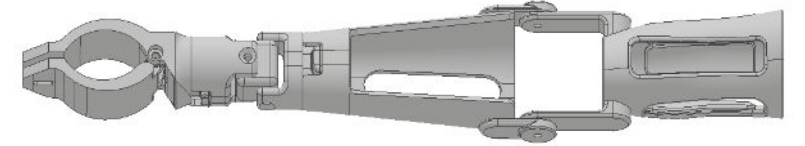
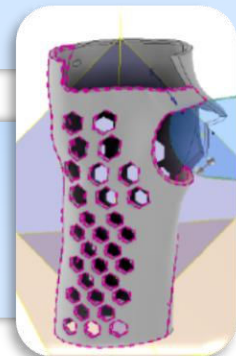
DESIGN



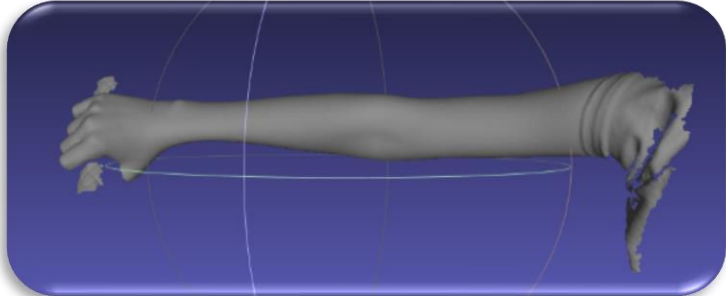
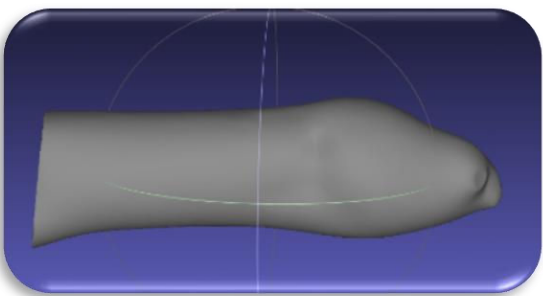
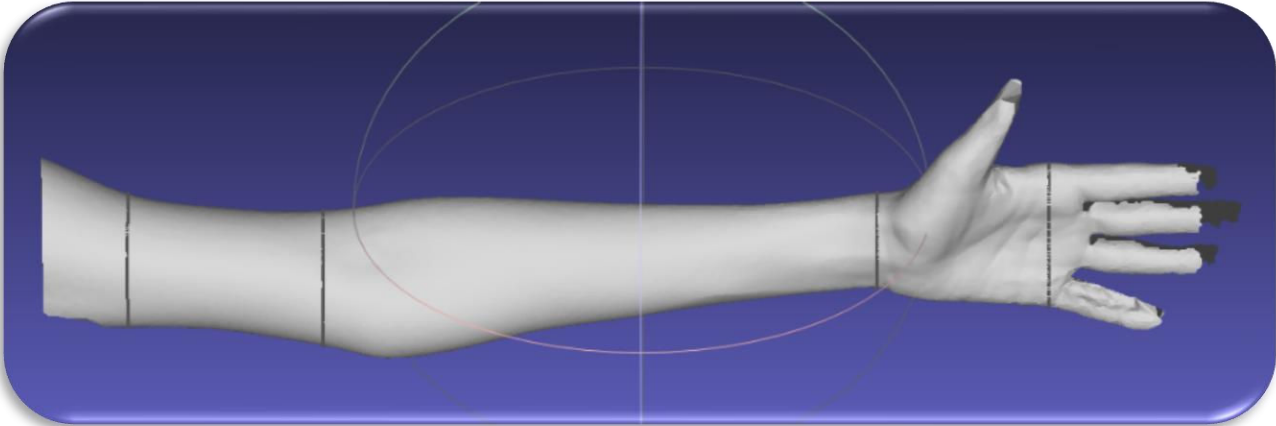
automated design, verification, product customization (AR/VR)

MODULAR AUTOMATION

- intelligent CAD model
- easy change of variants for one patient
- replacement of data from a 3D scan for different patients
- variant generation time: 5 minutes



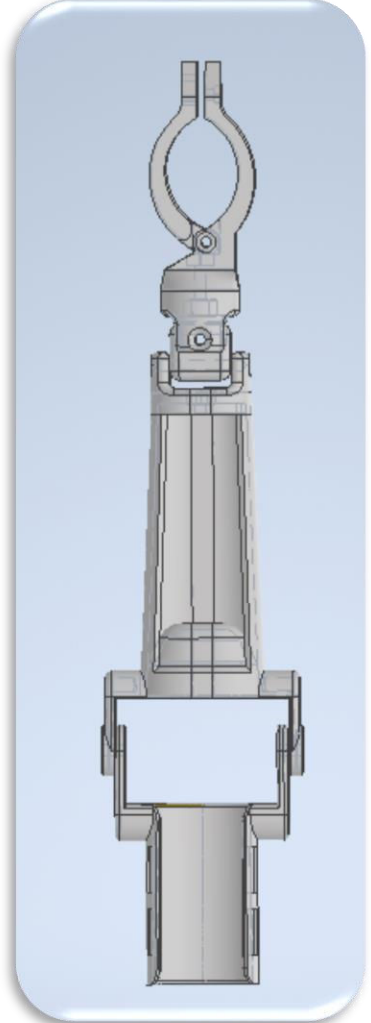
DESIGN



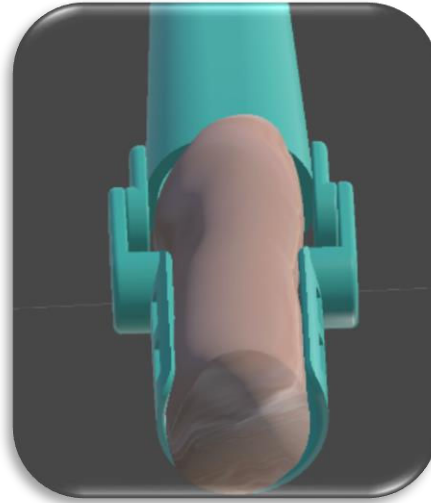
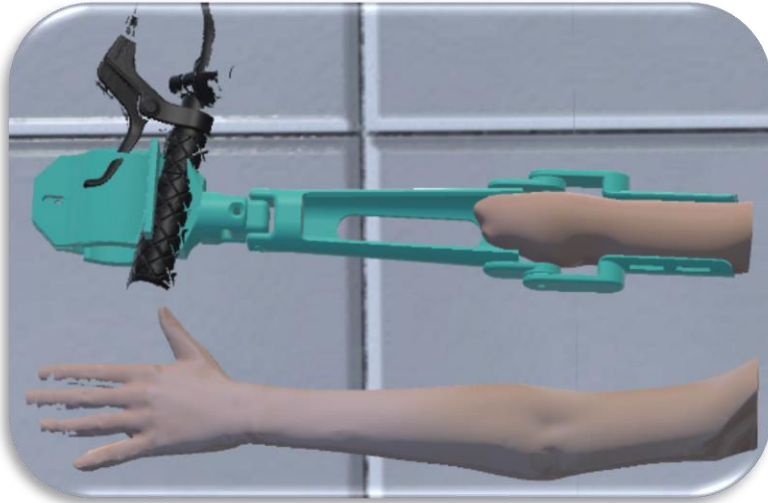
Part Name	Material	Volume	Mass	Centroid X	Centroid Y	Centroid Z
Part 1	Aluminum	1000	2.7	100	100	100
Part 2	Steel	500	7.85	200	200	200
Part 3	Carbon Fiber	200	1.6	300	300	300
Part 4	Plastic	300	1.2	400	400	400
Part 5	Glass	100	2.5	500	500	500



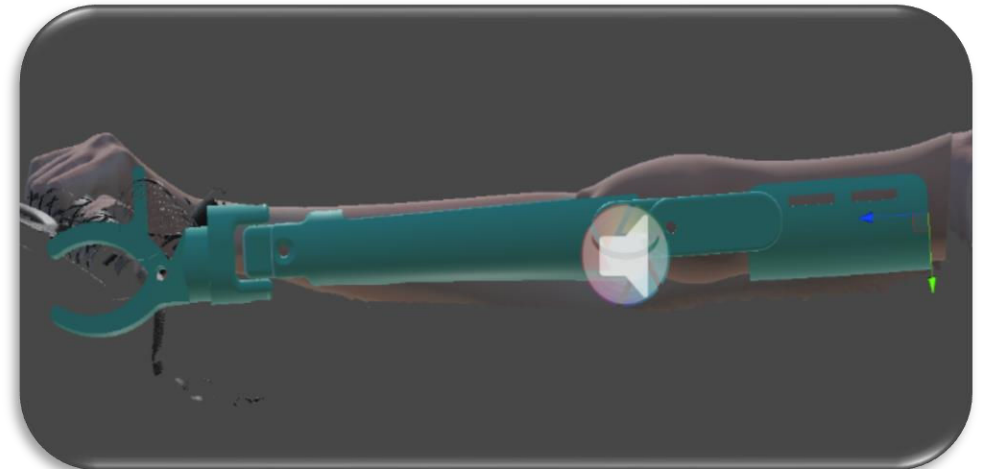
use of modular model – automated data extraction from scans



VIRTUAL FITTING

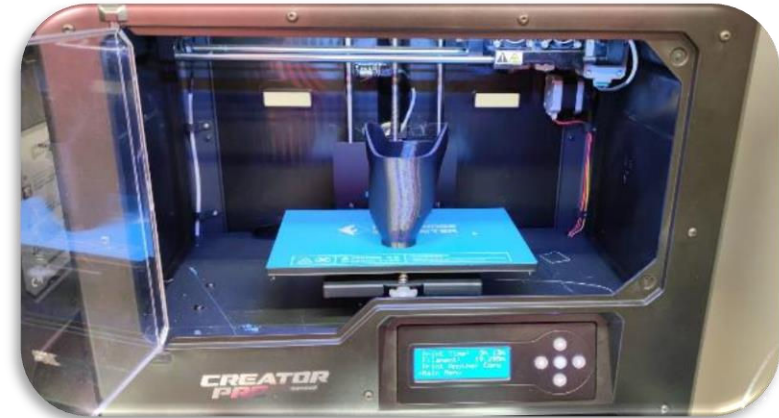


- visualization of product model in virtual environment
- immersive tests, collision detection, dimensions checking
- design decisions

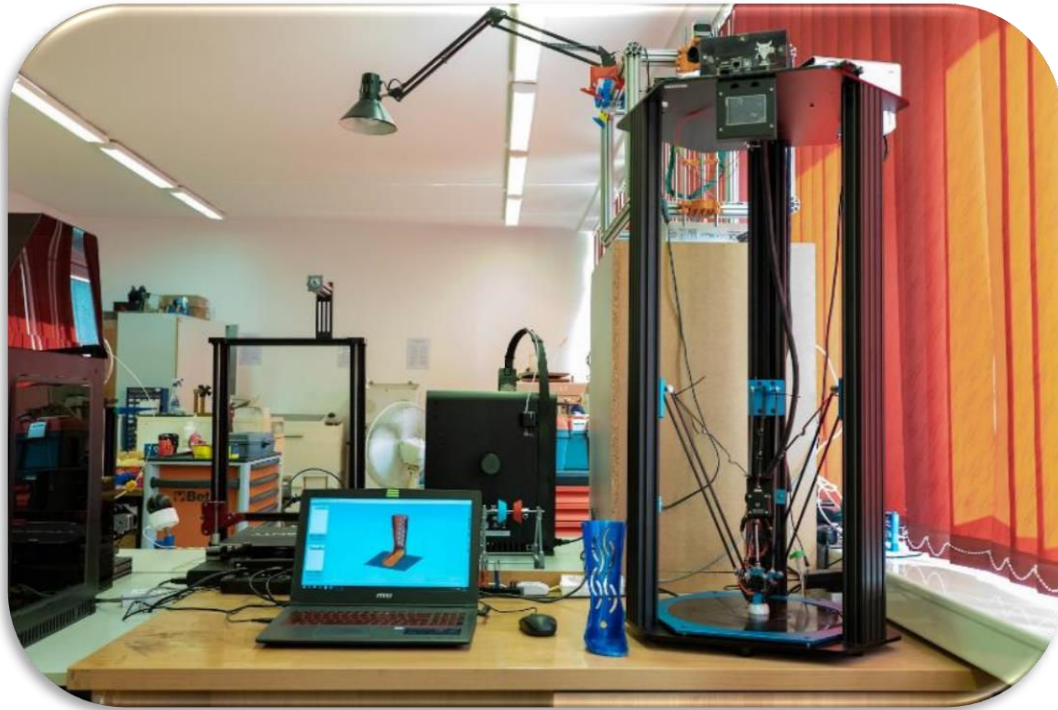


MANUFACTURING

- low-cost and simple FDM technology – printable at home, school, hospital etc.
- ecological and biocompatible materials: PLA, nylon or thermoplastic polyurethane
- the ability to control the weight of the prosthesis and "slimming down"
- complete prosthesis for a child - printed in less than 24 hours



MANUFACTURING



process preparation, realization,
post processing



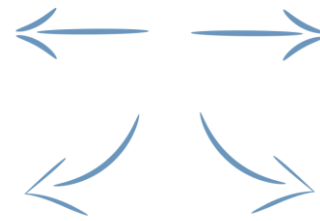
Virtual laboratory available at
<https://my.matterport.com/show/?m=NXHcatKcdW7>

TRY-ON AND USAGE



Try-on with patient (physiotherapist + possibly orthopedist),
feedback, modification

RESULTS - PROSTHESES



RESULTS - ORTHOSES



ZUZIA



MACIEJ



ADAM



KUBA



LEON



ZOSIA



JONASZ



MAJA



MIŁOSZ



JANEK



WHAT WE LEARNED?

- scanning: gather as much data as possible
- design: carefully analyse data for similarities and differences, improves efficiency of design process
- listen to your patients and improve your solutions
- learn along with your patients and adapt
- use 3D printing capabilities to create many variants for user to choose from
- perform virtual fit before you invite the patient
- **one small 3D printed piece of plastic can improve someone's life**



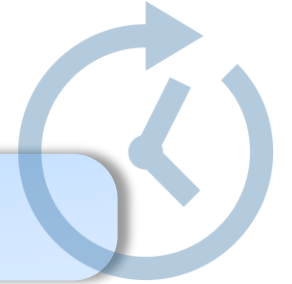
CONCLUSIONS

- potential of 3D printing in prosthetics is probably not used very efficiently – yet!
- needs of adult patients are different than children patients
- functional, specialized prosthesis can be 3D printed for a fraction of a cost of a traditional, expensive one – and they are useful!
- design changes can be introduced anytime, as many times as feedback is gathered from patients, also by virtual try-on



CHALLENGES FOR THE FUTURE

- quality management system (QMS) and product lifecycle management (PLM) introduction
- medical regulations (EU's MDR and others) compliance
- gaining interest of big companies and enforcing the change: from long & expensive to short & cheap automated production
- improving automation with use of AI
- **convincing patients that their life can improve!**



AWARDS AND MEDIA COVERAGE



newspapers, nation-wide TV



national/government level awards



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THANK YOU FOR ATTENTION!

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