#### Kunica, Zoran; Poje, Gorazd; Mlivić, Denis; Knežević, Mario; Antunović, Bartol

#### Conference presentation / Izlaganje na skupu

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:235:331985

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Download date / Datum preuzimanja: 2025-03-10

Repository / Repozitorij:

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## Digital transformation in nose surgery



University of Zagreb Faculty of Mechanical Engineering and Naval Architecture

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## Content

- Aim and goals of work
- Inferior nasal turbinates surgery in CAD
- Rhinoplasty in Virtual Reality
- Future work



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### Digital integration of the whole nose surgery process:

from the diagnosis and state of a specific patient, through surgery itself till wider health-care and social context.

- better understanding new knowledge
- normization increased efficiency
- new tools, mechanization and automation

[1] Towards virtualization and optimization of sinus surgery planning and execution Kunica Zoran, Poje Gorazd, Mlivić Denis, Topolnjak Jan Medica Jadertina 52 (Suplement 1), 17-17, 2022

[2] <u>Conceptualisation of Virtual Reality Experiments for</u> Optimised Sinus Surgery Planning and Execution

Aim and goals

of work<sup>[1][2]</sup>

Kunica Zoran, Poje Gorazd, Mlivić Denis, Topolnjak Jan International journal of industrial engineering and management 14 (1), 13-24, 2023

- Two surgery procedures observed in the work:
- inferior nasal turbinate surgery<sup>[3]</sup>
- rhinoplasty<sup>[4]</sup>.

[3] <u>Virtualizacija kirurških zahvata na nosu/</u>Virtualization of nose surgery Knežević Mario University of Zagreb Faculty of Mechanical Engineering and Naval Architecture 2023

[4] Primjena virtualne stvarnosti u radnom okružju/Application of virtual reality in a work environment Antunović Bartol University of Zagreb Faculty of Mechanical Engineering and Naval Architecture 2023



Inferior nasal turbinates surgery in CAD

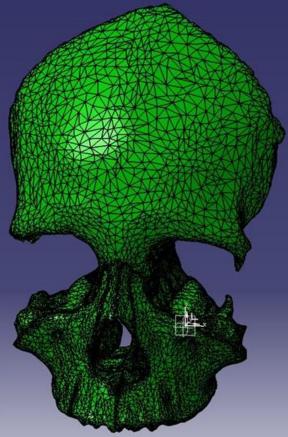
- designed and simulated in CATIA Delmia V5 software
- design stages:
- head and tissue
- tool and work environment
- process



# HEAD AND TISSUE design – complexity and simplifications



~	Surface.1 ( with JELE 9 : from *POL1 - wsp *MASTER - )	
-	Surface.2 ( with JELE 11 : from *POL2 - wsp *MASTER - )	
•	Surface.3 ( with JELE 13 : from *POL3 - wsp *MASTER - )	
-	Surface.4 ( with JELE 15 : from *POL4 - wsp *MASTER - )	1 de la
-	Surface.5 ( with JELE 17 : from *POLS - wsp *MASTER - )	Att
1	Surface.6( with JELE 19: from *POL6- wsp *MASTER - )	AN TAK
1	Surface.7 ( with JELE 21 : from *POL7 - wsp *MASTER - )	CARACKA AND A DECIMAN AND A
1	Surface.8 ( with JELE 23 : from *POL8 - wsp *MASTER - )	ARK XARA
1	Surface.9 ( with JELE 25 : from *POL9- wsp *MASTER- )	A REAL AND A
-	Surface.10   with JELE 27 : from *POL10 - wsp *MASTER -	
-	Surface.11 [ with JELE 29 : from *POL11 - wsp *MASTER - ]	BILK KIKK
1	Surface.12   with JELE 31 : from *POL12 - wsp *MASTER -	- WAXKEN R
1	Surface.13 ( with JELE 33 : from *POL13 - wsp *MASTER - )	<b>WHAT</b>
1	Surface.14 ( with JELE 35 : from *POL14 - wsp *MASTER - )	WX AXXX
2	Surface.15 [ with JELE 37 : from *POL15 - wip *MASTER - ]	
2	Surface.16 ( with JELE 39 : from *POL16 - wip *MASTER - )	(家族) 大法
2	Surface.17 ( with JELE 41 : from *POL17 - wip *MASTER - )	ARACKARS.
2	Surface.18   with JELE 43 : from *POL18 - wsp *MASTER -	Constanting and the
2	Surface.191 with JELE 45 : from *POL19 - wip *MASTER - 1	
2	Surface.20 ( with JELE 47 : from *POL20 - wip *MASTER - )	
2	Surface.21 ( with JELE 49 : from *POL21 - wip *MASTER - )	
2	Surface.22   with JELE 51 : from *POL22 - wip *MASTER -	
2	Surface.23 ( with JELE 53 : from *POL23 - wip *MASTER - )	<b>Distantis</b>
2	Surface.24 ( with JELE 55 : from *POL24 - wsp *MASTER - )	
2	Surface.25   with JELE 57 : from *POL25 - wsp *MASTER - ]	
	Surface.261 with JELE 59: from *POL26- wip *MASTER - 1	ALC: NO.
	Surface.27   with JELE 61 : from *POL27 - wip *MASTER - 1	
	Surface.28 ( with JELE 63 ; from *POL28 - wsp *MASTER - )	
		Y
-	Surface.30   with JELE 67 : from *POL30 - wsp *MASTER - )	
-	Surface.31   with JELE 69 : from "POL31 - wsp "MASTER -	YE
-	Surface.32   with JELE 71 : from *POL32 - wsp *MASTER - 1	4
51	Surface.33 ( with JELE 73 : from *POL33 - wsp *MASTER - )	



Preparation of the model of the head:

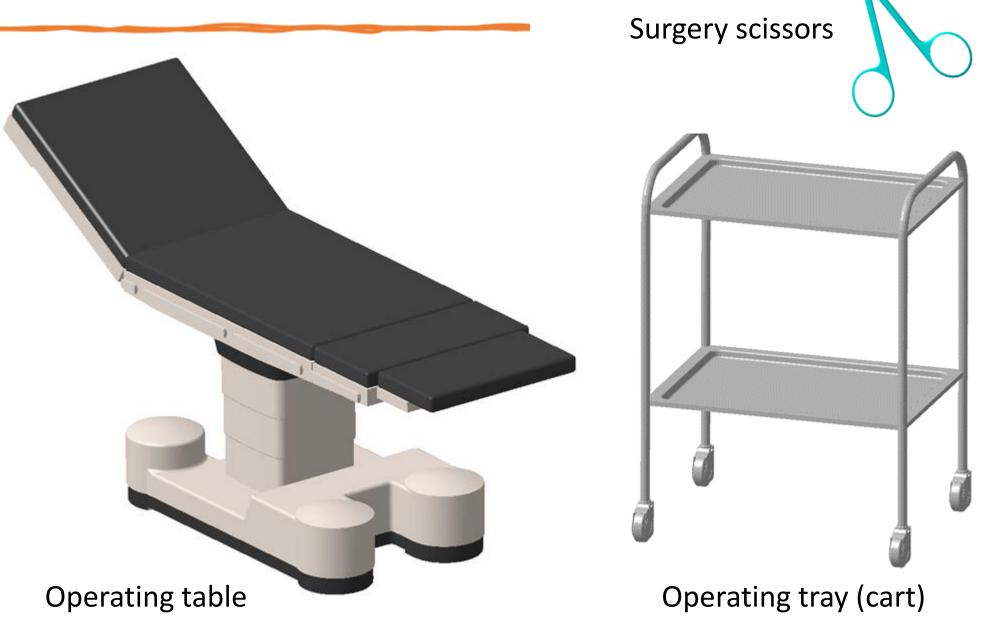
- 1. collecting CT scans
- 2. conversion into CAD models (STL format)
- 3. repairing with Blender



**FSE** 



### TOOL AND WORK ENVIRONMENT design

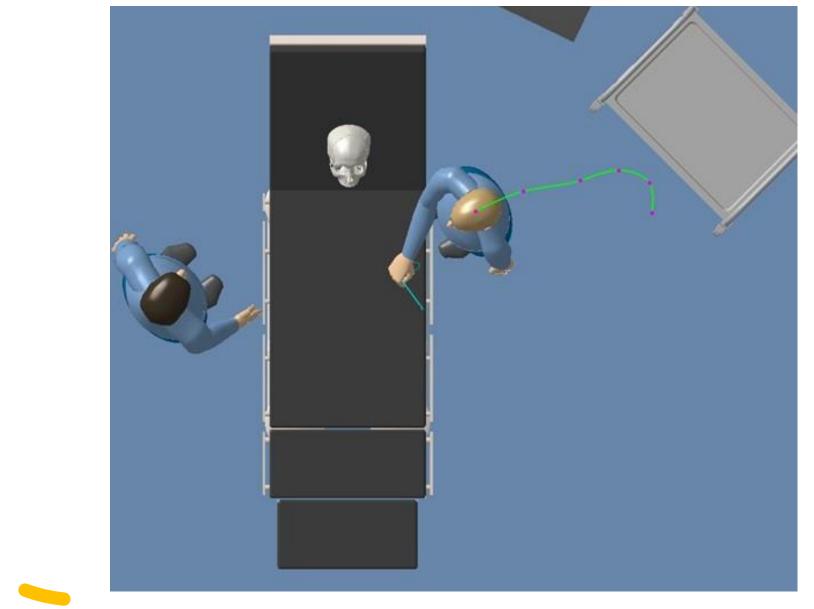




### The real-world and virtual inferior nasal turbinate surgery



PROCESS design: work of the surgeon and the instrument technician

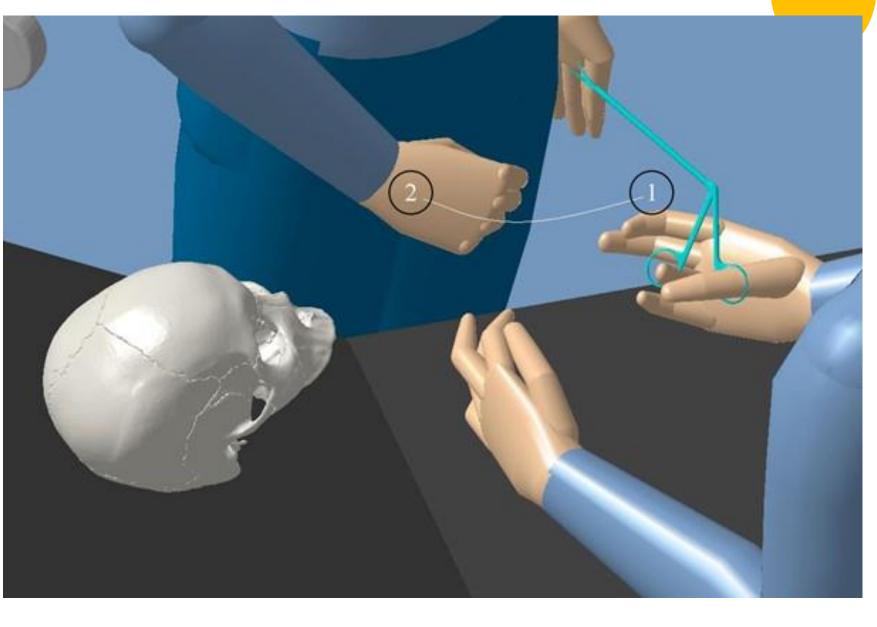




The path of the instrument technician shown

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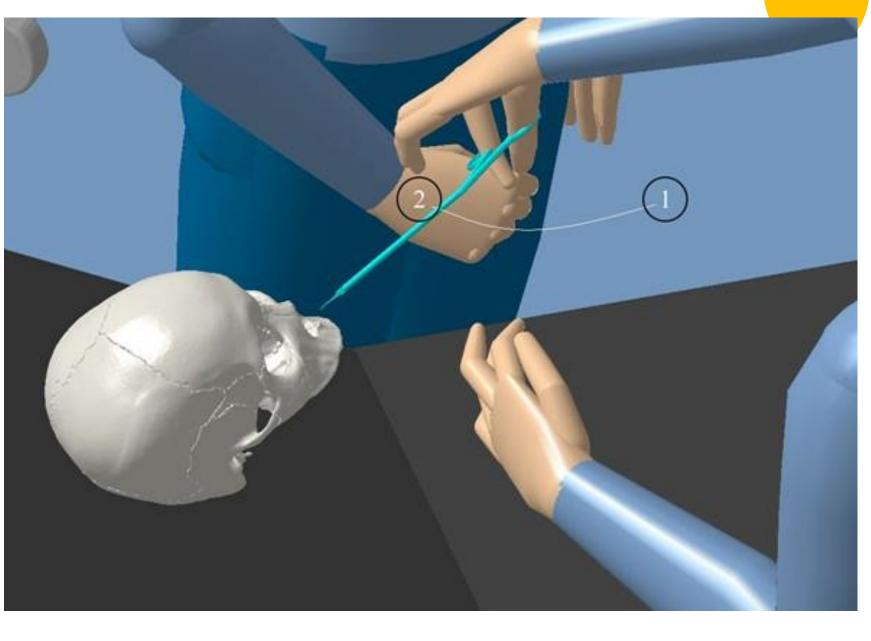
ZAGREB



- **1** starting position
- 2 approaching the inferior nasal turbinate
- 3 cutting

Ve FSB

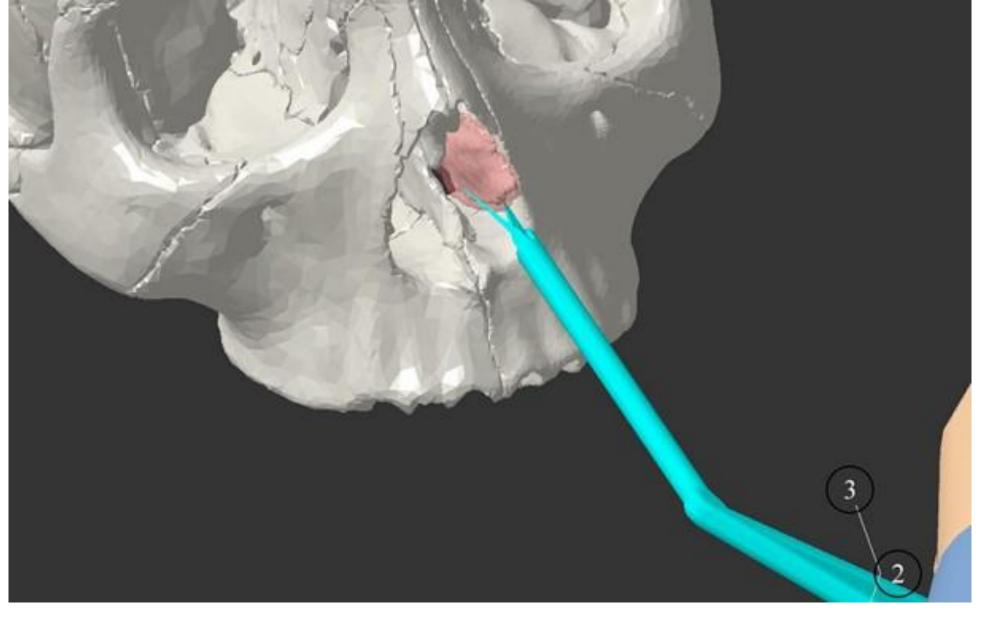
ZAGREB



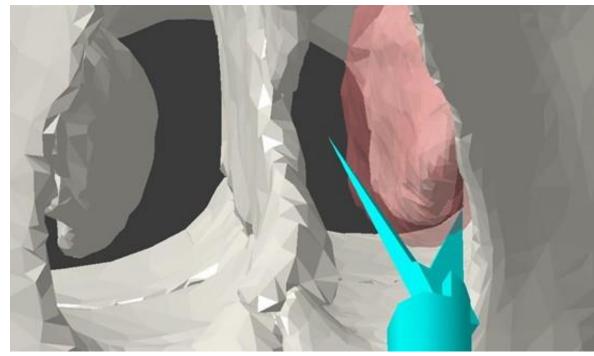
- 1 starting position
- 2 approaching the inferior nasal turbinate
- 3 cutting



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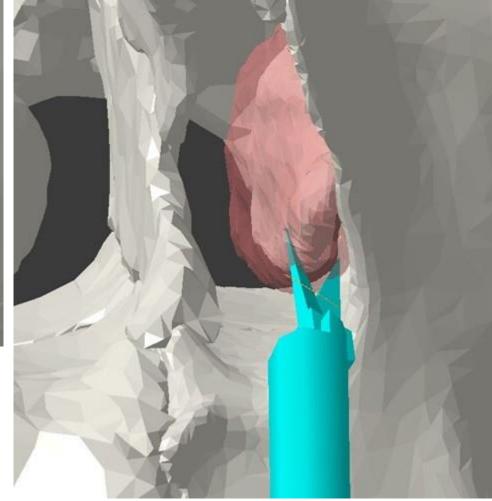


- 1 starting position
- 2 approaching the inferior nasal turbinate
- 3 cutting

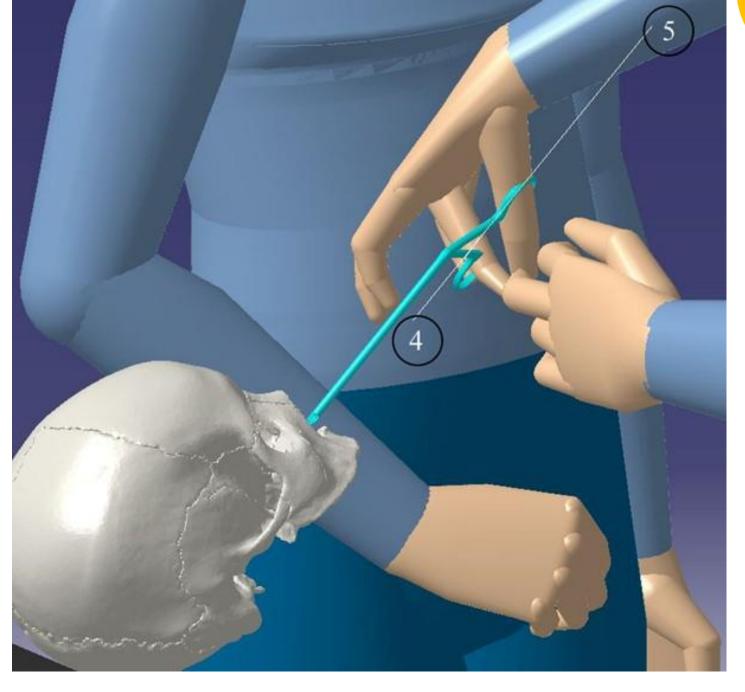


Virtual cutting (opening and closing of scissors) of the inferior nasal turbinate

<sup>⁰</sup> FSB



Ve FSB



# **4** and 5 represent starting and final points of the extraction of tool

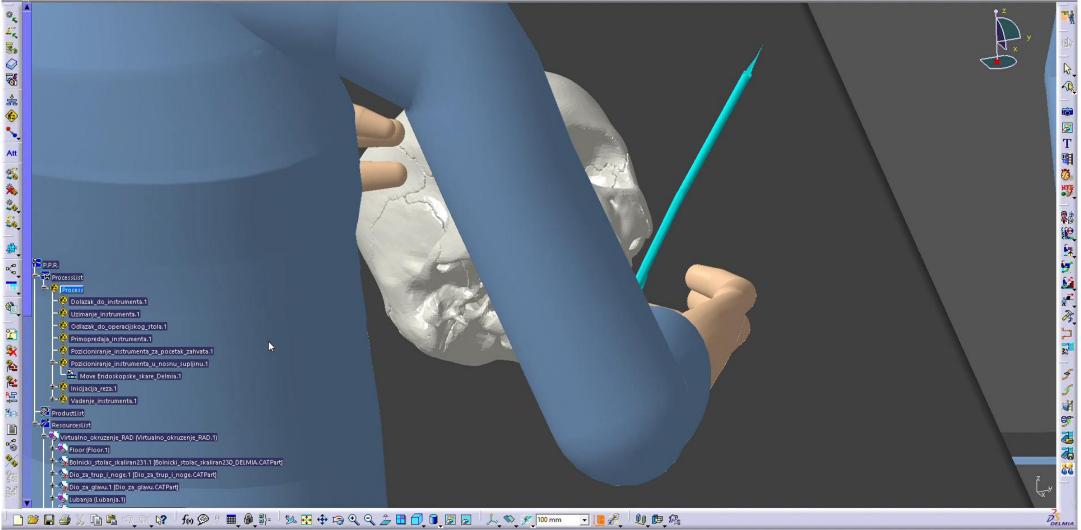




# 4 and **5** represent starting and final points of the extraction of tool



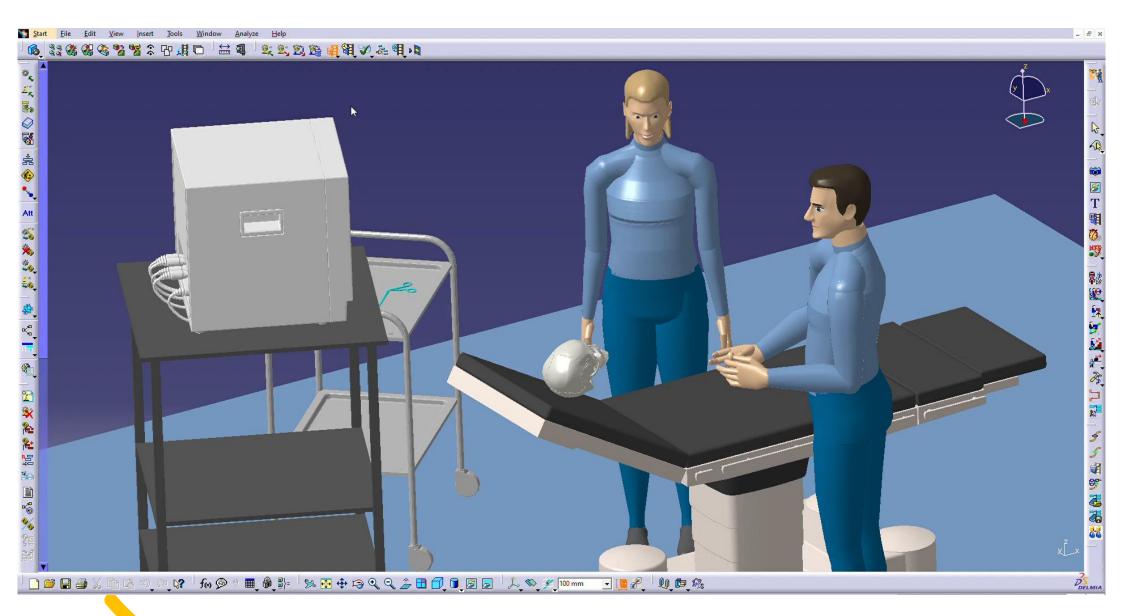
#### 



#### **Cutting process**







Simulation of the whole process

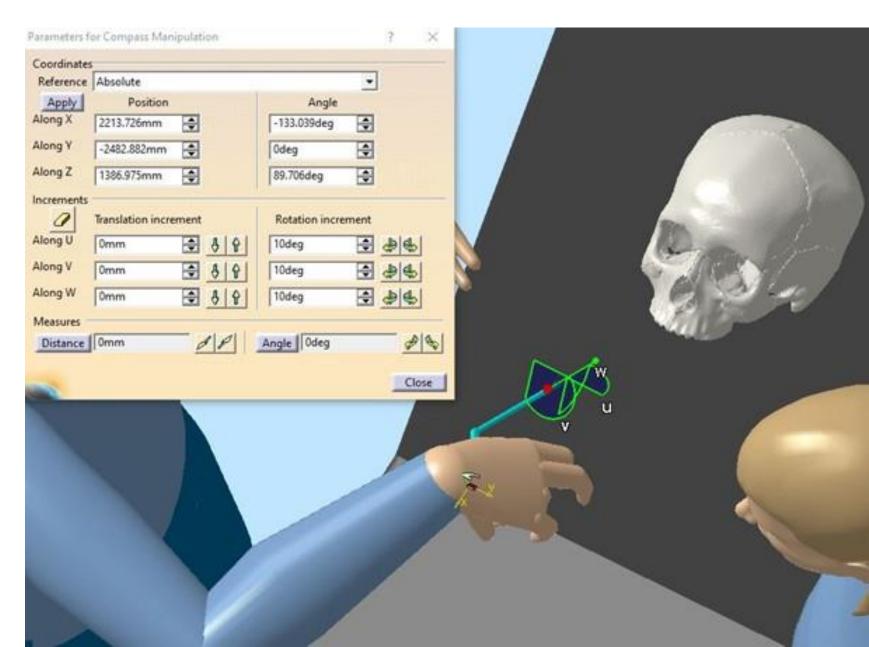


**Results:** 

- time of process
- precise angles and lengths of movements
- RULA ergonomy analysis

● FSB

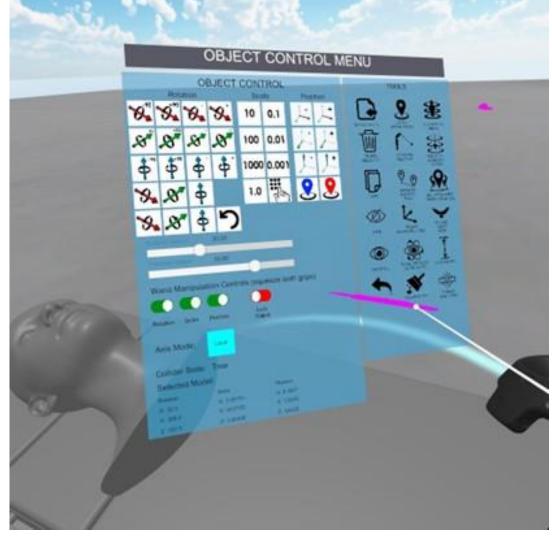




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## Rhinoplasty in Virtual Reality



- HTC Vive headset system
- Tool Center Point (TCP) represents the tip of scalpel

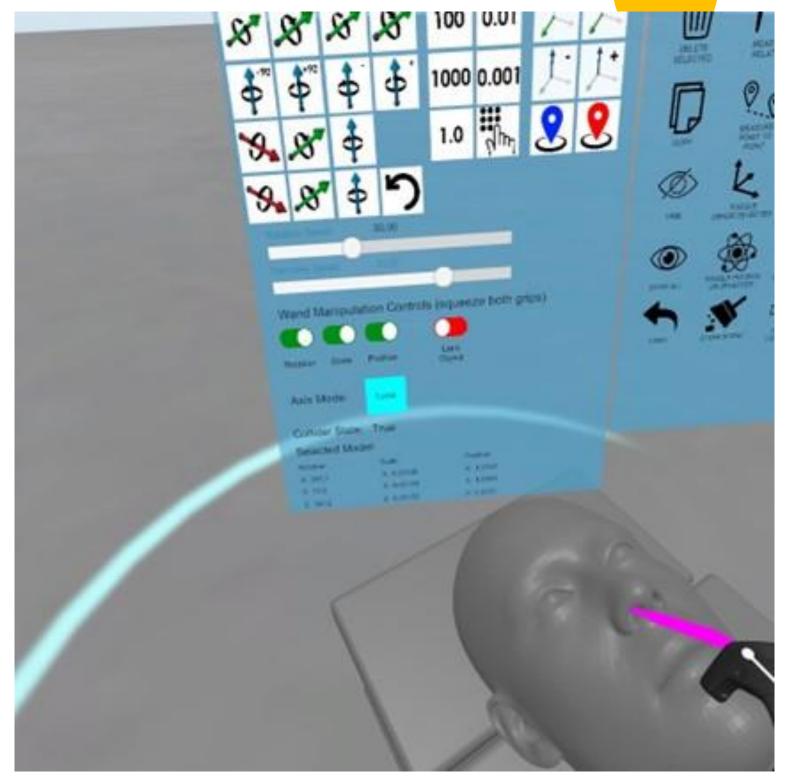
### Results:

- precise angles and lengths of movements
- similar feel of control during movements
- delay up to 20 miliseconds

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<sup>⁰</sup> FSB



## Future work

Both cases of nose surgery digital twinning give basis for future work, that may include:

- digital encompassing of further details of mentioned surgical procedures
- recording of the surgeon's actual movements during the procedures and their transfer to a digital model
- motion capture and comparing the work of several surgeons
- implementation on a larger sample of patients
- the introduction of virtual reality into training of surgeons
- the introduction of augmented reality into surgical procedures.

*Funding This research has been financially supported by the University of Zagreb.*