# Visionair Newsletter #6 - January 2015

## VISIONAIR's Trans National Access (TNA): An Incredible Success Story

VISIONAIR Newsletter Editor's note

Dear readers,

This is the last VISIONAIR Newsletter. We are about to close an exciting four-year period, during which some 24 research institutes and universities across Europe interacted and engaged in exciting scientific activities focused around visualization technologies. In this issue, we describe several trans-national activities (TNAs) that were carried out in recent months. All in all, the TNA framework proved to be a highly effective way to engage researchers from across Europe. More than 130 projects were supported by VISIONAIR, creating a great success story. Additionally, five general assemblies supported two open forums to promote access of scientists from a variety of disciplines. VISIONAIR partners also created about 50 tutorials and were involved in 20 internal Joint Research Activities. These results are reported in detail in VISIONAIR website http://www.infra-visionair.eu/ . The last General Assembly which took place in Rennes, France in December 2014 was a great event to demonstrate the added value of the infrastructure we have created.

VISIONAIR is not completely over, and the Consortium created to carry out VISIONAIR is still very much alive. In the near future, we plan to establish a Special Interest Group within the EURO-VR association. Our group of interconnected technical facilities shall promotes its activities, capitalizing on the added-value obtained through the connections among the Consortium facilities. We are confident that new projects and initiative will follow VISIONAIR project.

Enjoy reading, and we look forward to meet again in more successful projects like VISIONAIR.

**Professor Dov Dori, VISIONAIR Newsletter Editor**

Professor Frédéric Noël,
VISIONAIR Scientific Coordinator

# UPATRAS:

## Using Human Task Analysis Method for Immersive Validation

Start date Visit: 6-Aug-14
End date Visit: 15-Aug-14
Prof. Stanton Neville, University of Southampton

**Challenges**: Hierarchical task analysis is a popular human factors method that may be proven significant for the future of manufacturing. The challenge here was to have this method successfully integrated into new design concepts using virtual reality. The objective of HTA-VR is to set up and build a tool that will be able to interactively generate the HTA outputs, while the user will be performing various manufacturing tasks within the immersive environment. Thus, the HTA-VR TNA project aims to develop an immersive environment for the simulation of manufacturing tasks (e.g., product assembly), while implementing a semi-automatic technique for the HTA analysis to be performed on the immersed user.

**Work description**: The HTA method has been conducted with the help of at least one HTA expert who identified the tasks that an operator may perform. First, all the HTA verbs had to be translated in order to be identified within the VR environment. The next step was to find ways of generating the hierarchy achieved by setting conditions during the change of either the nature of task, or the tool used to perform a task in the virtual environment. The automated HTA generation was applied to the assembly of a car’s differential. The user was given instructions about the assembly, and after each step had been performed, the hierarchy was populated in an array.

**Results**: A semi-automated HTA resulted from the disassembly of the differential in which the tasks were generated by the user’s interaction with the virtual environment in a CAVE. The user’s interactions are identified by collision detections in the environment. The hierarchy of the tasks is generated within the virtual environment using identification areas and also by identifying the element that is collided with the user’s hand in each task. The functional area changes, when the hand has exceeded the fixed boundaries in VE for a specific area. Every time the user collides with the part of the differential, there is an identification that a task is being performed and depending on the hierarchy and the previous task performed, a new one is generated and is placed in the hierarchy accordingly.

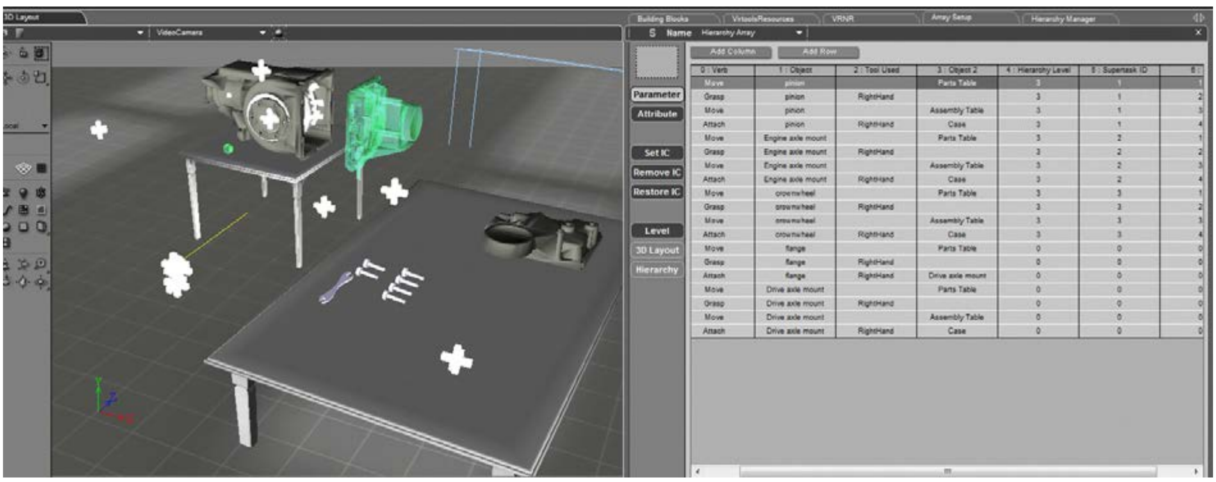



**Fig. 1 The differential assembly in the VE and the generated HTA**

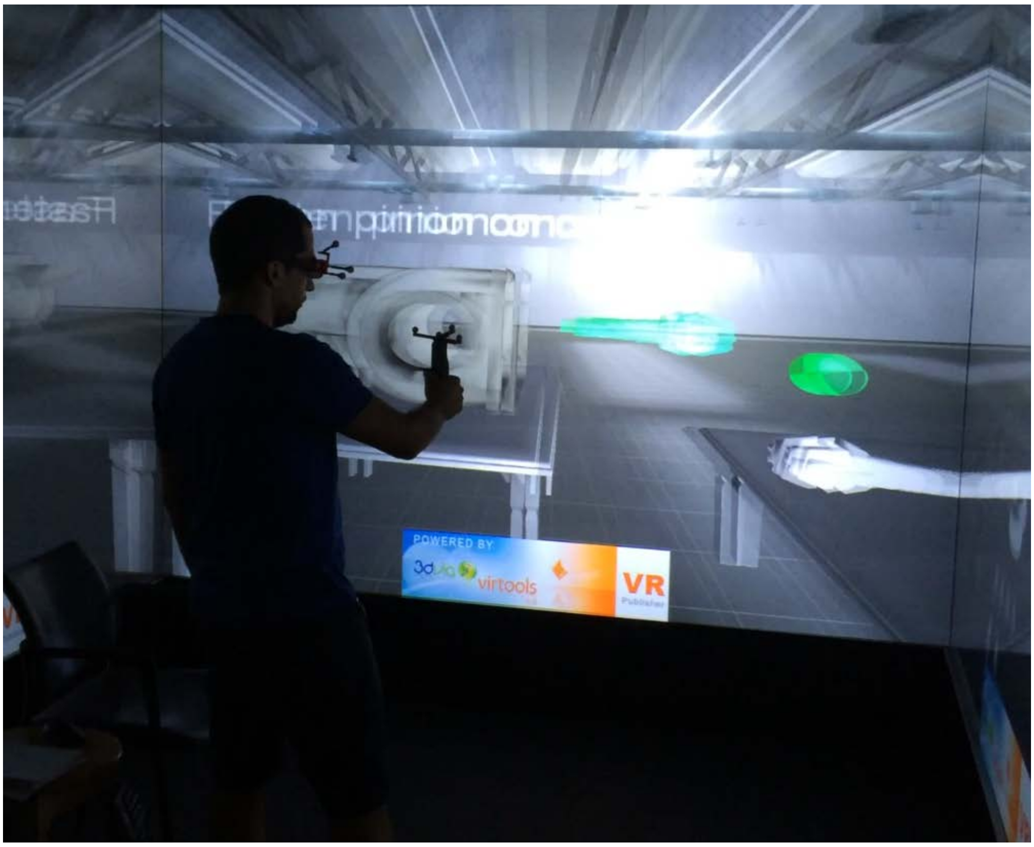



**Fig. 2 Operator performing the assembly task in the virtual environment**

# Technion:

# Gender Dimension in Conceptual Modeling & Visualization of Brain Activity during Learning Processes

**Proposer**: Prof. Valéria Csépe, University of Hungary

**Visited laboratory**: Technion, Enterprise Systems Modeling Laboratory (ESML), Haifa, Israel

**Visit Dates**: October, 2014

The main objective of the project was to link two fields of research, modeling and cognitive neuroscience, in order to use visualization to understand the complexity of spatial cognition as well as gender-related differences in learning and executing spatial tasks. The brain measurements carried out in Budapest (Hungary) generated a large amount of data that is very complex to analyze so that using visualization methods were assumed to help understand the complex system of spatial cognition and shed light on knowledge gaps researchers are not aware of.

Four working days were used for Conceptual Modeling of Human Navigation performed by Professor Dov Dori and Professor Judy Dori's research teams by using OPM (Object-Process Methodology). Our team made use of OPM and of the state of the art research and expertise in studying spatial cognition with behavioural and neuroscientific methods. In these four working days we created two versions of a general model of human navigation and included the gender dimension in the third version (last working day). We ran the conceptual simulation for validation and verification (last working day). The testing phase will include a new set of knowledge derived from behavioural and brain data recorded in subjects of both gender in the NeuroCogSpace Lab (NCSL) in Budapest providing further details for developing an evidence-based Gender Dimension Human Navigation Model (GDHNM). The outcomes of the project have both theoretical and practical implications; they will highlight controversies in brain research on human navigation and provide a relevant contribution to develop gender-specific learning methods to help improving STEM education.

The visit gave Prof. Csepe the opportunity to discuss the approaches and methods of Conceptual Modeling with Professor Dov Dori and Judy Dori, to learn more about the ESML, as well about the application of OPM for complex biological systems provided by and discussed with Dr. Judith Somekh. An additional benefit of Prof. Csepe's research activity at the ESML was to learn about the Technion in general and about the ongoing research at the laboratories of the Ruth and Bruce Faculty of Medicine. My visit (second working day) organized by the Dori teams gave me the opportunity to meet Professors Jackie Schiller, Hamar Kahn, Asya Rolls and Dori Derdikam. All topics and research methods discussed were highly interesting. The research work of the Biology of Spatial Memory Lab led by Professor Derdikam on the electrophysiological correlates of navigation recorded in rats in a virtual space is the animal model of the navigation in virtual maze Prof. Csepe is studying in humans. With this visit, Prof. Csepe discovered a possible link between her research work generating data that may provide even more complex information to be used for the Conceptual Modeling of Navigation.

# IRCCyN

# The use of 3D imaging techniques to digitize and visualize Technical Cultural Heritage artefacts

**Beneficiary:** Romain Jeanneret, Haute Ecole Arc Conservation-restauration (HE-Arc CR),CH-2000 Neuchâtel(CH) , romain.jeanneret@he-arc.ch.

**Host:** Florent Laroche, Ecole Centrale de Nantes - Research Institute for Communication and Cybernetics of Nantes (IRCCyN), F-44321 Nantes (FR), florent.laroche@ec-nantes.fr.

**Period:** from 16.06.2014 to 24.06.2014

## Purpose of the research

The 3D visualization of scientific and technical Cultural Heritage (ST CH) artefacts is often difficult due to their complicated shape, glossy metal surfaces and numerous mechanisms that move in different spaces. 2D representations are used to understand the links between the different parts constituting the objects, as well as the way the mechanisms run. Still, a 3D representation might be required to complete this 2D picture, as this is a more intuitive way to understand moving parts. New technologies are constantly developed to make these 3D representations much easier to obtain. The objective of this project was to get an overview of the different 3D imaging techniques that can be used on ST CH objects and to determine which technique best fits the artefact considered within this research regarding the shape and the surface rendering. The techniques that are the most accessible to end-users (conservation professionals) were further investigated to determine the conditions of a complete survey of an artefact representative of those usually found in our domain of expertise.
The project was organized to test different imaging techniques on an object representative of the problematic of CH collections. The aim was to screen the possibilities of various technologies to acquire a proper 3D model of a ST CH object. In what follows, we review briefly the available digitization techniques before selecting the ones that are considered to be the most appropriate to the chosen artefact.

### 2.1 Classification

The digitization technique depends on the dimensions of the artefact to be acquired, the accuracy requested, the acquisition time available and the possibility to handle the object. Consequently, when dealing with digitization of heritage object, it is recommended to combine the techniques (active/passive systems with/without contact) to optimize the acquisition chain, e.g., without contact due to major degradation state. Figure 1 gives an overview of the digitization techniques that can be used.

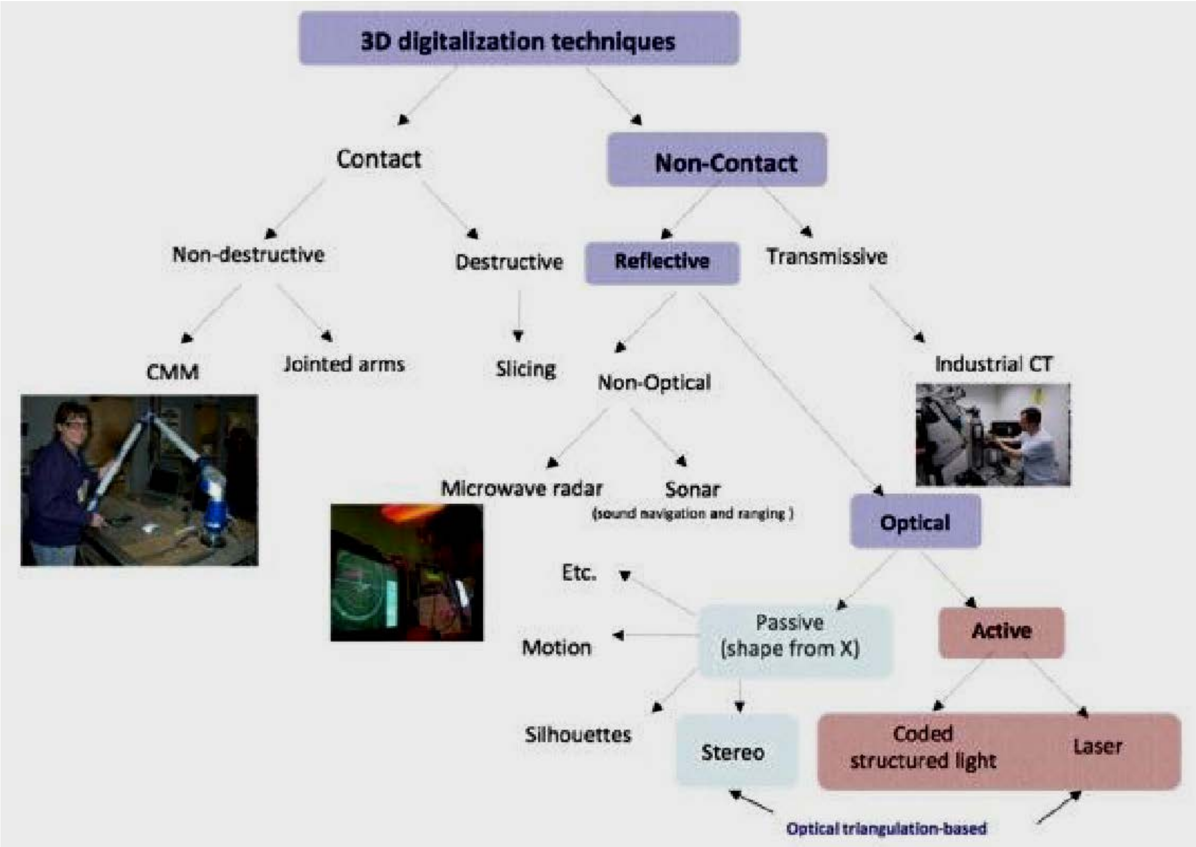



Fig. 1: Flowchart presenting the different digitization techniques (from Technologies de numérisation 3D et domaines d'applications, Boulbaba BEN AMOR, 2009).

Due to the fragility of heritage artefacts, the number of handlings that have to be done in order to get the whole 3D model has to be taken into account. If only one point of view is considered, a stereographic view will be obtained. In practice, it is necessary to combine various points of view and various types of scanners. In what follows, only the systems employed during this research are presented.

### 2.1.1. Passive systems without contact

Used for graphical design, these systems are passive without contact since they capture information with photographic systems or stereoscopic systems. The acquisition tools are cameras and movie cameras. Photographic systems allow building rapidly 3D models thanks to high definition digital photos. The process is as follows:

- Detecting common points between pictures,
- Automatic distance calculations and 3D wireframe modelling,
- Textures application using photography definition,
- Automatic virtual camera or virtual video camera positioning.

The precision of the model depends on the cameras definition.

### 2.1.2. Active systems without contact

Active systems without contact are technologies, such as laser, that generate short waves for measurements. According to the object size to be digitized, there are various solutions:
- TMM laser radar: High speed, high accuracy

- 3D laser scanner: These are the most popular and are used in medicine, industrial engineering, archaeology, e.g., Minolta
- X-ray tomographic systems
- Interferometer with fiber-optic
- Optic measurement system

**2.2. Techniques selected**

Considering the short duration of the project (10 days) and the relative availability of different techniques, a selection of two optical techniques was made by the host: photogrammetry (passive system) and handheld self-positioning 3D laser scanner (active system). We also decided to add the preliminary results acquired by the beneficiary during the COSCH Training School held in Warsaw on robotized structured light (active) system in November 2013.

Trial version of relevant software packages were also provided to the beneficiary with tutorials to test some specificities of these packages and continue the work carried out in Nantes beyond the project. I was also invited to seminars held by the IRCCyN during the project around visualization and virtual reality. The aim of those was to learn about new possibilities and developments in virtual reality and possible applications for ST CH artefacts.

As our investigation progressed, we saw the importance of extending the aims of digitization within the process and not limiting ourselves to technical aspects only. Having an insight on three different scanning techniques was enough to raise questions related to the conservation-restoration field. We found it necessary to review these techniques considering the final use of the 3D model, the study specificity, and the accessibility of the technology. A list of potential applications of 3D models to ST CH artefacts is presented in section 3.6. One final need considered especially for ST CH objects is the use of the 3D model to explain “how it works”. That is, virtually putting togehter the mechanism in order for them to function again, making each part moving with its specific interactions. Reverse engineering seems to be a good solution.

**2.3. The object under consideration**

The object chosen is a ring enlarger used to enlarge stone-set rings (Figure 2). This ring roller rolls out the shanks, thus stretching the metal and enlarging the size without popping out the stones or damaging the settings. It regroups specificities of ST CH objects such as glossy surfaces (plated steel), moving parts and complex shapes (gears), as well as finely worked surfaces (knurling), etc.

Fig. 2: View of the ring enlarger used for our digitization tests.

Treating such a complex object, we are interested in seeing how much relevant information the 3D model can carry. Can a 3D model be used as an information source like the real object? Should the 3D model be a perfect copy of the reality? In the case of the ring enlarger and its knurled handle, what would be the relevance of having sufficient spatial resolution for the knurling to be represented in volume? Would the application of a photographic or schematic texture be enough? It all depends on the final use of the 3D model. If the presence of knurling on the handle should be indicated, a schematic drawing might be enough. If a real close view or the monitoring of the corrosion development is required, applying a photographic texture should be sufficient. If the study of the wear of the knurled surface is of interest, a spatial high-resolution image would be necessary.

## 3. Description of the main results achieved

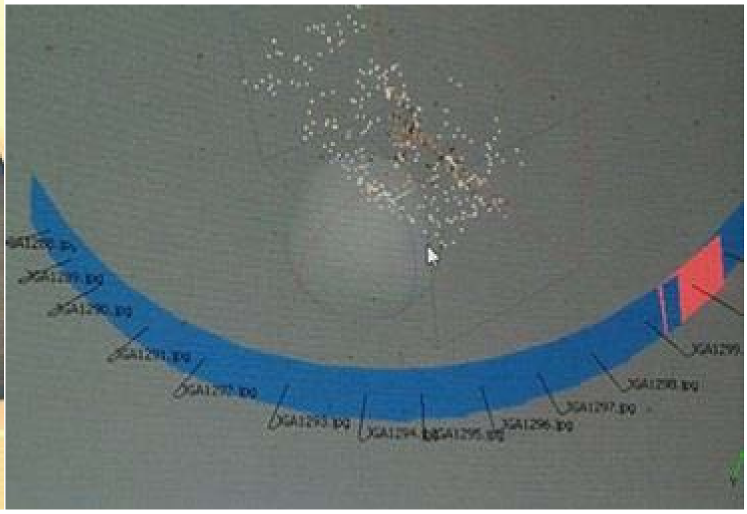


Fig. 3: Home-made light tent.

Fig. 4: Alignment of pictures inside the software.

After the photo campaign, the whole set of pictures (.tiff) were improved with a proper software package, such as Lightroom® or Capture One®. The pictures were then imported into Agisoft PhotoScan Professional® to create the 3D model. The computer interprets the relative position of the camera and the object. First, S. Jupin started by testing the 3D reconstruction using only 20 pictures. Due to the use of graph paper and the high presence of the behind-scene, the software was unable to position the camera in space correctly. To limit errors of interpretation, we had to manually select the portion of the pictures where the object was located. After recalibration, the alignment was conducted more easily (Figure 4).

Fig. 5: View of a portion of the digitization with a high resolution texturing

The software then attempted to recognize the position of each pixel in different pictures. For proper matching, it was necessary to have the same light condition in all directions. If a pixel does not have the same property in all the pictures, it cannot be easily selected by the software for the reconstruction. The result obtained after the dense cloud correlation process was very encouraging. Once the cloud was meshed and the texture was applied, the visual aspect of the 3D-model looked very close to the actual surface (Figure 5).

Fig. 6: View of the high bumping volume of the digitization.

**3.2. Handheld self-positioning 3D Laser scan**

The second method tested is an active system without contact—a portable 3D laser scanner, the View!scan Creaform® (Figure 7). The experiments were carried out at Ecole Centrale de Nantes with Florent Laroche. After a preliminary test, we did the acquisition in the dark with the scanner being the only light source. This enabled us to limit the reflectance of other light sources on the object surfaces. To scan the object, the View!scan scanner was plugged to a computer, transferring in real-time the data to the editing software VXelement. This functionality enables the user to see directly the construction of the virtual model during scanning. The scanning rate strongly influences the level of accuracy. Our first digitization was performed with a low accuracy of 0.9mm.

The scanner always acquires data at its highest possibility but the program displays the virtual model as soon as it fulfils the parameters settled. That means that if we scan at 0.9mm (Figure 8), the virtual model will be displayed as soon as the accuracy is reached. If the level of accuracy is changed to 0.2mm all the areas that have not enough points to construct the model with this accuracy will disappear on the computer screen. Therefore the user needs to scan again these portions to have a more completed digitization (Figure 9).

Fig. 7: View of the scanning process with the computer screen at the back.

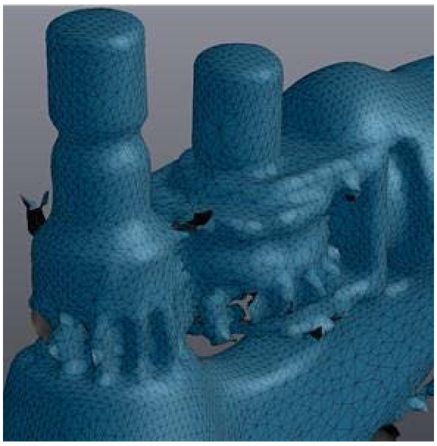


Fig. 8: Detail of the meshed 3D model with 0.9mm accuracy

Fig. 9: Detail of the meshed 3D model with 0.2mm accuracy

During the scanning, a lot of false points were scanned due to the high reflectance of the surface (Figure 10). This noise could be easily deleted by the software since the points are dispersed compared to the relevant point forming bigger groups with higher coherence.

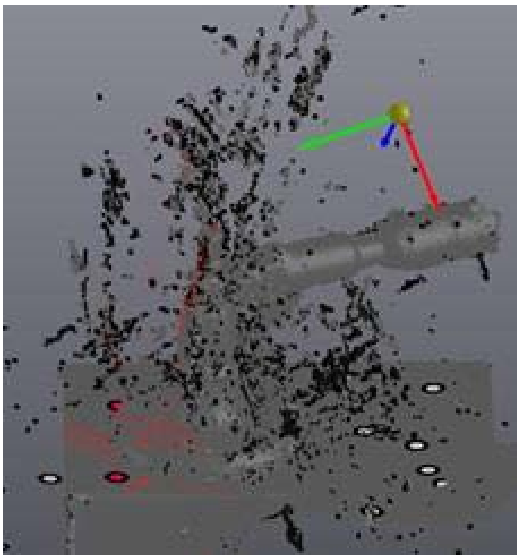


Fig. 10: View of noise points due to the highly reflective surface

With the higher resolution, we gained precious details on sharper edges, chamfers, gear tooth, etc. The knurling on the handle could be revealed without being represented completely. A 0.2mm accuracy seemed to be needed to distinguish different parts within the same object. The View!scan device is equipped with a visible light camera to acquire colour information. We made a test to see how a metallic surface could be rendered with such a technique. The result shows a medium grey applied on the whole surface (Figure 11), which is rather different from the real rendering of the metal (Figure 12). We also see the reflectance of the red laser polluting the rendering. We decided to continue the scanning without the colour acquisition.

Fig. 11: Detail of the meshed 3D model with 0.2mm accuracy and textures

Fig. 12: Detail of a picture of the real object

We scanned the object in three orientations to obtain the volume entirely. The three meshes were put together with Geomagic Studio® to obtain a unique 3D model. We did not go deep within the data processing, but a proper format (.stl) will be used for reverse-engineering with a CAO software Catia® to rebuild the object and add movement to it.

**3.3. Robotized structured light system (TS Warsaw 25-27 Nov. 2013)**

The Robotized structured light system technique was demonstrated during the COSCH Training school, jointly organized by the Warsaw University of Technology and the Museum of King Jan III's Palace at Wilanów at Warsaw in November 2013. Using this technique, a light pattern is thrown on a three-dimensional surface. The pattern appears distorted from perspectives other than the one of the projector. This new pattern can be used to reconstruct the geometry of the object. The robotized structured light system developed at the Warsaw University of Technology was applied on the ring enlarger. The object was covered with mat powder to prevent any reflectance. A thin titanium oxide layer was sprayed on the surface (Figure 13).

Fig. 13: Spraying of the ring enlarger with titanium oxide (left) to obtain a non-reflective surface (right)

In addition to being automated by using a robotic arm, the acquisition (Figure 14) enables a very high spatial resolution form (1000 to 10,000 points/mm2). Based on the experience of Eryk Bunsch (Museum of King Jan III's Palace at Wilanów), a resolution of 1600 points/mm2 is considered to be optimal for most CH artefacts.

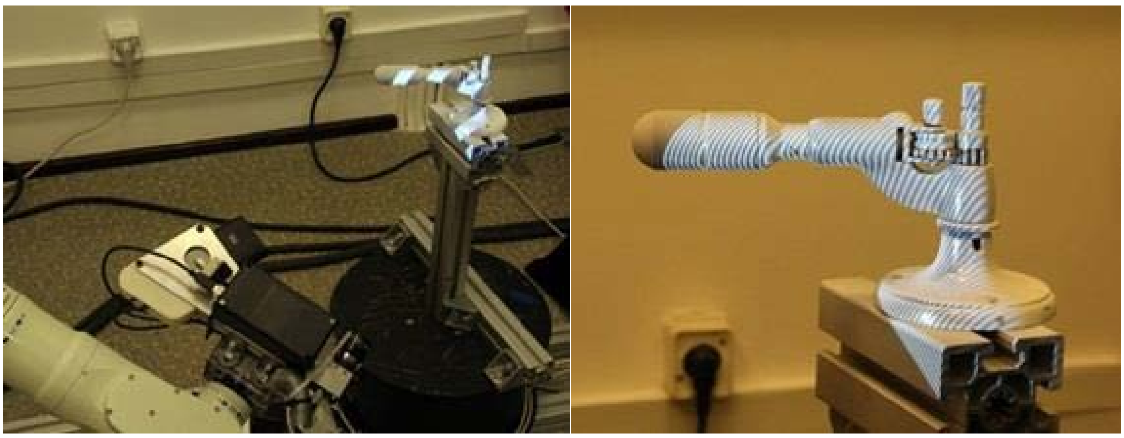


Fig. 14: View of the automated 3D scanning system with the projection of structured light on the surface of the ring enlarger

Thanks to the titanium oxide, we obtained a good digitization of the volume without reflectance. Unfortunately, the object was not correctly fixed on its support, so it moved during acquisition. Normally, the different clouds are correctly placed in space and no matching is required. In our case, the clouds had gaps between them due to the movement during the scanning. The high resolution enabled us to have surface details on the 3D model, with the gears and the knurling being well represented (Figure 15).

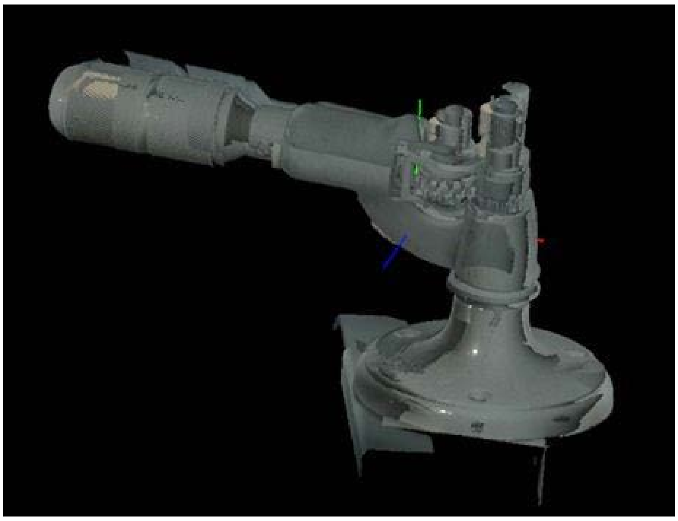


Fig. 15: View of the 3D model with the presence of the knurling and the gears.

**3.4. Reverse engineering**

For the reverse engineering work, which is still in progress, we used the result of the 3D digitization made by the Creaform View!scan. The STL data will be used for reverse-engineering with a CAO software Catia® to rebuild each part separately and add kinematic constraints. The digitized object will be used only as a geometric and dimensional reference to redraw all the parts of the object completely and manually (Figure 16).

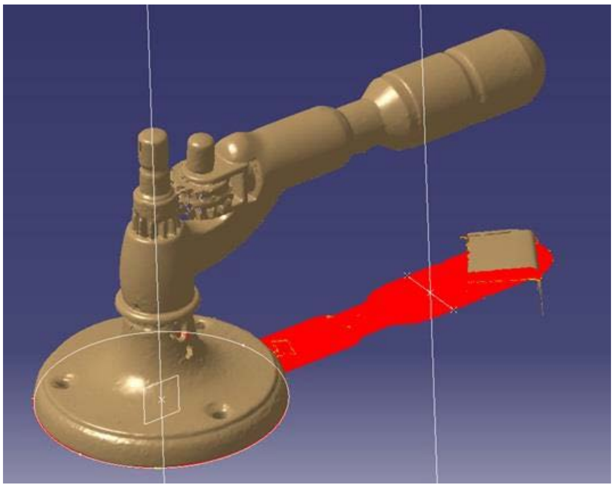


Fig. 16: View of the .stl format imported in Catia® during replacement in ortho-normative coordinate.

The first step of the reverse-engineering is to replace the model in the ortho-normative references of the workspace of the CAO software. To achieve that, the user needs to find geometric references, such as plans and axes within the 3D model. The next step is the dismantling and re-drawing of independent parts using the CATIA drawing tool. The scanned object acts like a “ghost” to give relevant measurements and shape.

At the end of the process, we expect to obtain a 3-D object with a perfect volume that is still non-representative of the reality. The 3D model can be used to get an engineer’s point of view. All the parts have a certain degree of movement and can move and interact together. This enables us to demonstrate the use of the object without putting it back in working condition. We can also add material attributes into the software and launch a simulation.

# Technion

## School as a 3D Textbook of Science and its Visualization

**Proposer**: Dr. Mirjana Popovic-Bozic, Institute of Physics, Serbia

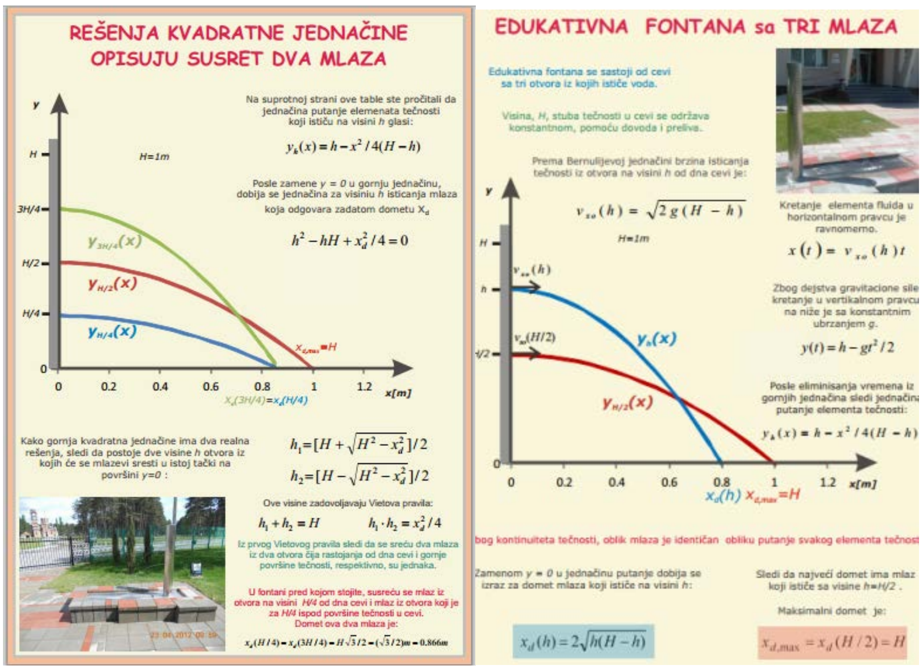
**Visited laboratory**: Enterprise Systems Modeling Laboratory (ESML), Haifa, Israel

**Visit Dates**: December, 2014

During various sessions with members of Technion's VISIONAIR team I presented the concept of School as a 3D textbook and how we implemented it in several schools and educational institutions in Serbia. Shmuela Jacobs, Noam Heimann and Dr. Niva Wengrowicz explained me the concepts and symbols of OPM and how to use OPCAT software for OPM-based conceptual modeling. Then we started to construct together an OPM model to present the concept of School as a 3D textbook. We shall continue to work on this initial model and plan to construct an OPM model for removing misconceptions in general. We shall start with OPM model for removing the misconceptions about the cause of change of seasons using the Day Night Year Globe.

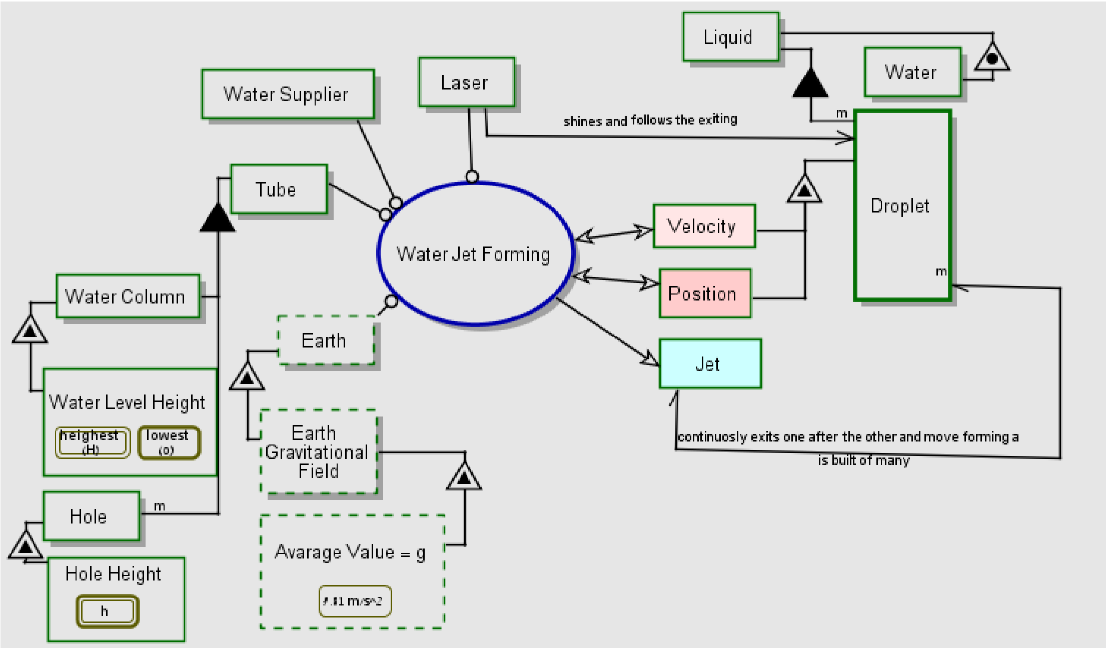
### OPM model describing the Torricelli Educating Fountain

We constructed an OPM model describing the Torricelli Educating Fountain. The figures below present the physical model of a fountain and the OPM model is described afterwards.



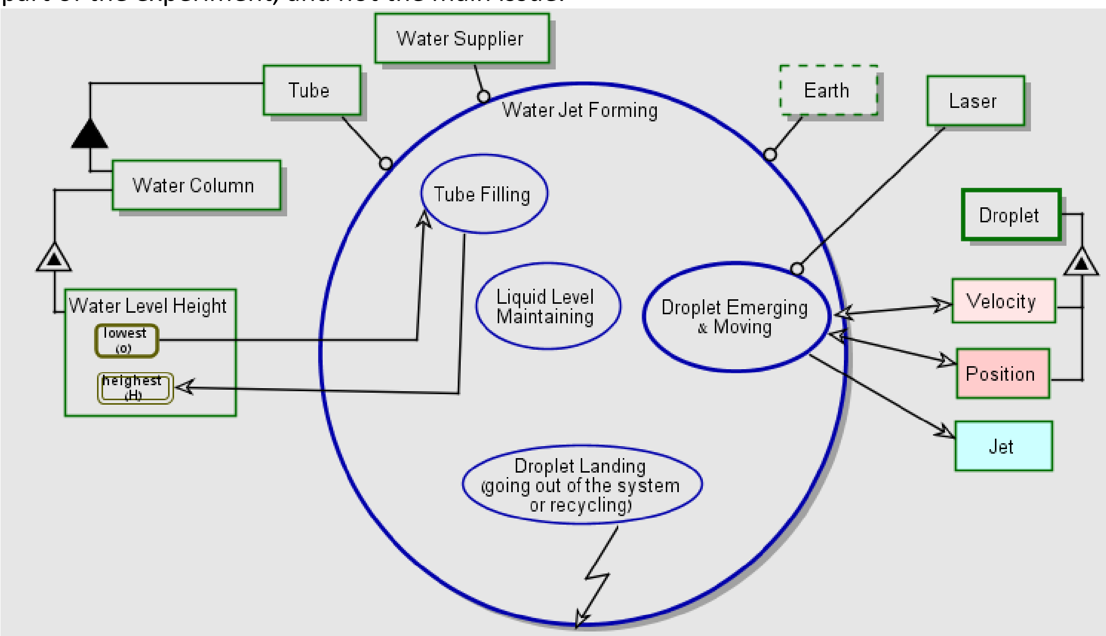

The main system diagram described the main process of this physical phenomenon and is called Water Jet Forming.  We add the main objects which take part in this process, and described which parts or which properties are actually relevant.

During the modeling we raised questions about the experiment. For example, will the equations remain the same if we use a different liquid? What will change if we take the exact gravity value at the location of the experiment? The model may be refined by taking all these factors into consideration.
The laser is not necessary, but we can improve the experiment by having lasers in different colours positioned at the tube's holes, so the light ray will follow and light each water jet. (The light will not "escape" out of the jet, and will "zig-zag" inside it, like in fiber-optics.)




**SD – Water Jet Forming**

Tube filling is the initial process. The tube has to be filled with water, and afterwards the water level should be maintained. We decided to zoom-in to these processes later on, since they are a technical part of the experiment, and not the main issue.




**SD1 – Water Jet Forming in-zoomed**

We chose to model the transformation of one droplet from the moment it exits the hole in the tube and moving through the ground. The droplet's position and velocity change in time. We can show that this process occurs to many droplets, simultaneously and consistently, thus creating the water jet.

# Grenoble

## Robot path generation and visualization: Application for virtual industrial robots learning

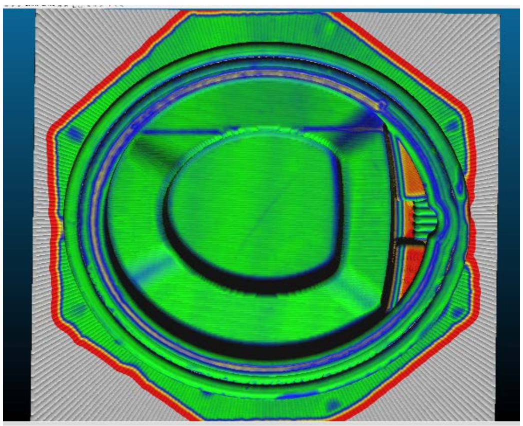
**Proposer**: Professor Bucinskas Vytautas, Lithuania

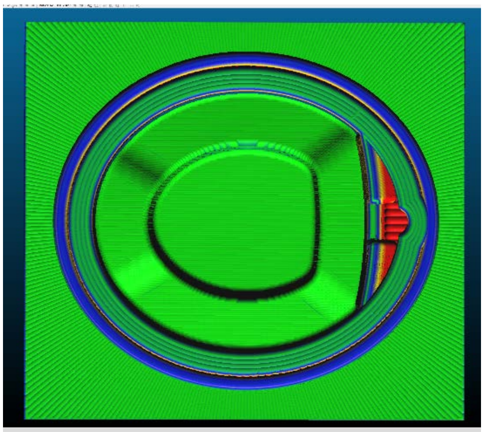
**Visited laboratory**: Grenoble-INP

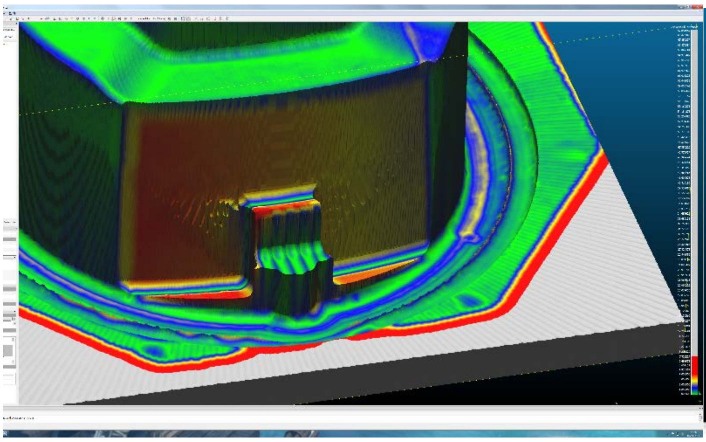
**Visit Dates**: October, 2014 – January, 2015

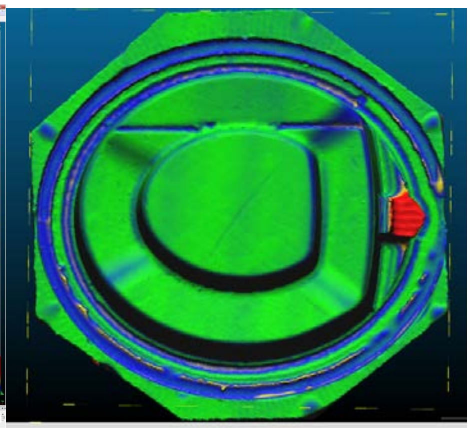
The project has been executed during three periods. The first visit from October 15th to October 17th 2014, the second from December 15th to December 19th, and the third from January 5th to January 12th 2015. The third visit was by Vytautas engineer Andrius Dzedzickis, who worked with us during the entire project as technical robotic expert.

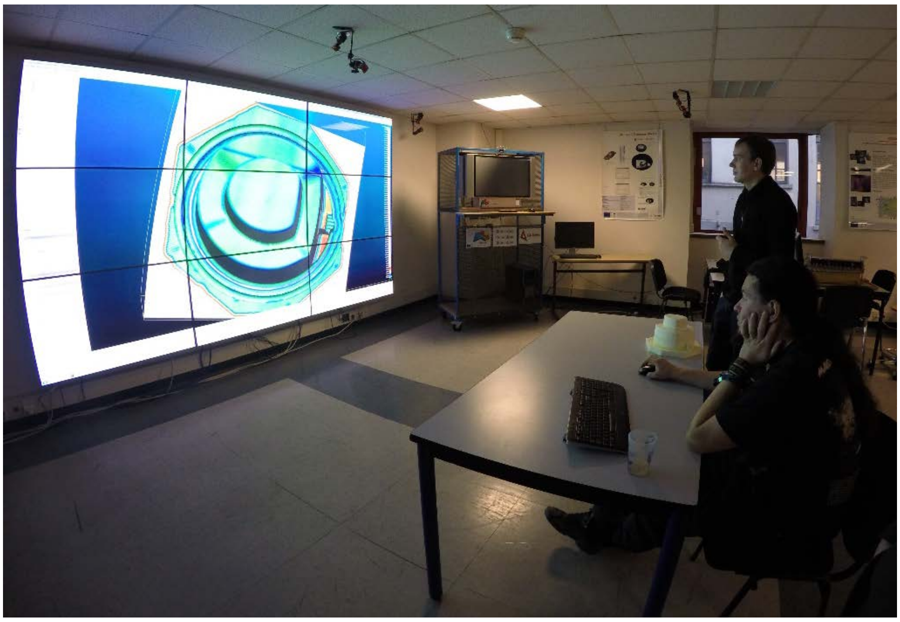
During the visit we examined the technical issues that affect the accuracy of models created by robot. We carried out comparisons of the different models and obtained results suitable for publication in a scientific article. We also created a new detailed prototype using different technologies. This provided an opportunity to compare different prototyping processes and examine high-definition visualizations advantages in detail.
The images below show our results and the setting of the visualization.











# Utwente

# Design of a Healthcare Analytics "War Room" to support healthcare data visualization for better problem solving and decision making

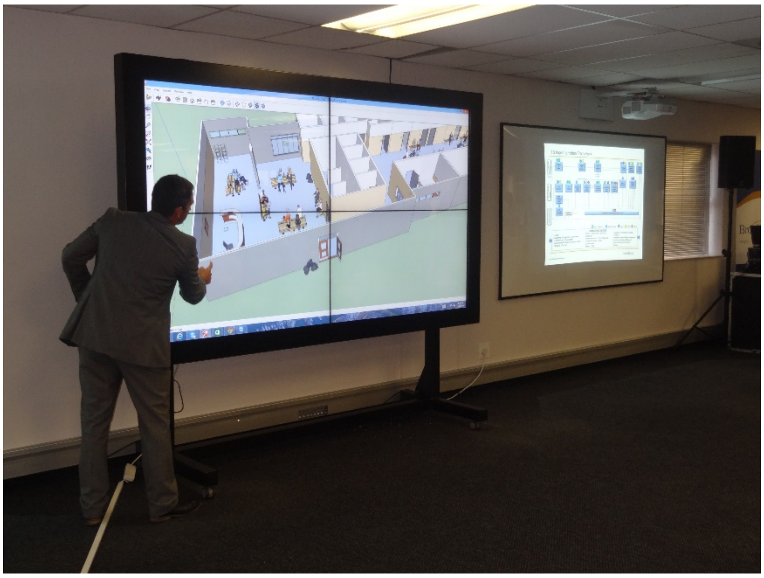
**Proposer**: Sargent John, Switzerland

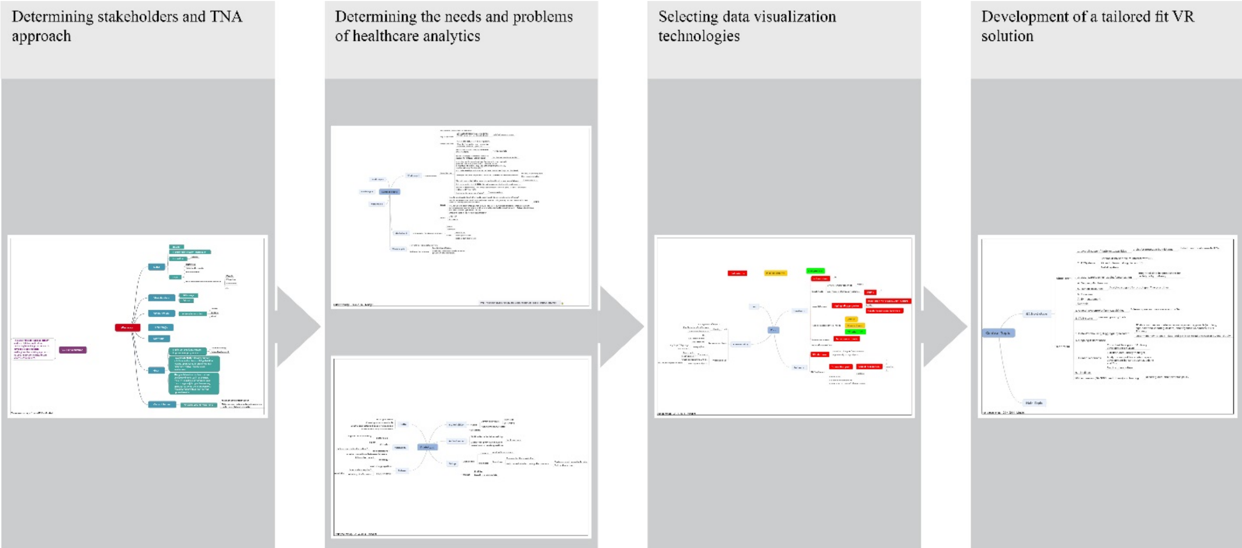
**Visit Dates**: April, 2014 and December, 2014

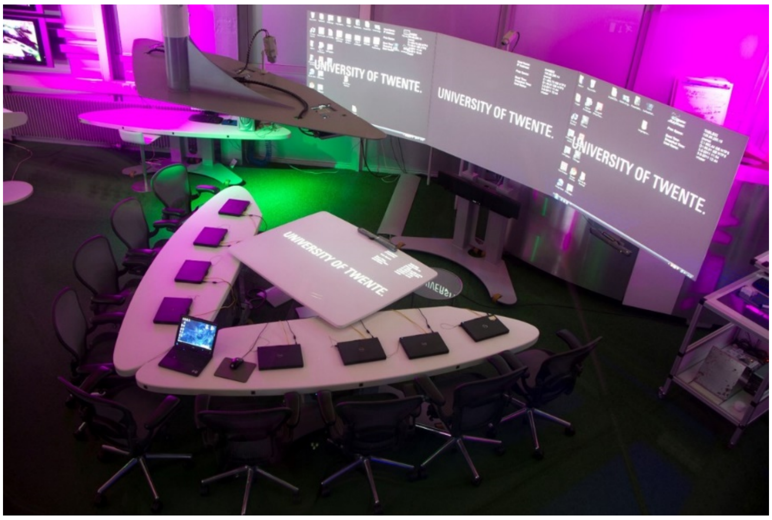
**Objectives**:
Determine various stakeholders' requirements with respect to data and visual representation of that data:

- Identify optimal data organization & tagging and structure/hierarchy approaches
- Select different data visualization techniques
- Test different visual problem solving technologies
- Finalise a decision making/problem solving approach using disparate data sets and different visualization technologies

The combination of BRHC and the University of Twente in this TNA has resulted in a workable blueprint for the development and realisation of the Health Command Centre (HCC). The approach was based on existing data and knowledge where BRHC already has been working on for over a decade, in combination with the process of developing a Synthetic Environment that is constantly evolving in the VR lab. The problem-based approach has resulted initially a workable list of requirements and needs for the HCC. This overview made it possible to convert and translate this theory into a workable and effective creation of the physical HCC. The development of the HCC will be an ongoing process for the coming years, and the experience of this TNA will also improve the processes used in the VR lab for future projects.




Determining stakeholders and TNA approach
Determining the needs and problems of healthcare analytics
Selecting data visualization technologies
Development of a tailored fit VR solution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# Inria, Hybrid Team Rennes

## Electrophysiological correlate of top-down attention bias in a realistic virtual shooting environment

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**Introduction**

One well-known source of sport performance variability is the shift of attention locus from the task due to a disturbing environment. In this collaboration, we aim at studying the neural correlates of such attentional shifts using scalp electroencephalography (EEG) in a virtual reality simulation.
For this purpose we considered an Olympic virtual shooting scenario which requires a high degree of concentration and does not involve intense physical activity. The lack of physical activity ensures that EEG recordings will not be polluted with artefacts due to excessive movements. The experiment was done at the Immersia platform which provided the optimal conditions to implement such a realistic sports scenario in virtual reality, assuring a high degree of immersion and providing an ecologically valid competition scenario.

The first objective of the collaboration was to better understand, on a group level, how cortical processes are impaired by the distracting environment causing a shift in the attention locus and leading to degraded performance. Electrophysiological signals can then be correlated with shooting accuracy while controlling for the amount/strength of distracting stimuli. The second objective was to attempt to find neural markers of successful shots before the shot is actually fired, by looking at the characteristics of the brain signals at a single trial (shot) level.

**Experimental design**

The experiment followed a two by two factor design. The first factor, distraction (2-levels), relates to the presence or not of virtual opponents and a constant background noise caused by a virtual crowd. The second factor, reward (2- levels), relates to whether each shot score is accumulated (competition) or not (training).

A trial (shot) starts when the system detects that the participants raised his pistol and is aiming at the target. Participants are only allowed to shoot after five seconds of aiming and a minimum of four seconds is enforced by the protocol. After the shot, the participants are instructed to wait one second before receiving score feedback and resting. A shooting session consists of four blocks of ten shots (one block per condition). In order to avoid ordering effects both factors were counterbalanced. A small break is proposed between sessions. In total, participants performed 40 shots lasting around 40 minutes. Ten subjects were recruited during the second week of the collaboration.

The experiment has an additional purely motor control condition, where participants are be instructed to shoot without aiming the target. This control, apart from serving as training, allows possible contrasts between conditions to be compared to a condition with similar motor characteristics but without the cognitive control and visuo-motoric integration induced by aiming. Two minutes eyes-opened and eyes-closed baselines are recorded at the beginning of the experiment to compute resting-state baselines. For each trial, we recorded the score and the time spend before shooting. In addition, the aiming error (distance between the aiming projection and the centre [bull's eye]) was constantly monitored. Shooting scores are used as a behavioural measure of performance while aiming time is used as a measure of the effectiveness of attention manipulation. Regarding the physiological data, electrophysiological signals were recorded using a 64 channel Biosemi system. Additionally, three sensors record horizontal and vertical electrooculographic signals and two bipolar electromyographic recordings track muscular activity of the forearm.

**Data analysis and prior hypotheses**

Based on current literature and previous studies, we make the hypothesis that top-down attentional process can bias electrophysiological signals on various levels, depending on whether the bias influences cognitive control, motor control or visuo-motor integration.

**Cognitive control bias**

Extensive evidence has shown that frontal midline theta carries information related to executive tasks, as action monitoring, reinforcement learning or conflict detection [Trujillo et al. 2007, Cohen et al. 2008, Cavanagh et al. 2012, Cavanagh et al. 2014]. It is probable that an increase in action monitoring during aiming due to increased reward expectation and/or less distraction from virtual opponents and public will lead to an increase in spectral power in the theta band over frontal midline sensors.

**Motor control and visuo-motor integration bias**

Event-related desynchronisation (ERD) in mu and beta bands is known to take place prior to movement onset in motor areas situated in the cerebral hemisphere contralateral to the moving limb and spread to the ipsilateral during the movement [Pfurtscheller and Berghold 1989, Alegre et al. 2003]. This ipsilateral contribution has been shown to be higher in closed-loop movements with sensory feedback and to be modulated by movement complexity but also and most importantly by attentional demands [Serrien et al. 2006]. Since aiming comprises continuous visual feedback to position the arm for shooting, we can hypothesise that this visuomotor integration based closed-loop adjustments will lead to increased ipsilateral ERD contribution and could be modulated by top-down attentional biases. Nonetheless, left parietal cortex was also demonstrated to play an important role in a motor-attention cortical network [Rushworth et al. 2001], so we cannot rule out that differences could be found in the contralateral hemisphere. Finally, occipital spectral power as well as fronto-occipital synchronisation in the alpha band are known to be related to increases in visual attention and could be modulated by our experimental manipulation.

**Preliminary results**

Repeated measure ANOVA on behavioural data showed that the reward level (accumulating the score) had a significant effect on shooting times ($F(1,9)=11.097$, $p=0.009$) while the presence of avatars did not have a significant effect on shooting time ($F(1,9)=3.408$, $p=0.098$). Nonetheless, this analysis was done on a group level and subjects reported different behavioural adjustments to the increase of stress provoked by the presence of avatars, some of them increasing attention on the task while others got disappointed by losing against the avatars and lessened their engagement in the task. EEG data analysis is ongoing.