

**Paul VOOGT**

## ***The museum as a platform for public engagement with science***

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### **Abstract**

Utrecht University is one of the pioneers of Open Science. Open Science is a movement to make science more accessible and more relevant to society. One of its pillars is public engagement with science: to involve society in science and science in society. Utrecht University Museum was founded in 1928 and opened at its current location in 1996. The museum presents the university's heritage and connects it with current research. The number of visitors to the museum has increased rapidly over the last two decades, from 10.000 in 1996 to around 75.000 now. The main target group are families with children aged 8 - 14 and school groups with pupils of the same age. It is a family museum, not a children's museum. Due to of the rapid growth in visitor numbers, but also because of the new strategic goal as a platform for public engagement, it was decided to rebuild and refurbish the entire museum. The museum plans to close for renewal in 2020 and reopen again in 2022. The ambition is to become the first research museum of the Netherlands. Not a science museum, that presents the results of scientific research, but a research museum, that involves the visitor in the scientific process. The museum will not just explain what the scientific method is, but allow the public to perform the scientific method, and in so doing understand more about the nature of scientific « facts ». The goal is not to make them more trusting of scientific institutions, but better citizens of a democracy who can engage themselves in informed debate about scientific issues, going beyond sound bites.

**Keywords** : research museum, public engagement, citizen science, outreach.

## Résumé

L'Université d'Utrecht est l'une des pionnières de l'Open Science, un mouvement visant à rendre la science plus accessible et plus pertinente pour la société. L'un de ses fondements est l'engagement du public envers la science : impliquer la société dans la science et la science dans la société. Le Musée de l'Université d'Utrecht a été fondé en 1928 et a ouvert les portes de son actuelle implantation en 1996. Le musée présente le patrimoine de l'université et le relie aux recherches en cours. Le nombre de visiteurs du musée a augmenté rapidement au cours des deux dernières décennies, passant de 10.000 en 1996 à environ 75.000 aujourd'hui. Les familles avec des enfants âgés de 8 à 14 ans et les groupes scolaires avec des élèves du même âge constituent le public principal. Il s'agit d'un musée familial et non d'un musée pour enfants. En raison de la croissance rapide du nombre de visiteurs, mais aussi du nouvel objectif stratégique du musée en tant que plateforme d'engagement public, il a été décidé de reconstruire et de rénover l'ensemble du musée. La fermeture du musée est prévue en 2020 pour une réouverture en 2022. L'ambition est de devenir le premier musée de recherche des Pays-Bas. Non pas un musée de la science (qui présente les résultats de la recherche scientifique), mais un musée de la recherche qui implique le visiteur dans le processus scientifique. Le musée ne se contentera pas d'expliquer ce qu'est la méthode scientifique mais il permettra au public de l'appliquer et, ce faisant, de mieux comprendre la nature des « faits » scientifiques. L'objectif n'est pas de rendre le public plus confiant envers les institutions scientifiques mais d'en faire de meilleurs citoyens engagés dans un débat démocratique éclairé sur des questions scientifiques.

**Mots-clés** : musée de recherche, engagement du public, science citoyenne, sensibilisation.

Utrecht University Museum is about to undergo a complete redevelopment as a platform for public engagement with science. This paper will offer an impression of the current museum and of the new strategy, in a new building. It will conclude with sharing some of the challenges that we face.

## **Introduction**

Utrecht University Museum is part of Utrecht University, a broad research university with 7 faculties. The university was founded in 1636. It currently has approximately 30.000 students, 6000 staff and 600 professors. Its Shanghai ranking is 49.

Utrecht University Museum was founded in 1928. Its current location is the former botanical laboratory of the university, in the city centre. The backyard is the old botanical garden of the university, which was founded in the 17th century and came to this location in 1723. The permanent exhibitions of the museum reflect the history of science in Utrecht. The collections date back to the 18<sup>th</sup> century with a few 17<sup>th</sup> century highlights, like a Van Leeuwenhoek microscope. The total collection comprises about 200.000 objects, in all fields of science that are currently taught or have been taught in Utrecht. All collections of Utrecht University have been centralized in the museum's storerooms, with a few exceptions in the medical faculty. The museum still collects present-day objects that reflect research and education in Utrecht.

Dr. Marta Lourenço performed a scan of the collections in 2016. She is a scientific collections and academic heritage researcher at the University of Lisbon and chair of ICOM-UMAC. She ranks the Utrecht collection among the most comprehensive and diverse in any university museum in Europe. Its unique character is its coherence: the collections have always been preserved in situ and in their context (LOURENÇO 2017).



Figure 1 - An impression of the permanent exhibitions: the anatomical cabinet of Professor Bleuland, dating from the 18th century. Photo: Utrecht University Museum.

## **A family museum**

Utrecht University Museum is much more than a showroom of historical objects. It is a family museum, with many interactive presentations and hands-on experiences. In the Youth Lab, families can do their own experiments and discover more about their senses: touch, hearing, smell but also sight. The Youth Lab is a very popular part of the museum. The museum's target groups are families with children aged 8-14 and school-groups of the same age. Why this age group? Because the museum's experience is that this age group is still open and curious enough to engage themselves with all different fields of sciences. Once they are over 14, most children already have fixed ideas about what they can and can't do and what they like and don't like. But at a younger age, they are not yet as prejudiced. The museum hopes to kindle the broad curiosity that they still possess at this age. It aims at family visits: children visiting with their parents or grandparents and at intergenerational exchange, which has been proven to enhance learning.



Figure 2 - Zoetrope at the museum's Youth Lab. Photo: Utrecht University Museum.

### **Students and staff of the university**

The main target group of the museum is the general public. Students and staff of the university also play an important role, not as the primary target group, but as contributors. They are engaged in the museum's scientific outreach work.

All museum guides are students of Utrecht University. The museum recruits them in a rigorous selection procedure and trains them. Those who pass the selection and training process get a paid position on an on-call contract. The goal is to keep them attached for several years, during which the museum regularly monitors their performance. Because of their age, they connect very easily with the museum's young visitors. Academic staff are partners in the museum's programs. Next to, or as part of the exhibitions, there is always some form of programming where they play a role, varying from short lectures to citizen science programs that can last for many months.



Figure 3 - Students and staff of Utrecht University engaged in science outreach work at the museum.  
Photo: Utrecht University Museum.

### **Reasons for redevelopment: visitor numbers and strategic shift**

There are basically two main reasons for the renovation and refurbishment of the museum. The first reason is the number of visitors. The museum was founded in 1928, but for a long time it attracted hardly any visitors from outside. From the time that it opened at its current location, visitor numbers grew rapidly. When it opened in 1996 it attracted 10.000 visitors per year and the ambition was to reach 25.000. The building was designed for this number of visitors. Now it has reached three times that number: 75.000, and is still growing. In the Netherlands this puts it in the bracket of medium-sized museums. The numbers are expected to grow further in the near future. The demographics of Utrecht and its environment are supportive: it is the most highly educated, fastest growing and youngest city of the Netherlands. The current design of the building is not able to absorb these numbers. The museum will stay at its current location, but enlarge the space.

All the halls of the museum will be completely refurbished as well. All exhibitions will be new. The main reasons for the new exhibitions is a strategic shift: to become a platform for public engagement as part of the Open Science strategy of the university. Utrecht University aims to make a difference outside the university walls, to have an impact on society. Utrecht University is one of the pioneers of Open Science, a movement to make science more accessible and more relevant to society. It starts from the conviction that scientific research can contribute to the solutions of complex problems in society and that it can do this even better when knowledge is shared with stakeholders. Not only at the end of the pipeline, when knowledge is applied, but also at the start, with the development of knowledge and ultimately even at the stage of setting the agenda for research.

One of its pillars is Open Access: unlimited access to scientific publications and research data. Another important aspect is Public Engagement with science: to involve society in science and science in society. It is a two-way process with real interaction that is beneficial to both parties. It is beneficial for the public, who become more involved in science and are able to make better-informed choices. And it is beneficial to the researcher, who is challenged and gets new ideas and new perspectives.

The mission of the museum is linked to the university's mission. It aims at scientific literacy: « the ability to ask questions, based on curiosity about the world around us, search for answers and know how to appreciate them ». This definition was coined by the Dutch Association of Science Museums, the VSC. Teaching the public about the scientific method is crucially important, especially in this day and age of « alternative facts ». The museum is convinced that the current fact-free discourse will not be countered by providing even more facts, but by conveying insight into methods instead of facts. Explain what the scientific

method is; that it is not about « the truth », but about putting « truths » to the test, with transparent and reproducible methods.

The ambition is to become the first *research* museum of the Netherlands. Not a *science* museum that presents the results of scientific research, but a *research* museum that involves the visitor in the scientific process. The museum will not just explain what the scientific method is, but allow the public to perform the scientific method, and in doing so understand more about the nature of science.



Figure 4 - From a *science* museum towards a *research* museum. Photo: Utrecht University Museum.

### **Citizen science**

The whole museum will transform into a laboratory where (historical) objects, contemporary research and inquiry-based learning are interconnected. Citizen science labs will be central in this approach. In these labs, visitors participate hands-on in real scientific research. The common denominator is that both researchers and the public will benefit. The researcher receives data and input from a very diverse audience. The level of participation varies: from test subject, to research assistant, to citizen scientist. Utrecht University Museum experimented with all of these modalities: the visitor as test subject in Skull LAB, as research assistant in Archeo LAB and as citizen scientist in Fungi LAB. In each lab the dialogue between researcher and the public is vital. Our ambition is to strive to a next level of engagement where the public helps to set the agenda for research.

The Skull LAB was a project in cooperation with a group at the medical faculty that designs facial reconstructions for people who lost part of their face or skull due to an accident or a disease. They need reference data of the build of skulls of healthy people of all ages. The museum invited them to set up a 3D photography unit on the museum floor and take pictures of the skulls of the visitors, as part of an exhibition on the subject. Next was an archeology lab. In this Archeo LAB, the visitors helped to sort out archeological



streets of the model. Then one can block one of the streets and observe what happens. What will be the most likely route of the crowd? This research is being used regularly by the city of Utrecht when preparing for big events.

Just the other day the research group published an academic paper on the simulation table and its use in the context of our museum.



**CrowdAR Table -  
An AR Table for Interactive Crowd Simulation**

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*Abstract*—In this paper we describe a prototype implementation of an augmented reality (AR) system for exploring and interacting with crowd simulation software. We describe a target audience and tasks relevant to the software in a science museum setting. The design of AR system can structure table computer around with handheld AR as a multipurpose and flexible implementation. Our vision has been realized as a prototypical implementation involving in hardware and software. Detailed our vision will be part of our future work.

*Index Terms*—Crowd simulation, augmented reality, interaction.

**I. INTRODUCTION**

Crowd simulation software can be used in various contexts, such as testing and how to improve crowd flow in public places [1], but also for educational purposes, such as teaching people about potential crowd-related problems in cities or at special events. Likewise, examples exist where such software has been used to teach scientific principles about running simulations to answer research questions [2]–[5]. In [3], we categorized such use cases and analyzed them according to their needs and user requirements. We identified that immersion environments with different virtual (VR) and augmented reality (AR) implementations have great potential in this context. AR implementations are particularly suited for educational purposes where experienced users include the general public and thus very significantly. Based on our analysis, we describe a particular use case in this paper: AR interfaces for access to crowd simulation software in a museum. We motivate our design choices and report on the actual implementation and summarize the current prototype along with its interaction concepts. A thorough evaluation of the system with actual end users is part of our future work. The contribution of this paper includes:

- A motivation of design requirements for a relevant use case of AR interaction in context of crowd simulation.
- A system design that is based on these requirements, implemented, and verified for its feasibility. It includes a mix of the current implementation of an AR table as well as a new interaction concept combining this table with handheld AR.

**II. CROWD SIMULATION IN A MUSEUM CONTEXT**

The goal of our research is to provide a museum in Utrecht that focuses on scientific exhibitions with a presentation installation allowing visitors to experience and learn various aspects related to crowd simulation. The system will be based on a crowd simulation framework developed in our research group. This framework covers everything from the AI for individual planning to local navigation and tracking of realistic crowd behaviors based on agent profiles and scenarios such as a scenario animation [4], [5]. Yes, it takes an interface that is easy to operate and suitable for a presentation in a museum. The purpose of this installation will be twofold. First, it should educate people about the complex, dynamic systems embedded in crowd simulation. It should create awareness, for example, to help them reflect on their own behavior in crowds, but also to illustrate the challenges and difficulties city planners or event organizers are faced with. Second, the museum also focuses on engaging the public in the process of science itself, and connecting them to actual research. Thus, the installation should also be used to teach people how simulation can be used for scientific research.

The goal is to educational purpose, the presentation should be interactive. Visitors should be able to place obstacles, such as buildings or barriers that cannot be crossed, visitors where crowd energy, such as his station, and target where crowd flows to or gather, such as food stalls at a festival. The target audience for this museum presentation varies significantly – ranging for example from very young kids to pre-school age to senior citizens. Thus, the system needs to provide an easy-to-use, yet powerful interface and interaction design.

Firstly, the installation itself should be able to deal with crowds, that is, large amounts of visitors as we anticipate larger groups, such as school classes, where each individual wants to explore the system and play with it. This, and the varying age ranges, also pose high requirements on the robustness of the implementation, since we cannot expect, for example, very young kids to always follow certain rules or behavior when playing with it. People will not be as often anticipated by the system designers.

**III. AR INSTALLATIONS – AR TABLE & HANDHELD AR**

The requirements above were identified by our own observations of different interactive museum installations. Demonstrations of preceding AR prototypes that we developed, and the feedback and comments from people at the museum where the

installation will be placed. Based on these and the analysis of different immersive technologies presented in [3], we decided on a spatial AR installation in the form of a table where AR content is projected from the top, and an additional handheld AR component that is accessed and operated by visitors via an open up mobile phone.

Special AR projects virtual elements onto reality, then augmenting it with virtual visuals. Common installations include tables where a data projector is mounted on the ceiling. Fig. 1 shows an example of an earlier demo of our system with a fixed city model. The new installation for the museum uses a mobile setup where people can place obstacles and other objects, both real and digital, onto the table.

There are several existing implementations of AR tables using data projectors to create and interact with mixed realities, that is, virtual and physical objects. Some of them just project digital content onto physical surfaces, similar to our implementation shown in Fig. 1. The final installation in the museum should however allow people to interact with a crowd simulation by both physical and virtual objects. We envision a solution where the museum provides certain blocks or obstacles, visitors can place their own physical objects on the table, or use a menu to place and manipulate digital elements via multi-touch gestures – all seamlessly integrated into one experience. From a hardware point of view, this requires the actual table (along with physical objects), a data projector creating the virtual parts of the simulation, and a camera for tracking the physical objects as well as hands of the users to realize multi-touch interaction. Our current installation uses Kinect camera for tracking, but can be extended to use alternative cameras such as the Intel RealSense if needed. In the following, we describe our implementation.

**IV. IMPLEMENTATION**

**A. AR Table**

The first step in realizing such a table is the calibration of the system, which aligns the camera space (i.e., the space of the table that is visible to the camera for tracking) with the projector space (i.e., the part of the simulation that is projected onto the table), and the simulation space (i.e., the 3D environment running the simulation on the computer). We are using a standard approach that detects the corners of the table to define the camera space. The projector space is determined by recursive line drawing, and both spaces are mapped using OpenCV’s warpPerspective function (see Fig. 2).

Yes, places at this table that are close enough for users to interact with its content are limited. Also, actions done by individuals to support their learning process (e.g., secrecy of meta-information) might interfere with the learning process of others. While certain parts of the simulation should be visible to everyone, a personalized view of some information might be desirable in certain situations as well.

For this reason, our AR table is complemented with handheld AR. Where the visitors in the museum are able to make use of an AR app provided by the museum that shows a live image of the AR table (via the phone’s camera) augmented with virtual information on the screen. Fig. 6 shows an exam-

Figure 6 – Testing the crowd simulation table in the museum and publication.  
Photo: Utrecht University Museum.

But of course, the historical collections will also be presented in the new museum, even more than now. The museum strives for presentations that connect the past, present and future of research at Utrecht University. Like Johanna Westerdijk, who started the fungal research at Utrecht University 100 years ago and her present-day successor Corné Pieterse. The museum shows that it is not by chance that Utrecht is outstanding in particular fields of research, but that it often has a long history.

Even the enlarged museum will be able to show only a few thousand objects in the context

of the stories that are being told. But there is an urge to also use the rest. And show the multitude of particular collections. This could be done with installations built from objects and designed by artists.

The museum will not be able to get all research groups of the university into the museum. Their work is often confined to laboratories with very specific conditions that will never be able to travel. The museum intends to overcome that problem by making live video connections with labs elsewhere on the campus.

The museum will close for refurbishment in 2020 and hopes to reopen again in 2022. The building will be closed for two years. How does it keep in touch with the public in the meantime? First by going to the schools that normally would visit the museum. In-school programs have been developed for some time already and it is bearing fruit; more and more schools participate in the program. The museum travels to the school with real objects. And - being Dutch - the bicycle is the mode of transport, a cargo-bike in this case. Apart from schools, there is outreach to other public places, like libraries and theaters in the city.

The museum also participates in events like the National Science Weekend, by bringing the programs to outside locations.

## **Challenges**

The new approach of Utrecht University Museum comes with challenges. Running a citizen science lab is a labor-intensive process. How to find research that fits the format? What does it take from both sides: the researcher and the museum? How to keep the participants informed? Utrecht University Museum is gathering experience on all of these issues and sharing them. Citizen science projects are not new for museums. But often these projects are isolated events and restricted to a limited number of scientific fields (psychology, biology). The ambition of Utrecht University Museum is to include all fields of science and to offer this form of engagement permanently, throughout the year. And to build on the experiences to break new barriers and eventually engage communities in setting the research agenda.

Choosing families as a target group is a challenge in itself, because the content needs to be interesting and enriching for all generations. The aim is not to be a children's museum, but a family museum. It means developing multi-layered exhibits and interactives and it means choosing a design that is appealing to all generations.

The unique selling point is the interaction with the audience. The new museum will no longer put all its efforts and money in costly temporary exhibitions. Programming is key: research activities, citizen science projects, interaction with scientists. These programs can be updated much quicker and easier than a big exhibition. But it also means a turnaround in the way of working: exhibition makers will become programmers. And many more members of staff on the floor are needed than the museum has now.

Each day the public can choose from a list of activities. If you just want to roam around, there will be more than enough to see, but the museum entices you to be active. Which means that it is not a museum for everybody. It will attract people who are curious about the world around them. Those who seek a thrill, an experience like in a fun-fair, which you can undergo passively, will not be attracted by the museum's offer. They will go to another museum in Utrecht that offers a roller coaster ride. So, within the target group of families a specific kind of family is targeted, mostly with a high education and an active attitude. And, as experience shows, those for whom museum-visits are part of their lifestyle.

This brings us to one of the biggest challenges of this time: how to reach a more diverse audience? Although (science) museums in the Netherlands have been striving for more diverse publics for decades now, the success rate is limited. It is not a matter of better marketing, but a matter of strategy. To be successful, the focus should not be limited to the public, but also to personnel and partners. The experience of Utrecht University Museum has shown that the threshold to come to the city centre and visit the museum remains high. More can be expected from reaching out to these audiences in their own communities. That is why the museum invests in outreach to schools, libraries and other public places during closure. If this approach proves to be successful, it will be continued after its reopening.

## **Bibliography**

HÜRST Wolfgang & GERAERTS Roland, 2019 : « Augmented and Virtual Reality Interfaces for Crowd Simulation Software-A Position Statement for Research on Use-Case-Dependent Interaction », *IEEE Virtual Humans and Crowds for Immersive Environments (VHCIE)*, p. 1-3. Available on: <https://www.researchgate.net>.

LOURENÇO Marta C., 2017: *Utrecht Universiteit museum's collections and heritage: brief*.

## **Biographical note**

Paul Voogt was Director of the Museum at the University of Utrecht in the Netherlands until 2022. Before that he was a member of the management team of the Tropenmuseum Amsterdam (ethnography) and Naturalis Leiden (natural history). He was responsible for renovation projects of the National Museum of Nairobi in Kenya and the House of Wonders Museum in Zanzibar in the early 2000's. In each museum, he was involved in/responsible for the redevelopment of permanent exhibitions. He studied anthropology at the University of Amsterdam and business administration at Henley (United Kingdom). In 2012-2013, he was a fellow at the « Noyce Leadership Program » in Palo Alto (USA) and is now a member of its successor, the « Informal Learning Leadership Collaborative ». He is currently an independent consultant in the museum field.