https://doi.org/10.2352/EI.2023.35.2.SDA-388

Virtual Reality Workshop at the Grand Challenge 2022 – A Review with two Case Studies

Bjorn Sommer[1*], Steph Jump[1], Yihan Dong[1], Kam Raoofi[1], Robert Daniel Phillips[1], Ashley Hall[1], Paul Anderson[1]
[1] School of Design, Royal College of Art, Howie Street, SW11 4AY London, United Kingdom
[*] Corresponding author: bjoern@CELLmicrocosmos.org

Abstract

Since 2016 the Grand Challenge is a large-scale interdisciplinary design event that runs each year across the entire School of Design at the Royal College of Art. A large number of Master's and PhD students with design backgrounds participate each year in this event, with the focus on tackling key global challenges through collaboration.

In 2022, the Grand Challenge was focused on elaborating topics in the context of Ocean-driven activities. Around 340 Master's students participate in this lecture module. In this context, a VR workshop was conducted with 50 students, mostly limited to no background in using VR platforms.

In the end – after a 4-week design sprint – ten functional UNREAL engine-based projects were presented by the students. We will present here two case studies – one of which was among the overall winning teams of the Grand Challenge 2022.

We discuss here the lecture, general schedule, and setup of the VR workshop. Student feedback showed that the VR workshop was overall a successful learning experience, but also signposted room for improvements in future iterations of the workshop setup.

Introduction

Grand Challenge

Since 2016 the RCA Grand Challenge is an interdisciplinary event that runs each year across the entire School of Design at the Royal College of Art. In 2022, around 340 Master's students with design background participated in this event, focusing on tackling key global challenges through collaboration. Participating programs at the School of Design were Design Products, Fashion, Global Innovation Design, Innovation Design Engineering, Intelligent Mobility, Service Design, Textiles and MRes (Design Research).

In 2022, topics were focusing on ocean-driven activities and problems in the context of the NEMO project – the New Economic Model for the Oceans [1].

As a parallel activity, it was decided to organize a *Virtual Reality (VR)* workshop to expose design students to these new emerging technologies and to test if it is possible to enable students who never worked with VR before to develop fully functional VR projects.

VR Workshop Group Composition

From the overall ca. 340 students, 50 students were selected to participate in the parallel Virtual Reality workshop. Students had to apply to get a space, provide their background information, previous experiences in terms of 3D modelling, coding, and Virtual Reality-related technologies. Students were able to provide an optional motivation text. A point-based system was used to weight student experience and engagement. As more students applied then places were available, only students who submitted a supporting motivation text had a chance to get into the workshop.

The finally selected 50 students were divided into 10 groups of 5. As it was planned from the start to use the UNREAL engine, students were asked for experiences with UNREAL, UNITY or other related platforms. As expected, most students did not have any experience with these platforms.

Therefore, it was decided to mix groups and make sure that each group had at least one to two persons who had at least minor experiences with UNREAL. In addition, each team had one to three people who used UNITY before.

We introduced the UNREAL engine to our students which was then used to develop the 10 VR projects. For this purpose, two technical instructors joined the workshop organization, who had already initial experience with teaching UNREAL engine to students at beginner level.

Lessons Learnt from Grand Challenge 2021

The VR workshop in 2022 profited from experience collected during the initial test run in 2021.

There were three major problems with the setup in 2021:

1. The delivery mode was fully remote, as all students were distributed over the world and had to work from home. Therefore, no in-person interaction was possible, VR devices had to be shipped to different locations, and students were mostly operating separately instead in groups. Moreover, we were not allowed to create VR-dedicated groups. Therefore, the largest number of students ended up in Grand Challenge groups who were not interested at all in VR as an option for delivery output – and in this way the content was very disconnected from VR.

2. Then, there was not sufficient time for the lectures and workshops, and it was not possible to deliver the context required to enable students to create VR environments given the short amount of time they had.

3. Finally, we tried to introduce the Android pipeline for exporting UNREAL projects to the Oculus Quest which could be run at the time as a standalone (without being connected to a VR-compatible computer). However, as the visual quality would have to be drastically reduced for the Android version and an extended pipeline had to be used to export for the standalone version which again required a lot of extra time to adapt to its requirements, we learnt that it would be better to stick with cable-supported/tethered direct visualization of the projects.

Technology

For Virtual Reality gear we decided to use *Head-Mounted Displays (HMDs)*. HMDs went through many developmental stages since their invention by Sutherland 1968 [2]. In recent years, the biggest advancement occurred in 2013 when the Oculus company presented the Development Kit 1 version of their HMD.

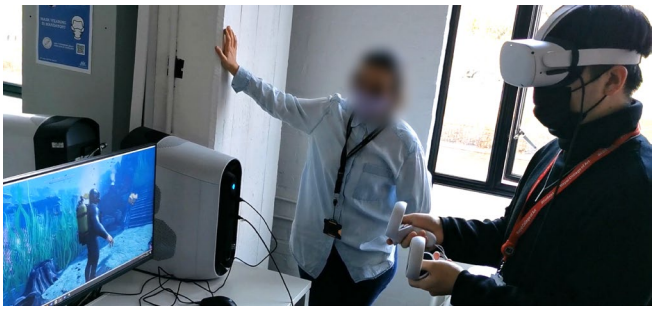

Figure 1. Ocean Investigator: Hardware Setup with Oculus Quest 2 and Alienware VR-compatible computer.

For this project, we were using one of its successors, the Oculus Quest 2.

Alienware computers with VR-compatible graphics (NVIDIA RTX 3080) were used for visualization as well as interaction purposes. For teaching, a computer workshop space was used which provided workstations for around 20 students.

Figure 1 shows the hardware setup. The Oculus Quest 2 was connected via Oculus Link cable to an Alienware VR-compatible computer with an integrated NVIDIA graphics.

The Lecture setup and Workshop Plan

The whole taught module ran from January 10 to February 4, 2022. As there was not much time available for our workshop setup, we had only very limited time to provide introduction lectures. Each week was initiated by a lecture (Figure 2). Afterwards we made a survey to find out how useful the lectures were in the context of the workshop setup (number of submitted answers: 13):

- Lecture 1: An Introduction
- Lecture 2: Tech & Immersive Analytics (preferred by 46.2%)
- Lecture 3: VR Lite & Stereoscopy (preferred by 7.7%)
- Extra Lecture: Data Visualization (preferred by 30.8%)
- The lectures were not useful at all (15.4%)

For some students who never worked with VR technologies in previous projects, it was rather challenging to learn how to use those technologies in this short amount of time, some students were struggling with the short-paced workshop and lecture setup.

We also evaluated the workshops (number of submitted answers: 15):

- Workshop 1: Framework (20%)
- Workshop 2: Interaction & Blueprints (60%)
- Workshop 3: Experiments (6.7%)
- The workshops were not useful at all (13.3%)

The workshops were organized in hands-on sessions during which students were introduced to the UNREAL engine, its blueprint concept, implementation of interactions, how to connect to the previously-mentioned VR hardware, and how to optimize the environment for interactive VR demonstrations. All workshop sessions were recorded to enable students to revisit its content and pick up where they probably missed out on some content and/or working steps.

In addition, tutorials were provided on an individual sign-up basis to help students modeling and setting up their VR environments.

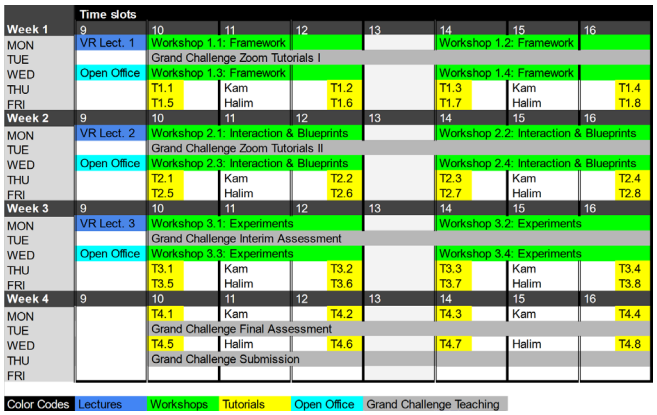

Figure 2. Time plan for the Grand Challenge Workshop which happened from January 10 to February 4

Two Case Studies from Grand Challenge 2022

As previously mentioned, the Grand Challenge is an annual competition that brings together multidiciplinary designers across the School of Design at the Royal College of Art.

The two case studies we are discussing here were realized by students from the following programs: Design Products, Fashion, Global Innovation Design, Innovation Design Engineering, Intelligent Mobility, as well as Service Design.

Whereas the first case study used UNREAL to conceptualize and design a computer game, the second one focused on illustrating different time-dependent scenarios using UNREAL.

The second case study "Decibel" was one of the three overall winning projects of the Grand Challenge 2022, while the first one "Ocean Investigator" was involved in a successful Pokémon Scholarship award application.

Case Study 1: Ocean Investigator

Designed for the RCA x Logitech 2021/22 Grand Challenge competition, 'Ocean Detective' is an immersive VR environment and game concept. It is aimed at educating students about science and environmentalism in an engaging way. Ocean Detective takes players around the globe to solve real-world ocean mysteries, from investigating coral bleaching at the Great Barrier Reef to uncovering the source of microplastics on the ocean floor. Along the way, players can collect personalized "skins" — digital garments inspired by the various sea creatures they help, which can be exported to other digital environments such as the Metaverse or AR.

The question the students were following in this project was: "How might we increase people's sense of ownership of the ocean?"

The UNREAL project consisted of two main level.

The first level is an early prototype of the entry point to the application and should give an idea how a user in the future could switch between different levels (Figure 3).

The second level presents a working prototype of the computer game component which provides different, partly interactive activities.

Plastic waste bottles can be collected when the user is navigating towards the bottle (Figure 4). Moreover, the user can collect the Crown-of-Thorn Star Fish which is toxic to the great barrier reef by using the Quest 2 controllers (Figure 5).

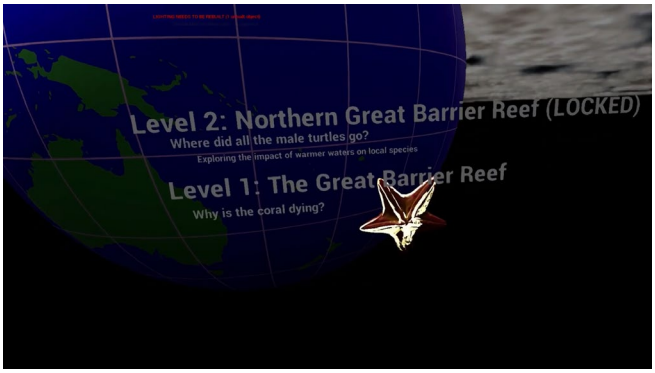

Figure 3. Ocean Investigator: An early prototype of the Entry Point which allows to select different levels.

Figure 4. Ocean Investigator: Bottle Collection.

Figure 5. Ocean Investigator: Collection of toxic crown-of-thorn star fish to save the corals from being destroyed.

The scenario contains different characters, such as divers and sea creatures, which in future versions of the software would communicate and interact with the user (Figure 6). Different versions of digital garments or "skins" would be provided to the user during different missions (Figure 7).

Up to now, a working prototype of the Ocean Investigator exists which implements a few elements of the final vision – especially the bottle collection is a functional feature which can be used to show the potential of the overall vision.

Figure 6. Ocean Investigator: Communication with sea creature characters in the virtual water world.

Figure 7. Ocean Investigator: Exhibition of digital garments or "skins" in the virtual ocean world.

Case Study 2: Decibel

Decibel, one of winners of RCA x Logitech 2021/22 Grand Challenge competition, focuses on the invisible sound pollution in the ocean. The issue of underwater sound pollution is a pressing concern that has been widely neglected. Marine animals rely on their hearing to survive, but human activities have resulted in an alarming increase in sound levels in the oceans. According to the Animal Welfare Institute, 27 species of marine mammals are currently affected by noise pollution. Decibel tackles on how to prevent the growing noise from shipping while safeguarding marine animals and mitigating underwater sound pollution.

A team of five interdisciplinary designers adopted an animal-centered design methodology to tackle this challenge. As the original application area, they were looking at sound pollution-related problems in North Norfolk (Figure 8). After conducting in-depth user and secondary research and utilizing iterative sketching and prototyping, they developed a solution for underwater sound barriers (Figure 9). The solution comprises modular hexagonal oyster pods on which kelp is grown, acting as a natural sound barrier between shipping highways while simultaneously creating a regenerative marine permaculture system.

This innovation also paves the way for a circular economy system where oysters, fish, and kelp can be harvested sustainably. The proposed location for implementation is Northern California, where kelp forests have dwindled by over 95% due to noise pollution.

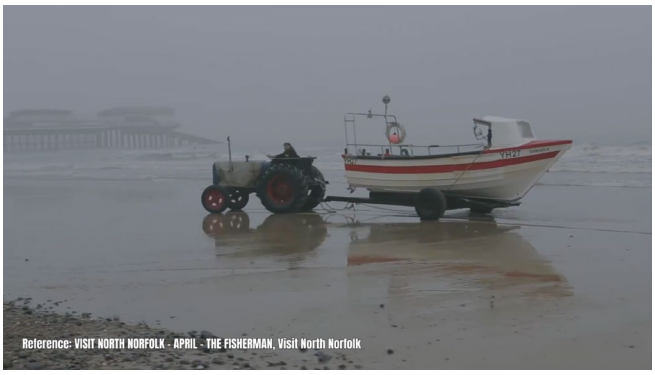

Figure 8. Decibel: Video Footage from Visiting North Norfolk – Fishermen transporting their working equipment.

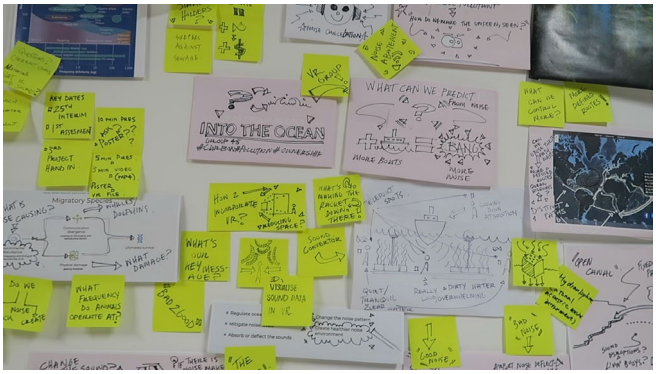

Figure 9. Decibel: Cross-disciplinary collaboration of research and ideation, showing here results of the collaborative brainstorming process.

Figure 10. Decibel: Noise pollution visualization in VR showing noise emitted from a boat.

The solution is designed to rebalance the ecosystem and enhance biodiversity, while also enabling fishermen to obtain agricultural products and form a circular economy system. The highlight of this project is to make the invisible pollutant visible; an immersive virtual reality (VR) experience was created for decision-makers and UN bodies to comprehend the magnitude of sound pollution in the oceans and how the Decibel solution could mitigate sound pollution from ship propellers when implemented.

Figure 11. Decibel: Kelp as living absorption material to reduce underwater noise.

Figure 12. Decibel: Marine habitat thriving after the sound pollution barriers established an underwater kelp forest absorbing the sounds from boats.

Decibel holds the belief that virtual reality (VR) is an influential instrument for storytelling, capable of enabling audiences to view issues from a firsthand perspective and foster empathy towards them.

The VR experience consists of three distinct scenes. In the first scene, noise emitting from a boat is portrayed as black polluting bubbles (Figure 10), which affects the surrounding ecosystem and environment.

In the next scene, set a few years in the future, the installation of the underwater kelp sound barriers insulates noise for the habitats (Figure 11).

The final scene showcases thriving marine habitats with the reduction of affected noise (Figure 12).

Decibel is a nature-based solution for noise pollution, which is an invisible yet significant and often deadly threat to marine life. It offers a framework on which kelp and oysters can be cultivated, effectively serving as a natural barrier to reduce sound levels in shipping highways while simultaneously creating a regenerative marine permaculture system.

The innovation serves a dual purpose as the growth of kelp reinforces sound protection measures. Decibel leverages the power of VR as a storytelling medium to deliver this ingenious and effective solution that addresses a pressing environmental concern, making it a valuable addition to the literature on environmental sustainability.

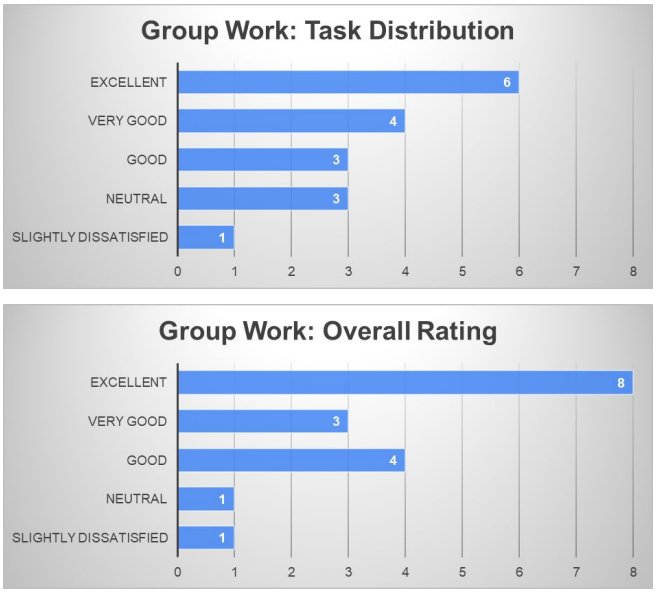

Figure 13. Group Work Rating: Task Distribution (top) and Overall (bottom)

Feedback & Evaluation

After the workshop ended, we collected feedback from 17 students. A selection of direct feedback is listed here:

- "Really great experience and very happy I was selected to be on a VR team! "
- "This workshop is one of the best experience [sic.] I have in RCA so far."
- "Please make this a separate elective course."
- "Loved the opportunity, thank you all for so much effort put in <3"
- "Thank you for making this happen."

We had a good number of positive responses and some students even suggested to create an elective based on this workshop. Since an elementary concept of this workshop was the involvement of group work, we also evaluated the group work component. As Figure 13 shows, the group work in general, as well as the task distribution, was mostly rated positively.

Figure 14 shows the overall rating of the workshop organization, the rating in terms of achieved personal goals and learning experiences during the workshop, as well as the rating for using the Oculus Quest 2, plus the information for how many hours the Quest 2 had been used at maximum per student.

As mentioned before, the workshop occurred during January 2022. Although students acknowledged the positive learning outcomes of the workshop, a couple of them criticized the fast pace of the workshop. However, some students acknowledged the fact that all sessions were recorded, so students were always able to go back to the recording and continue where they failed to keep pace.

A couple of students would have preferred to have the sessions before January 2022 to be able to practice working with UNREAL over Christmas. In this way, a couple of students struggled to realize their own ideas as they were not always sufficiently supported by those students implementing the UNREAL project.

Another problem was that due to the fast pace of the workshop, there was often not sufficient time to explain the deeper logic of e.g., Blueprints in UNREAL and communicate the specific coding jargon which was unknown to most students, as most School of Design students do not have strong coding skills.

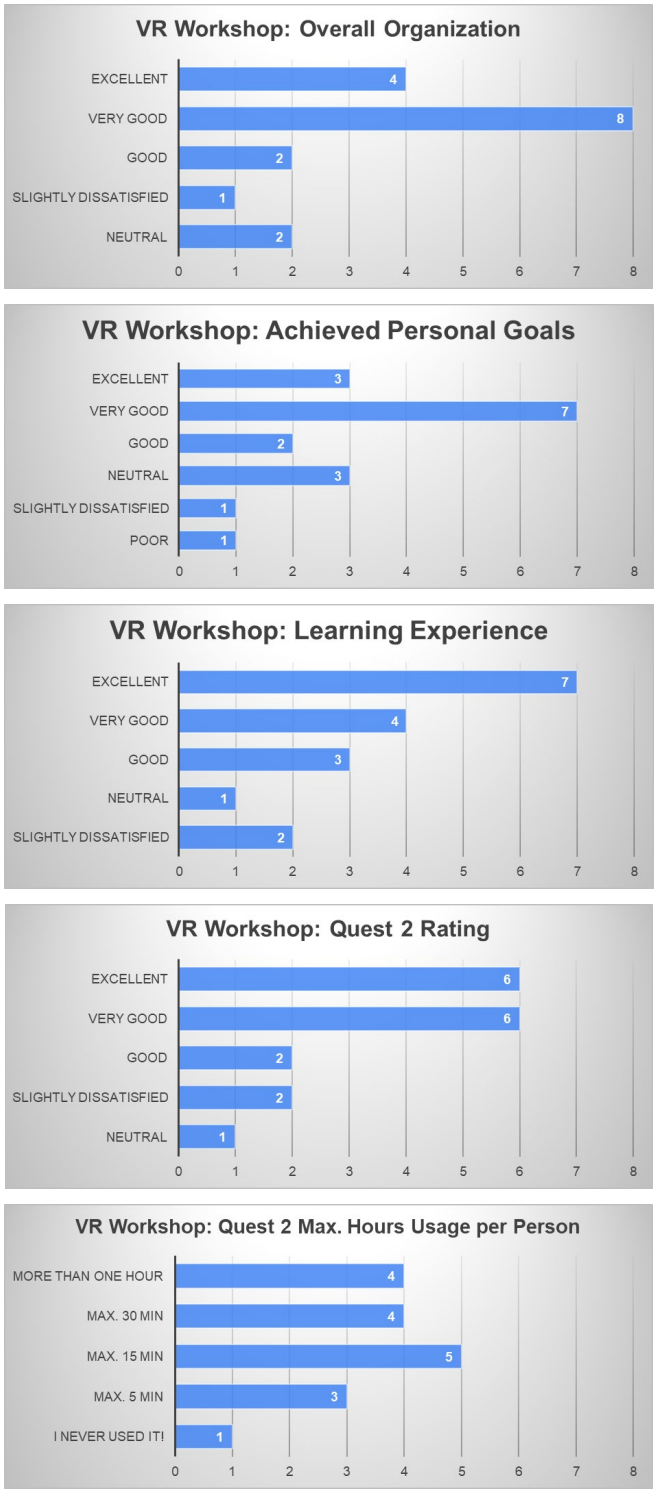

Figure 14. VR Workshop - Personal Experiences Rating (top to bottom): 1. Overall Workshop Organization, 2. Achieved Personal Goals, 3. Learning Experience, 4. Quest 2 Rating, 5. Maximum Hours the Quest 2 was used.

Summary & Outlook

In previous work, we were discussing the usefulness of VR-related technologies in the context of Immersive Design Engineering [3].

We also discussed previously-implemented Immersive Analytics projects to showcase VR technologies used in different data visualization and analysis-related contexts [4]. Immersive Analytics is an emerging field which investigates how novel interaction and display technologies may support analytical reasoning and decision making [5]. In this way it combines Visual Analytics [6], [7] – which usually tends to provide 2D visualization-based solutions – with the broad use of immersive 3D visualization and therefore largely profits from Stereoscopic 3D technologies [8].

In one previous Immersive Analytics project we were visualizing the Great Barrier Reef and related environmental effects with a tiled-display and Augmented Reality technology [9]. The Great Barrier Reef in Australia is one of the world's most important marine eco-systems and a UNESCO World Heritage Site. It has been under constant severe threat several decades [10], [11].

In more recent work, we introduced *Spatialized Video Communication Platforms* as an alternative concept to fully-immersive VR approaches in the context of distant education on one hand, and on the other, on standard video communication platforms which come with the drawback of side effects like the so-called Zoom fatigue and the very limited interaction opportunities with classmates and educators [12], [13].

Here, we discuss for the first time how we were using the UNREAL engine in the context of the Grand Challenge – a large-scale design student challenge – enabling many first-time users to get accustomed to VR technology. In this way we presented new insights in terms of immersive design education.

The use of VR technologies allows designers to engage and empathize with hard-to-reach environments like the deep ocean. The combination of data visualization allows designers and stakeholders to discover critical information combined with virtual experiences of hard to reach/hard to empathize environments. This is critical for designers who will have to engage with some the major issues of climate change. It also challenges some of the traditional forms and organization of design education and how immersive technologies are introduced into the curriculum and how they interface with user-centered design and design methods.

The Grand Challenge 2022 VR Workshop was very successful in enabling students from different design disciplines and undergraduate backgrounds to implement a functional VR project using the UNREAL engine. Although some students were able to follow this fast-paced workshop which had to follow quite tough time constraints provided by the main Grand Challenge module, all 10 groups were able to deliver a working prototype at the end.

We showcased here two successful projects which either used UNREAL as a gaming engine to create an edutainment prototype with basic functionality, or as visualization framework to illustrate different scenarios supporting the overall narrative.

Abbreviations

- 2D two-dimensional
- 3D three-dimensional
- HMD Head-Mounted Display
- S3D Stereoscopic 3-dimensional (visualization)
- VR Virtual Reality

Acknowledgement

We would like to thank all students involved in the two Grand Challenge projects showcased here, who were part of the programs Design Products, Fashion, Global Innovation Design, Innovation Design Engineering, Intelligent Mobility, as well as Service Design:

1. Ocean Investigator: Rosa Angelica Avilez (F), Ming Chen (SD), Diana Epel (IDE), Steph Jump (IDE), and Yutong Wang (DP).
2. Decibel: Yihan Dong (IDE), Richard Newman (IM), Khanh Nguyen (DP), Rhea Thomas (GID), and Haochen Zhou (SD).

Also, we would like to acknowledge the two leading tutors from Grand Challenge 2022, Rob Philips and Anne Toomey, who supported us in delivering the workshop.

We would like to thank Celia Pym who was involved in tutoring the involved Grand Challenge groups, as well as Halim Lais for technical support during the VR workshop.

B.S. would like to thank for additional funding from the RCA-internal Research Knowledge Exchange and the Communication department.

S.J. would like to thank for being awarded the 2023 Pokémon Scholarship based in part on the work discussed here.

The Grand Challenge 2022 was kindly sponsored by Logitech and partly supported by CERN.

References

[1] "New Economic Model for the Oceans," *RCA Website*. https://www.rca.ac.uk/research-innovation/projects/new-economic-model-for-the-oceans/ (accessed Apr. 02, 2023).

[2] I. E. Sutherland, "A head-mounted three dimensional display," in *Proceedings of the December 9-11, 1968, fall joint computer conference, part I*, ACM, 1968, pp. 757–764.

[3] B. Sommer, C. H. Lee, N. Martin, and V. S. Torrisi, "Immersive Design Engineering," *Electron. Imaging 2020 Proc. Stereosc. Disp. Appl. XXXI*, vol. 2020, no. 2, pp. 265-1-265–16, Jan. 2020, doi: 10.2352/ISSN.2470-1173.2020.2.SDA-265.

[4] B. Sommer *et al.*, "3D-stereoscopic immersive analytics projects at Monash University and University of Konstanz," *Electron. Imaging*, vol. 2017, no. 5, pp. 179–187, 2017, doi: 10.2352/ISSN.2470-1173.2017.5.SDA-109.

[5] T. Chandler *et al.*, "Immersive Analytics," in *Big Data Visual Analytics (BDVA), 2015*, IEEE, 2015, pp. 1–8.

[6] D. A. Keim, F. Mansmann, J. Schneidewind, J. Thomas, and H. Ziegler, "Visual analytics: Scope and challenges," in *Visual data mining*, Springer, 2008, pp. 76–90.

[7] K. A. Cook and J. J. Thomas, "Illuminating the path: The research and development agenda for visual analytics," Pacific Northwest National Laboratory (PNNL), Richland, WA (US), 2005.

[8] N. Greffard, F. Picarougne, and P. Kuntz, "Visual community detection: An evaluation of 2D, 3D perspective and 3D stereoscopic displays," in *International Symposium on Graph Drawing*, Springer, 2011, pp. 215–225.

[9] H. Nim, T. Done, F. Schreiber, and S. Boyd, "Interactive geolocational and coral compositional visualisation of Great Barrier Reef heat stress data," in *Big Data Visual Analytics (BDVA), 2015*, IEEE, 2015, pp. 1–7.

[10] G. De'ath, K. E. Fabricius, H. Sweatman, and M. Puotinen, "The 27–year decline of coral cover on the Great Barrier Reef and its

causes," *Proc. Natl. Acad. Sci.*, vol. 109, no. 44, pp. 17995–17999, 2012.

[11] A. S. Wenger *et al.*, "Effects of reduced water quality on coral reefs in and out of no-take marine reserves," *Conserv. Biol.*, vol. 30, no. 1, pp. 142–153, 2016.

[12] D. Serhan, "Transitioning from Face-to-Face to Remote Learning: Students' Attitudes and Perceptions of Using Zoom during COVID-19 Pandemic.," *Int. J. Technol. Educ. Sci.*, vol. 4, no. 4, pp. 335–342, 2020.

[13] B. K. Wiederhold, *Connecting through technology during the coronavirus disease 2019 pandemic: Avoiding "Zoom Fatigue."* Mary Ann Liebert, Inc., publishers 140 Huguenot Street, 3rd Floor New …, 2020.