# CYBER SANDBOX – AN EXPERIMENT ON COLLABORATIVE SKETCHING IN SHARED VIRTUAL SPACE

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**Abstract**: This paper investigates the potential and challenges of real-time collaboration in shared virtual space, focusing especially on emergent collaborative efforts, for which the 2017 social network experiment Reddit r/place can function as an example.

In order to carry out several experimental sessions of virtual collaboration an application was programmed that allows multiple participants to interact in a shared virtual environment. The effect of this was tested in different sessions, each no longer than 20 minutes. The experiments taken into consideration were carried out as part of a seminar with 50 student participants at ./studio3- Institute of Experimental Architecture at the University of Innsbruck, winter term 2019.

In this paper the prospects of virtual collaboration as a future design tool are approximated by documenting and analyzing the results of these experiments as well as the functionality of the application, to come up with usable instructions to repeat these experiments in further investigations. This seems relevant as the developed interaction design differs from traditional CAD software, as the use case and situation is still an unexplored territory.

The experiments showed that collective problem solving gives results, which are visually novel and unfamiliar. They were achieved magnitudes faster and the results showed to be higher in geometrical and formal complexity than one single person could achieve by conventional 3D modeling.
**Keywords:** architecture, digital design, virtual space, collaboration

## INTRODUCTION

Collaborative artistic work is investigated through digital media by a software interface that enables multiple players to simultaneously 3D-model within a shared virtual environment. The focus is on forms of collaborative, network-based crowd interaction and their mutual impact on identity, freedom of choice and manipulation in the design process. All the players join one file simultaneously and can edit, observe, copy, undo or redo anybody else's actions in real time, much like a couple of children in a sandbox, communively constructing castels, which are oftentimes way more inventive and complex than a single mind could ever have produced.

The Sandbox – the area of action – is a virtual interactive environment built in Unity:[1] an empty world seen through the computer screen. The players interact with each other by placing or deleting predefined 3D-Geometry (Assets) into a virtual environment. Navigation happens only through a first person view. The environment is rendered with artificial shading. The objects are simple geometry-wise, and are articulated by colored textures.

The players had to accomplish simple assignments, like constructing an animal, in a limited time frame of 10–15 minutes. Without the possibilities of verbal communication they had to negotiate through actions what the common understanding of the given assignment could be.

There are multiple approaches to confront the blank-piece-of-paper problem. Observing each other naturally lowers this barrier and the inspiration gets boosted. This kind of playfulness and how such integration could have a highly desirable influence on the creativity and efficiency of a digital workflow is also to be investigated.

### Field of application

The bespoken experiment was conducted as part of the master course *Experimentelle Architektur 1 – safari (za'fa:ri) رفس Reise – A Multiplayer Exploration* at ./studio3 – Institute for experimental architecture which is under the lead of Univ. Prof. Arch DI Kathrin Aste at the University of Innsbruck, Austria. This course was taught by Valerie Messini, Damjan Minovski, Dominic Schwab, Dominik Strzelec during the winter term 2019–2020.

The 54 students participating where Astl Kevin, Auer Dominik, Azizi Armin, Bauer Kilian, Casovskij Bogdan, Castegnaro Paolo Francesco, Castellanos Hornung Hedwig Michelle, Devos Michel, Dorner Sabrina Hildegard, Edelmann Julian, Etzelstorfer Sophia, Fantini Mirco, Felder Marco, Frick Magdalena, Gmeiner Melanie, Groß Larissa, Hamedinger Oliver, Hefel Jonas, Hetzenauer Michael, Hristov Toma, Jensen, Peter Marius, Kammerlander Valentin, Kennel Christian Josef, Kipp David, Kirejenko Valeria, Kröss Daniel, Leiter Andreas Matthias, Linta Madeleine, Lukasser David, Mayer Johannes Michael, Navarro Preuß Luis, Nadia Rumpfhuber, Nagenrauft Caspar, Niederleitner Marina Carolin, Öcal Erkut, Petrovic Natalija Natasa, Plunger Alina, Pomberger Martin, Praxmarer Francisco Javier, Preims Nadia, Priester William, Reichinger Alexander, Rosenfelder Jonas Frederic, Sauer Robin Stefan Maria, Schlenz Wilhelm Konstantin, Stein Marian, Stock Lilly Anna Maria, Storke Elvis Samson Maxim, Trojer Maximilian, Garcia Überbacher Marc, Vogler Leon Viktor, Warmuth Adrian, Winner Lisa-Maria, Wörister Michael, all enrolled in the master's degree course in architecture at the University of Innsbruck.

1 unity https://unity.com/

### Expected Results

Collaboration and teamwork in design involves a great deal of communication and organization. Because of this, for architects, the method and corresponding media of choice used to be sketching and a tracing paper roll, where ideas can be iterated and several people can contribute by adding yet another layer, sketching out their designs. In spite of all digital design tool developments, this method or better workflow still persists because of its excellent communicational qualities and the allowed intuition. Currently, 3D design software and CAD solutions offer no equivalent real-time tools for the complex and seemingly chaotic workflows of early design stages; they only offer non-real-time organizational protocols to manage and organize large-scale projects involving many people. Analogue sketching, though, has limitations regarding how many people can participate and and regarding the need to be physically present in the same space; additionally, there is the inherent limitation of drawings being two-dimensional. All those limitations are to be overcome once entering virtual space. This project investigates the potential and the challenges of real-time collaboration in shared virtual space, focusing especially on emergent collaborative efforts.

Our present is characterized by instability, uncertainty, complexity and ambiguity. This might profoundly change the way we live, learn, work and socialize. We will require new forms of individual and collective action, as well as interactive and hybrid types of space. This experimental setup for collective content creation should offer an outlook to the visual and spatial qualities of crowd-sourced art and/or architecture. Forms of collaborative, network-based crowd interaction will have a profound impact on the concepts of identity, freedom of choice, and manipulation in the design process. The intuitive and spontaneous actions are believed to ultimately generate a highly speculative and fragile form of spatial and material organization. It is expected that collective problem solving gives outcomes, which might be achieved faster and result higher in complexity and density.

Furthermore, its social effects are to be taken into account: Not only is it post-race and post-gender, as only the action of placing or deleting as well as the interaction with others defines the players' identity, but it is also a multiverse of harmonic approval, ruthless destruction, democratic collaboration, communal effort, uncompromising struggle and never-ending collective inspiration, as such it erases the binary categorization of a good versus a bad action.

## RELATED WORK

### Previous Version of Sandbox (Rhino)

A related predecessor project is called 'Rhino Sandbox'. It is an experimental real-time collaborative plugin that runs on Rhinoceros 3D,[2] a computer-aided design (CAD) application. Rhinoceros 3D is widely used in architectural practice and educational environments, due to its low cost, accessibility and potential to be extended and adapted in functionality through plugins.

'Rhino Sandbox' was developed by Damjan Minovski in 2017, in order to be used during an InnoChain workshop at the IAAC in Barcelona.[3] The main goal of the project was to develop a minimum viable product that can be tested during the workshop.

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2 Rhinoceros 3D, https://www.rhino3d.com/

3 http://innochain.net/workshop-seminar-2-iaac-barcelona-4-7-july-2017/

In terms of functionality it allows the user to access the most native commands and functions of the host application Rhino, which are then repeated in real-time across all connected users, effectively allowing them to work in the same document. From a technical standpoint, though, it is better described as multiple unique workspaces that are kept synchronized by the plugin 'Rhino Sandbox'.

The main focus of the prototype is to allow access to all modelling related tasks, such as creating, modifying and deleting geometry. More specialized functions such as creating drawing layouts for printing were not implemented. While working with the software each user has only limited information about the state of their collaborators. One is a uniquely colored 'view arrow' that represents the viewing cone of the viewport of any given collaborator. Further, a colored indicator is displayed over objects that are selected by other users, in order for all to be aware that a change on this specific object might happen soon. As the host application Rhino is not intended to support this functionality, several limitations are present. For example, it is not possible to track authorship of the created objects, nor is it possible to protect objects from being changed or deleted by other users.

### Other related work

According to curator, researcher, educator, and arts writer Rachel Marsden, the notion of collaborative, digital artistic practice has become increasingly prolific in recent years,[4] allowing for transcultural exchange and global participation. A new contemporary art field seems to be emerging, welcoming new audiences, as it becomes part of a specific type of mass media – the online and viral domain.

From the online and viral domain-based art field mentioned above, the *MOON* collaborative online drawing platform stands out: collaboration between Chinese artist Ai Weiwei and Danish-Icelandic artist Olafur Eliasson. *MOON* is based on a web platform where participants from all over the world can collaboratively draw and connect.[5] Visitors were invited to actively participate in leaving their personal mark, by doodling or writing a statement on an initially blank, white digital moon's surface. Thereby, the collaborative platform transcended international borders and allowed participants to remotely connect in a creative and expressive exchange. During the time in which the webpage was accessible for visitors to contribute (November 2013 to September 2017), over 80,000 entries were submitted, turning the blank, digital lunar landscape into a collaborative online-archive of diverse comments, statements, drawings, and responses. Olafur Eliasson posits that 'Each contribution has created a small but distinctive change to a developing landscape – highlighting the importance of individual expression amongst collective participation. Moon's open call for creative input is a powerful statement about the potential for ideas to connect people across vast distances and break through political, social, and geographical boundaries in the Internet age.'[6] Eliasson's statement describes the necessity for collaborative and meaningful ways to bridge geographical and social gaps while opening up creative practices towards human and non-human intra-action. Spatial setups prevalent in online multiplayer video gaming are promising, since its invention in the second half of the 20$^{th}$ century online multiplayer video gam-

4 https://rachelmarsden.blog/2013/11/12/moon-by-ai-weiwei-and-olafur-eliasson/, online source, retrieved 2021-05-19, 16:00

5 accessible on moonmoonmoonmoon.com from 2013–2017

6 https://olafureliasson.net/archive/artwork/WEK108821/moon online source, retrieved 2021–05–19, 16:00

ing has increased its relevance as a social space.[7] In MOON, surrealist traits of collaborative playful artwork meet the global practice of online video gaming. Eliasson's account highlights that collaborative online spaces do not need to be limited to the practice of gaming; instead, boundaries are blurry, so online spaces may turn into social spaces in which works of art are collaboratively generated in a playful manner.

## EXPERIMENT SETUP / TECHNICAL IMPLEMENTATION

As a technological basis for the project, the cross-platform game engine Unity[8] was chosen. It allows for fast iterative development as well as easy integration with 3D modeling software used in architectural schools.

### Navigation Design

The first person perspective (FPP) was chosen as the basis for all navigation and interaction in the project. The other option would have been to implement an orbit navigation system as it is used in most 3D content creation packages. It was decided against it in favor of the FPP because it enabled a more direct and localized interaction in human scale. Further it allows for a more interactive and immersive environment, with gravity acting upon users and enabling created objects to act as a physical 'collider' or barrier, akin to game environments.

On the technical level, a first person controller is responsible for receiving and processing user inputs related to navigation. The interaction scheme called 'WASD navigation' was recreated, where keyboard inputs with the respective 'WASD' keys are translated into movement along the positive and negative X and Y axis, relative to the current orientation / view of the player. The view direction itself is controlled by moving the mouse, where the X-axis of the mouse is translated to yaw and the Y-axis to pitch. The player avatar is composed of a 180 cm high and 40 cm wide capsule-shaped collider, with the virtual camera situated at the eye-level.

This configuration allows the player to move inside the virtual environment, but at the same time he is constrained by only being able to move on surfaces or objects (the colliders) and is prone to 'fall off' the game world if he walks off a ledge, as gravity acts on the player. In case a player falls off, a respawn mechanism is responsible for moving him back to a common starting point (spawn point).

### Interaction Design

There are two main modes of interaction: placing and deleting objects in the virtual environment. With the FPP system in place the user has limited abilities to draw objects inside the program, as the movement of the mouse is directly linked to navigating the environment. Instead, it was decided that the user can place predefined objects. By pressing the left mouse button, a mathematical ray is created. It originates at the user's camera view, directed through the center of the view intersecting with the virtual environment. If the intersection point is closer than

7 Katie Salen, Eric Zimmerman, *Rules of play. Game design fundamentals*. MIT Press 2003; Henry Jenkins, "Game Design as Narrative Architecture", in Noah Wardrip-Fruin, Pat Harrigan (eds.), *First person: new media as story, performance, and game*, MIT Press 2004, 118–130; Friedrich von Borries, Matthias Böttger, and Steffen P. Walz, *Space Time Play. Computer Games, Architecture and Urbanism: The Next Level*, Birkhäuser 2007; James Ash, T*he interface envelope. Gaming, technology, power*, Bloomsbury 2016 and Espen Aarseth, Stephan Günzel (eds.), *Ludotopia. Spaces, Places and Territories in Computer Games*, transcript 2019

8 unity https://unity.com/ online source, retrieved 2021–05–20, 12:00

50 meters, this is the position where an object is created. The orientation of the object is determined by the normal vector of the intersected object. The scale is set beforehand by the mouse-wheel. The possible range of the scale factor lies between 0.2 and 4.0, while 1.0 is assumed as default value and is defined to be an object that fills approximately one cubic meter.

Figuratively the user 'shoots' objects that stick to previously created ones, or the objects of the predefined virtual environment.

In order to have visual feedback on possible operations in the environment, a wireframe box representation of a potentially created object is shown constantly in the viewport, following the view-center of the user. Thereby the user can estimate where an object can be created before taking action, with respect to orientation and scale.

The other mode of interaction with the environment is deleting objects. By pressing 'X' the mode switches from 'creation' to 'delete', indicated in a text overlay, whereby pressing the left mouse button removes the object at the center of the view from the environment. Here also, an overlayed wireframe box, encompassing the potentially deleted object, helps to guide the user.

### Asset Creation

The term 'asset' and 'object' both describe a 3-dimensional digital object, with the difference that once it is used in the context of the real-time virtual environment it becomes an 'asset' in the engine.

In order to generate a diverse set of objects to be used in the Cyber Sandbox, the participating students were asked to prepare 3D models in advance. To give an overarching theme, they were asked to create 3D models of three distinct parts of an animal that each student could choose freely beforehand. The idea was to create a diverse set of objects, both in topology and shape. Students created their objects in blender[9] and Rhinoceros 3D, and assigned colors and textures to add detail to their appearance.

To allow these objects to be used as assets several preparation steps were necessary. Current software and hardware technology allows the creation of very detailed 3D models, but the requirements on a real-time application where dozens of users can potentially place hundreds of objects in minutes, pose a hard limit on the level of detail possible for each asset. It was decided to limit each asset to ten thousand triangles and one medium sized texture. After an average 10 minute session this still added up to more than 30 million triangles, which introduced noticeable slowdowns for most participants.

### Multiplayer and Network

To facilitate the required network functionality an external library named 'Photon PUN'[10] was used. It integrates directly into unity and removes the need to program low-level network protocols. Further, the service hosts its own servers in the cloud, removing the requirement to have a dedicated server on site. This theoretically allows anyone located in Europe to join the sessions, given that they have the proper authentication. The students identify themselves by writing their student-ID number in a configuration file of their local copy of the software. Through this ID it was possible to create a relatable server-side recording of all actions taken during a session.

9 blender https://www.blender.org/ online source, retrieved 2021–05–18, 12:00

10 photon https://www.photonengine.com/en-US/PUN online source, retrieved 2021–05–18, 12:00

### Rules and Level Design

The concept was to have as few rules as possible, but just enough to direct and orchestrate the collaboration insofar as to allow for comparable and analyzable results.

The basic rule, so to say the first commandment, was that everybody is allowed to delete everything, while each player can only place and scale assets that are originating from their own prepared animal model (section 3.3).

This rule was never changed throughout all sessions and games.

Variables were introduced by the given targets, as well as by the scope of economy, a kind of currency allowing the 'richer' to build more.

The different targets are described in detail in the session report (section 4).

The world/level design started by just being a huge plane. Then the infinite feeling plane shrunk to a tiny square 100m² platform, making it easy to fall off and requiring more skillful navigation and the building of walkable extensions.

Furthermore, the world consisted of multiple small platforms scattered in all three dimensions.

Eventually, the world was composed of an oblique, slippery plane, several flying platforms on top of a virtual ditch. On the other side of the ditch, there was a vertical plane, offering no possibility of holding, intersecting with the horizontal plane, the target to reach, by building a bridge in mid-air.

## LIVE SESSIONS

There were three live sessions throughout a time period of one and a half months with an interval of two weeks: 29th of November, 13th of December 2019 and 11th January 2020. Each session had a duration between three and four hours and included eight to nine games. A total of 25 games were performed by 54 different players altogether.

Not all 25 games were successful, some even had to be aborted (those are not documented in this paper because of lack of significance). The games were varying in players, but also in applied rules and environment as described below:

### Session I – 29th of November: game 01–08

For the first sessions, simple assignments were chosen: an elephant and an airplane. To allow a learning process, each assignment was repeated multiple times.

*Elephant* (Figure 1)

The players were given 15 minutes of time to build an elephant. They had to negotiate the position of the four legs in space as well as to agree on the direction (head versus tail) and handle the proportions. This first set of three games clearly showed a surprisingly steep learning curve: developing from a creature looking more like a badger to a proportionally accurate elephant with a distinguishable trunk, ears and other characteristic body parts, all matching in scale and place.

This exercise was repeated twice with a runtime of 10 minutes and a third and final time with an extended runtime of 15 minutes.

The assets built (measured at the last frame) increased starting from 1813, reaching 2346 in the second run and finally to 3866 in the third session.

*Airplane* (Figure 2)

The task, to build an airplane was similar to the first exercise as the players had to manage symmetry and directionality but increased in complexity by also asking for

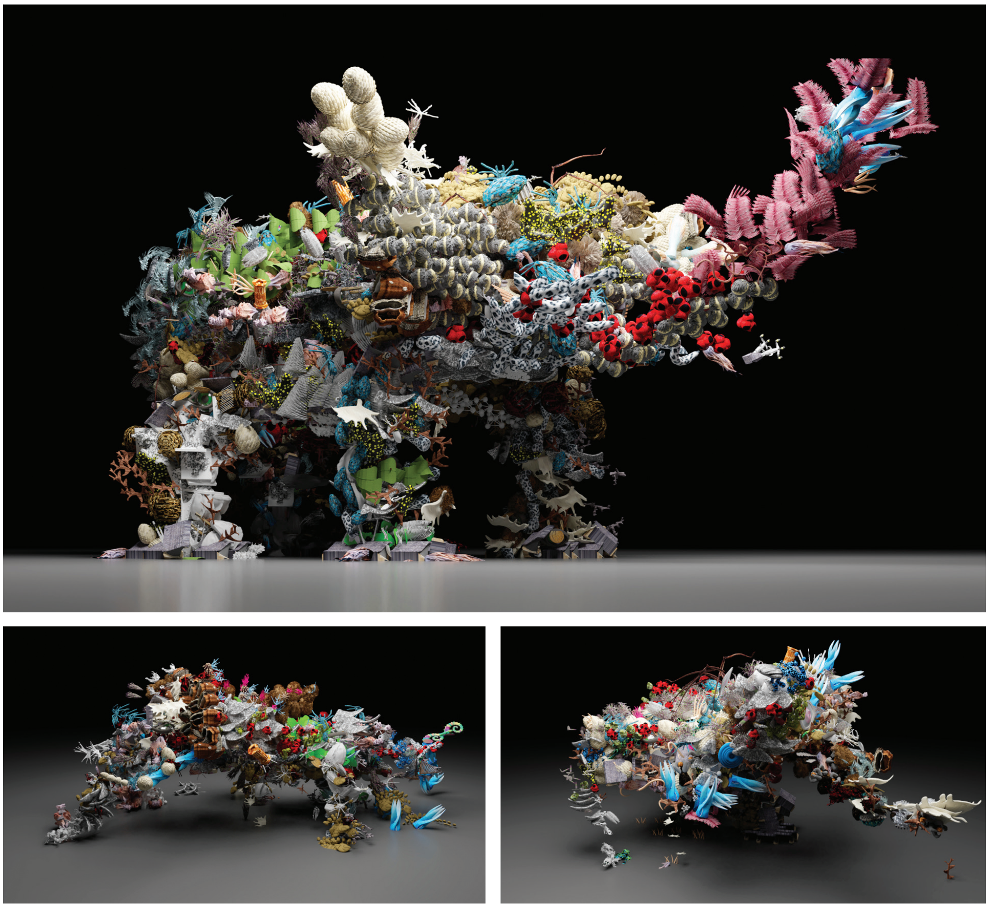

Fig. 1

Fig. 2

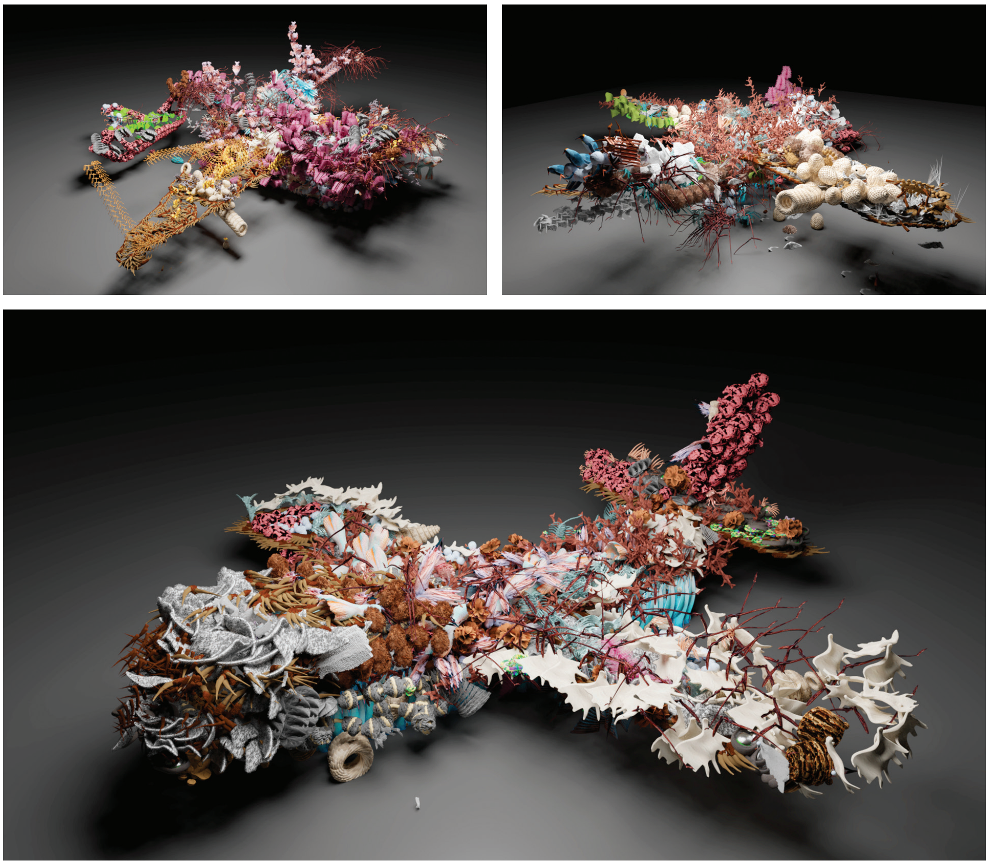

Fig. 3

an interior design. In the first iteration, symmetry was not fully achieved. Already in the second iteration (game 07) symmetry as well as some interiorities were achieved whereas by game 08 even a cockpit and seating could be differentiated.

**Session II – 13th of December 2019: game 09–17**

In the second session, the assigned goals were not any more object-like, semiotically clear and describable in one word, as in the first session. Instead, they were more descriptive and spatial in order to approach architectural properties.

Also it seemed interesting to test how well a non-verbal common understanding of a spatial structure without predefined or commonly agreed typology can emerge.

*Courtyard houses* (Figure 3)

The task was to build an enclosed space adjacent to at least one other enclosed space and sharing an open space with possibly four other enclosed spaces.

Still based on a simple plane, the players were asked to explore building part typologies such as floor, wall or roof in order to create enclosure as well as openings and connections to handle circulation. The aim was to create structured density, such as of settlements, evolving into multiple storeys. This exercise was repeated in the third session, starting with a different level design enforcing vertical densification (see Platforms).

Additionally, economy was introduced: they had to handle a given number of credits by deciding on the number and size of the placed objects, as the subtracted credits did correlate to the placed objects scale. If players ran out of credits, they were allowed to reimburse their placed objects by deleting them. If deleted by any other player, the respective credit got lost. (Easter Egg: respawn to recharge your credits)

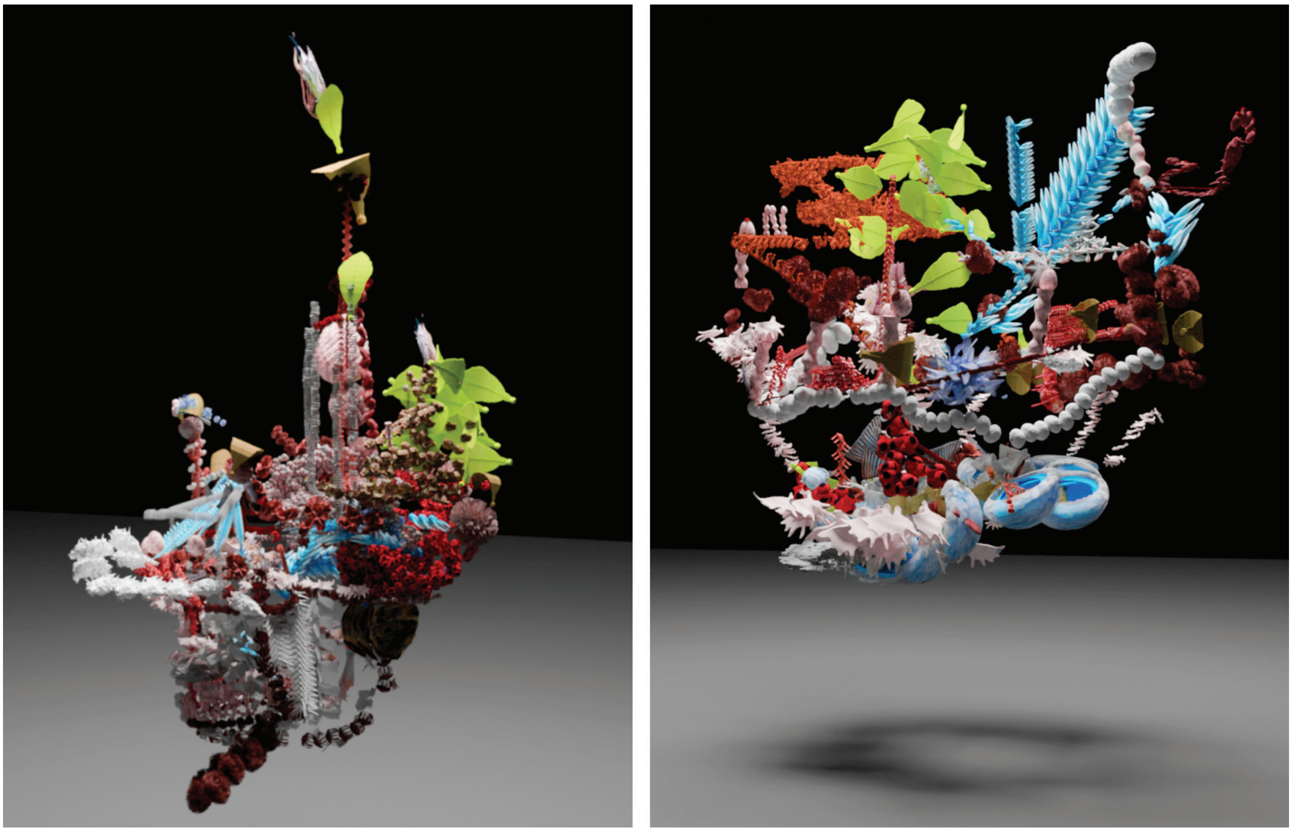

Fig. 4

### *Castle in the Sky*[11] (Figure 4)

Inspired by Miyazaki, the target was to build a castle in the sky. As per definition, the construction had to fly so all the pillars and ramps previously constructed to build the castle had to be consequently deleted.

Analog to the previous experiment, this one also was to be repeated in the upcoming session in order to enhance the layering in the Z-Axis.

### *Carceri* (Figure 5)

The etching *Carceri d' Invenzione, Plate VII, Untitled (The Drawbridge)*[12] was shown to the players for five minutes.

Then they were given twenty minutes in order to reconstruct what they could communively memorize of Piransis' impossible geometries.

Certain elements became recognizable, but in general the exercise appeared to be too complex, as the output is not fully convincing probably also due to the difficulty in memorizing the mesmerizing spatial configurations which appear to have been edited by Piranesi for the second publishing to contain (likely deliberate) impossible geometries.[13]

## Session II – 11th January 2020: game 18–25

During the third and last session the tasks were similar to the second session. But the world design changed: according to the task the infinite plane was substituted

11 Laputa – Castle in the Sky, British Film Institute. Retrieved January 5, 2019.

12 Giovanni Battista Piranesi, Carceri d' Invenzione, Plate VII Untitled (The Drawbridge), etching, ca. 1780 (Third Edition) Courtesy of the Arthur Ross Foundation

13 Piranesi's Carceri as Inconsistent, The University of Adelaide – Inconsistent Images. November 2007. Retrieved 6 September 2017.

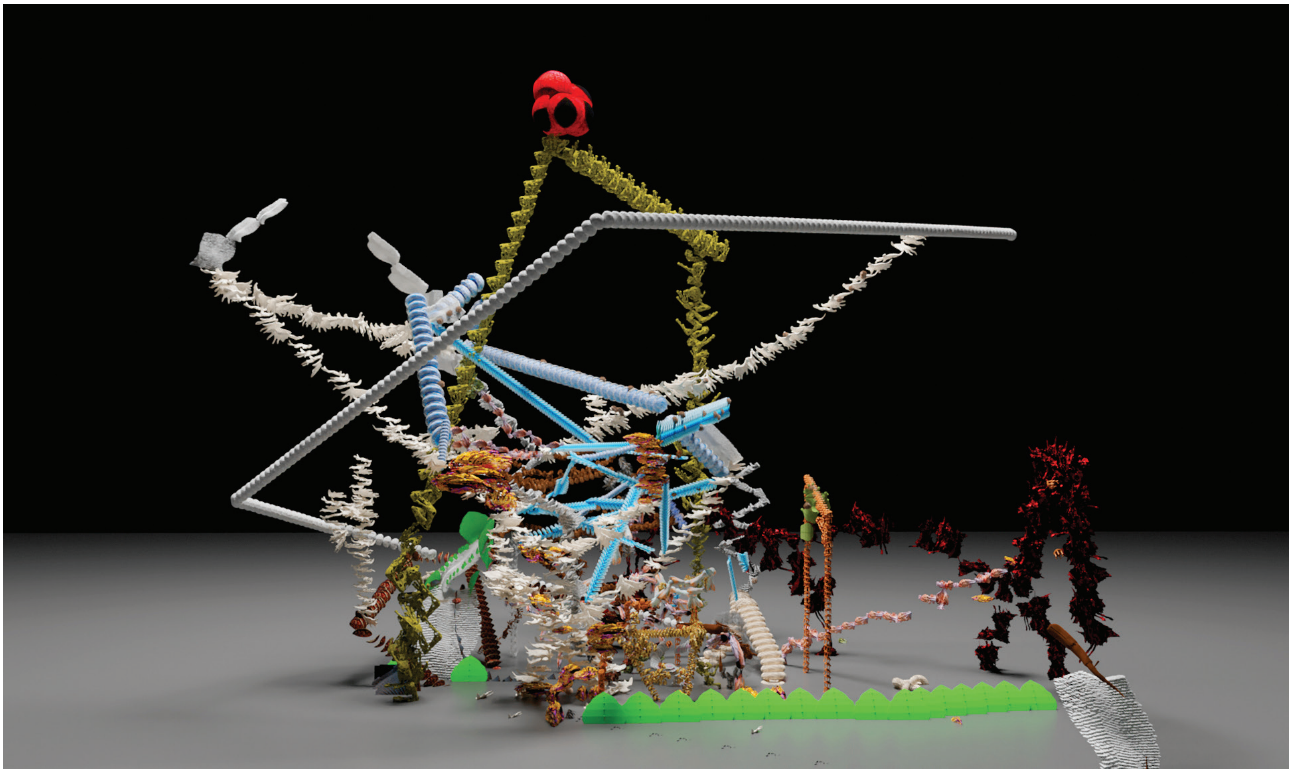

Fig. 5

by smaller platforms not continuously connected. This was introduced to promote a multidirectional population of space not constrained by one ground level.

*Bridge*

Players spawned at the edge of the abyss on an oblique platform. The players had to build a walkable bridge to the other side. The flying platforms across the abyss should be fully incorporated into the bridging construction. There were no economical constraints, if the player fell into the abyss while building the bridge, they would respawn at the start on the oblique platform. The experiment was repeated three times and should develop to provide a roofed walkway and viewing platforms.

*Platforms* (Figure 6)

Here players spawned from top into an environment consisting of several platforms. Players should team up with at least 3 others and build a house around a platform of their choice.The house has to be connected to at least two other houses and therefore it needs to have an entrance. Outdoor, landscape areas should connect the single houses in order to form a giant castle in the sky.

*Tiny world* (Figure 7)

The world consists of a tiny plane. The task was to construct a walkable landscape and expand as much as possible having no economical or any other constraints.

For the very last game, no kind of restriction was retained, to analyze the expertise collected throughout the preceding experiments in terms of Object/Figure/Void. They were free to build what, how and where they want but still trying to react to the others and use emerging synergies to reach individually formulated goals. No time limit was defined. An interesting formation emerged, a mutant of one of its predecessors, articulated, walkable and disconnected from the ground, as illustrated in the lowest image of Figure 5.

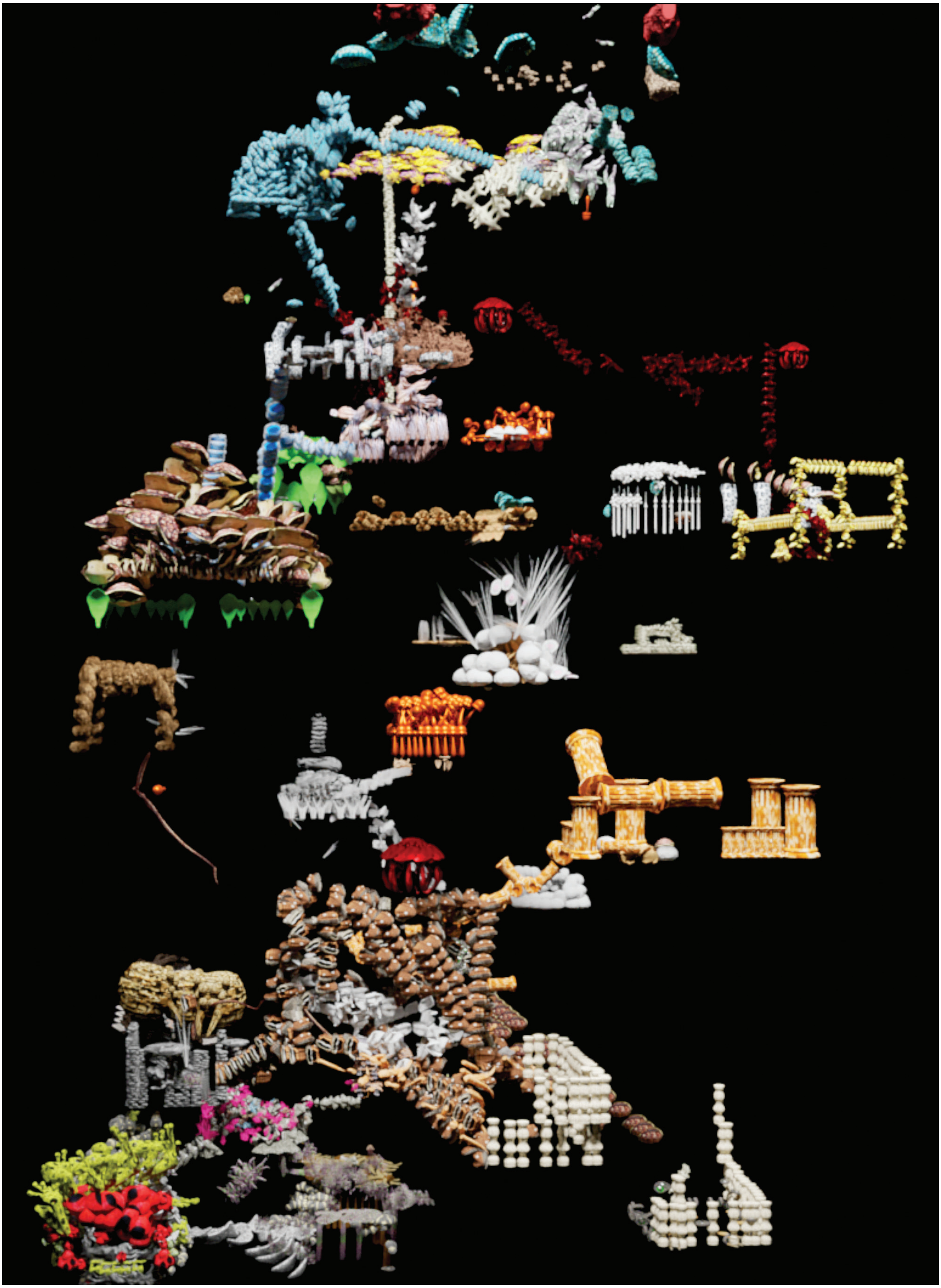
Fig. 6

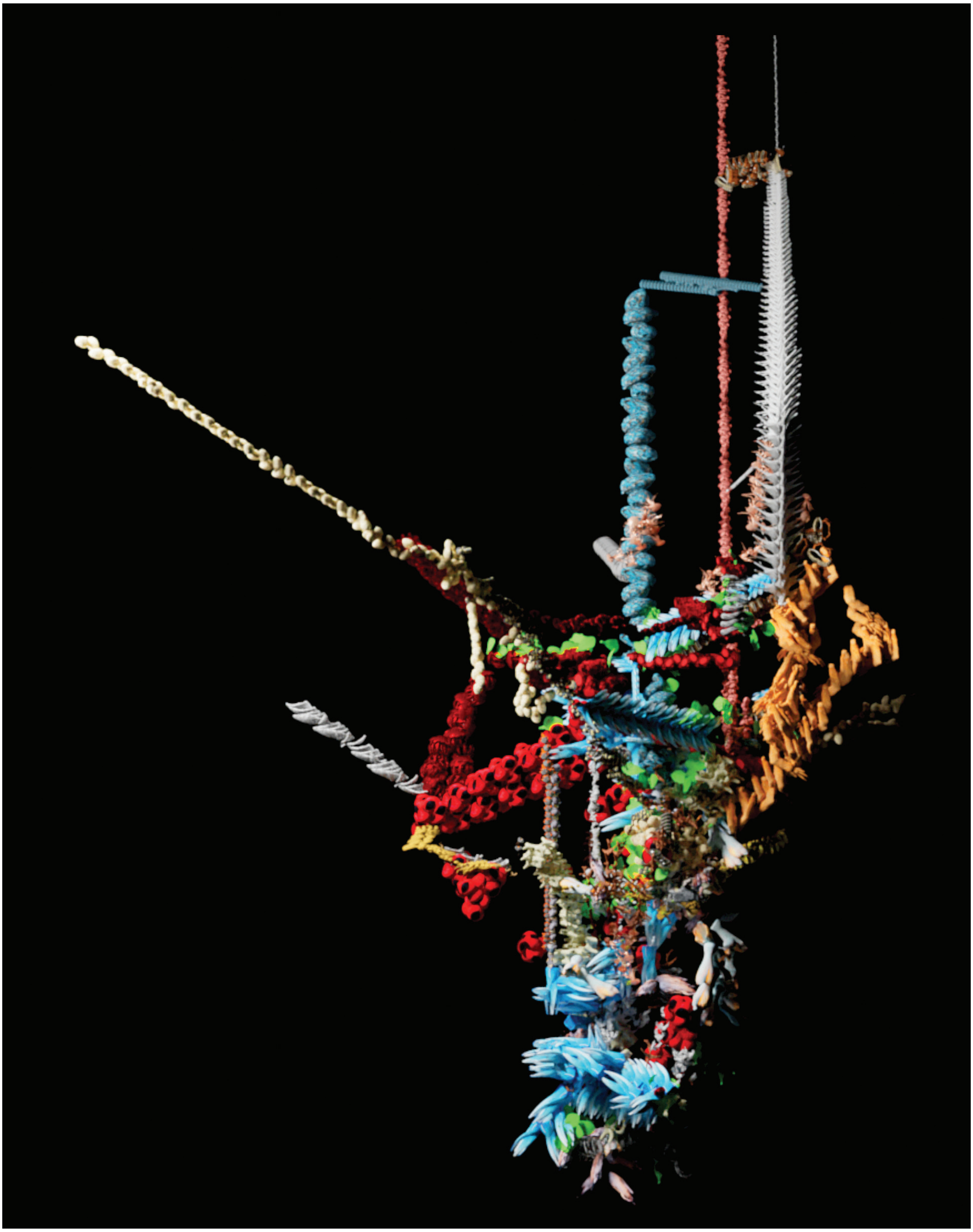
Fig. 7

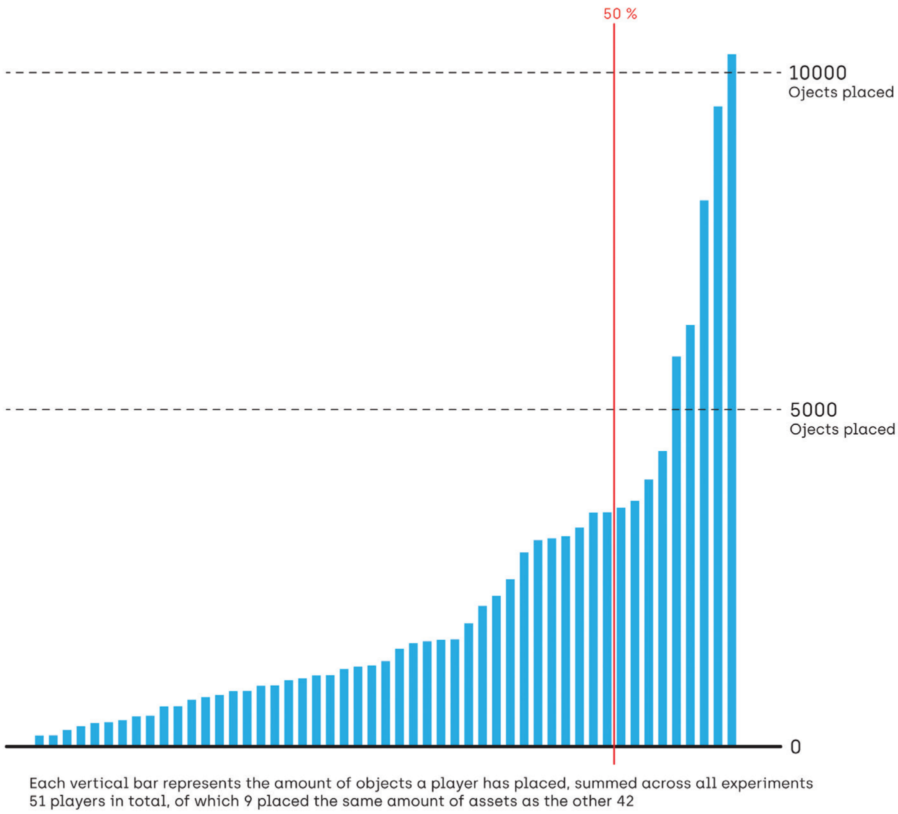


Fig. 8

### Recorded Data (Player Activity)

During all sessions and experiments, information about the creation and destruction of assets was recorded. While the destruction of assets is anonymous, the creation is linked to the person performing the task.

Every 0.5 seconds a full description of the active environment is saved in text form, including the ID of the student, the ID of the asset created as well as its position, rotation and scale in the virtual environment.

Using this information, we created animated re-enactments of the different sessions, as well as extracted 3D models of the final state of each session.

Those were rendered and are shown in Figures 1–7.

Further, we created videos showing the building and re-building process from different angles to examine the quality of the object and spaces created.

During the sessions, students created screen recordings of their screens to document their view of the session. Additionally,the session itself – the 50 students sitting in one space – was filmed.To disseminate the experiment, an exhibition was installed. The exhibition showed the animated videos as a large scale projection surrounded by multiple small screens showing the individual players' experience. A selection of these videos was published on instagram.

## CONCLUSION

The experiment clearly showed that collective problem solving gives results, which are visually novel and unfamiliar. They were achieved incomparably faster, and the results showed to be of higher geometrical and formal complexity than one single person could achieve by conventional 3D modeling.

The results also led to the conclusion that there seems to be a relation between the complexity of the task and the ruleset needed to allow for a good result.

The clearer the task, the fewer rules were needed, or were even counterproductive. In contrast, a fuzzier assignment task needed a good rule set. As this was the first experiment, the rule sets for complex tasks demand further investigation and expertise to clearly determine what a good rule set looks like.

Also this experimentation made it clear that a virtual object is easier to handle than a virtual space. This does not seem to be a surprise since functioning virtual spaces are still rare, whereas virtual objects are already well established, even in the art market.

The real-time interface created a high level of immediacy throughout the design process. This was even enhanced by the immersion created through the first person view, which was the only available navigation mode while designing.

Surprisingly, a high level of identification was observed between the students and the created objects. This is explained by two circumstances:

1. The immediacy and immersion created an event, limited in time and unrepeatable. Being part of it created a feeling of community and through that – identification.
2. As the design process was something constantly evolving, becoming and developing, this liveliness created sympathy and through that again – identification.

One interesting finding is represented in Figure 8: collecting the data across all sessions – 9 students were responsible for 50% of the created environments, while the remaining 42 students accounted for the other 50%.

This experiment gave an insight into the visual but also ontological potential of such unconstrained, immersive and real-time design processes,defined by the fluctuation and interrelations of the players.

Building relations with one another is the core concept of feminist theorist Karen Barad's theory of agential realism. According to Barad, the universe encompasses phenomena that are 'the ontological inseparability of intra-acting agencies'.[14] Barad states that phenomena or objects do not exist, as such; they do not antecede their interaction; instead, they come into existence via so-called 'intra-actions'. As follows, an apparatus[15] which brings forward a phenomenon is not an assembly of a human and a non-human (as actor-network theory states[16]); rather, humans and non-humans produce dispersed meanings. The scientist (or in this case the artist) is always part of the apparatus, their participation is needed to make scientific work (or art) more accurate and more rigorous. Following Barad, Safari pursues an onto-ethico-epistemological approach in the field of collaborative technology-based spaces of artistic intra-action.

The following questions arose:

- How can collaborative environments be designed in order to guide the players towards a non-hierarchical cooperative artistic production, in which a task is not given beforehand but emerges from the collaborative process?

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14 Karen Barad, "Getting Real: Technoscientific Practices and the Materialization of Reality". In: *Differences: A Journal of Feminist Cultural Studies*, 1998, 10 (2): 87–128. p.99; See also Gregory Hollin, Isla Forsyth, Eva Giraud, Tracey Potts, (Dis)entangling Barad: Materialisms and ethics, Social Studies of Science, 47 (6) 2017, 918–941

15 Giorgio Agamben, *What is an Apparatus? and other Essays*, *Meridan: Crossing Aesthetics*, 2009

16 Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network Theory*, Oxford University Press 2005

- Which concepts from video game design can be adapted to serve as an inspiration for the research?
- How can fabrication-constrained collaboration in a virtual environment foster the unfolding of new creative synergies?
- How can the human body be integrated into the virtual realm as a tool to navigate space?[17]
- Which new forms of collaboration can emerge from being together virtually, performing a digital real-time identity that is post-gender and post-ethnicity?
- How can in-situ working in a collaborative virtual environment empower the critical inception in Karen Barad's sense of 'agential realism', where the intra-action itself constitutes meaning and knowledge?
- How can – with the help of collaborative virtual spaces – distances be overcome and lively and imaginative places of artistic and architectural intra-actions be allowed?
- To which extent can automated fabrication processes be synchronous to the unfolding of an artistic collaborative process?
- Are there more open and inclusive alternatives to the linear and product-oriented 'master-slave' model which defines current automated fabrication processes?[18]

## FUTURE WORK

The advantages of a multiplayer environment in terms of boosting creativity and decisiveness should also be made available in an environment populated not exclusively by humans. This will offer the multiplayer advantages also when accessing the environment as a single human player. It seems to be the logical next step to use the generated data to train a machine-learning model. Through this model, collaborative bots will be created and made accessible online. It is of major interest to study emergent collaborative strategies: we might observe agents discovering progressively more complex tool use than foreseen by the project team or documented throughout the human experimentation session. A reference for such an emergent tool use from multi-agent interaction was shown by the research company OpenAI's *hide-and-seek* study. Through training, agents came up with a series of distinct strategies and counterstrategies, some of which the project team did not know their environment supported. That is why they concluded that 'self-supervised emergent complexity in this simple environment further suggests that multi-agent co-adaptation may one day produce extremely complex and intelligent behavior'.[19]

17 Jonathan Frazer, "The Architectural Relevance of Cyberspace" (1995), in Mario Carpo, *The Digital Turn in Architecture 1992–2012*, John Wiley & Sons 2013, 48–56.

18 Peter Testa, *Robot House: Instrumentation, Representation, Fabrication*, Thames & Hudson 2017

19 https://openai.com/blog/emergent-tool-use online source, retrieved 2021–05–19, 16:00

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Валери Л. М. МЕСИНИ, Дамјан МИНОВСКИ

**ВИРТУЕЛНИ БАЗЕН СА ПЕСКОМ – ЕКСПЕРИМЕНТ КОЛАБОРАТИВНОГ СКИЦИРАЊА У ЗАЈЕДНИЧКОМ ВИРТУЕЛНОМ ПРОСТОРУ**

**Резиме**: Колаборативни уметнички рад истражујемо кроз дигиталне медије помоћу софтверског интерфејса који омогућава да се више играча истовремено бави 3Д моделовањем у заједничком виртуелном окружењу. При раду у окружењу „Cyber sandbox“ акценат је на облицима колаборативне, мрежне интеракције веће групе учесника и њиховом заједничком утицају на идентитет, слободу избора и манипулацију у процесу дизајнирања. Пројекат се одвијао у оквиру мастер курса Експериментална архитектура 1 – Сафари – Истраживање групе играча у Студију 3 Института за експерименталну архитектуру, под вођством проф. др Катрин Асте на Универзитету у Инсбруку, Аустрија, уз предаваче Валери Месини, Дамјана Миновског, Доминика Шваба и Доминика Стрелеца, током зимског семестра школске 2019–2020. Одржане су три сесије уживо током периода од месец и по дана са размаком од две недеље. Свака сесија је трајала између три и четири сата, укључујући осам до девет игара. Укупно 54 различитих играча одиграло је укупно 25 игара. Подручје деловања било је виртуелно интерактивно окружење изграђено у погону игре Јунити (Unity). Играчи су међусобно комуницирали постављањем или брисањем унапред дефинисаних 3Д-геометријских облика (поставки) у овом виртуелном окружењу. Сви играчи укључују се истовремено у једну датотеку у којој могу, у стварном времену, да уређују, посматрају, копирају, поништавају или понављају поступке других играча, слично деци у базену са песком која заједнички праве дворце, који су често много инвентивнији и сложенији него што би га појединачни ум могао произвести. Експеримент сугерише да колективно решавање проблема даје резултате који се постижу брже и показују већу геометријску и формалну сложеност него што би једна особа могла да постигне конвенционалним 3Д моделовањем.

**Кључне речи**: архитектура, дигитални дизајн, виртуелни простор, сарадња