From Body Movement to Sculpture to Space

Employing Immersive Technologies to Design with the whole Body

Günter Barczik[1]
[1] *Erfurt School of Architecture*
[1] *guenter.barczik@fh-erfurt.de*

We present and discuss an experimental student design and research project that investigates how architectural design can be enhanced via immersive technologies. Specifically, by employing not a 2D interface for designers' thoughts, but a 3D interface and thereby activating the whole body instead of merely head and hands.

Keywords: *Virtual Reality, Design Tools, Design Concepts, Design Methods*

"It is only ideas gained from walking that have any worth." Friedrich Nietzsche

"I anyhow think with the knee." Joseph Beuys

Background

Architecture, being maybe the quintessential 3D - 4D design field, has throughout its history been limited by 2D or only comparatively cumbersome 3D representation: drawing and sketching by hand on plane surfaces, or building physical scale models. This limitation may be removed by the new immersive technologies of virtual reality (VR) which have become easily available and usable, together with tools facilitating easy creation of 3D or 4D (animated) sculptures.

Furthermore, using VR, the movement not only of the designers hands can be brought into play, but that of all their limbs and of their whole body through space. Activating designers' whole bodies for design, additional to their minds.

Movement of the body has in the past decades come into focus as being able to facilitate if not essentially enabling movement of the mind (thought processes), all but reviving the ancient greek school of peripatetic philosophy that had at its core the bodily movement of its practitioners (Adler 2002, Balthussen 2014, Brodie and Lobel 2012, Gross 2015).

The implications of this accessibility of thinking an moving in 3D and 4D space for architectural design has to our knowledge been little if at all investigated.

Content of experimental design and research course with students of architecture

We investigate the above in an experimental design and research course with bachelor students of architecture.

A thematic foundation is established by studying theoretical work analyzing bodily movement and its implications for thought together with artistic work employing movement through space from the field of sculpture and dance.

Specifically, we study the greek philosophical school of the Peripatetics who advocated the improvement of thought by bodily movement (walking) (Balthussen 2014) and their recent followers (Gross 2015, Brodie & Lobel 2012, Adler 2002).

Figure 1
Jackson Pollock paiting standing on canvas and in painting

Figure 2
Joseph Beuys working with felt and coyote

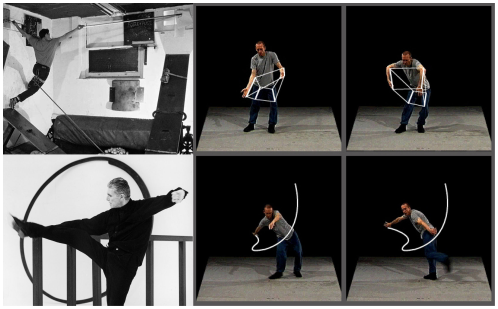

Figure 3
Matthew Barney (top left), Robert Schad (bottom left), William Forsythe (right)

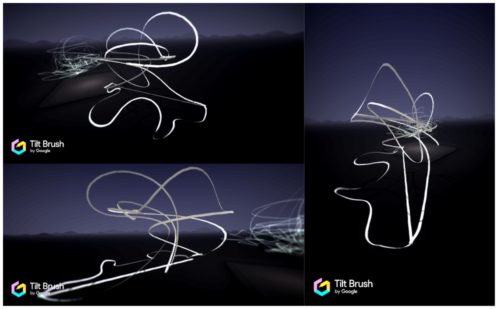

Figure 4
Google Tiltbrush Screenshots: Virtual Painting

We investigate the work of several artists who activated their whole body to create their artworks and furthermore entered the artworks with their body instead of facing it like painters facing canvases:

- Jackson Pollock laying his canvases onto the floor, stepping around and onto them (Figure 1).
- Joseph Beuys performing his installation pieces, most specifically the installation *'I like America and America likes Me'* (1974) in which for one week he shared a gallery space with a coyote, using a felt blanket and a walking stick to play with and shelter himself from the animal (Figure 2).
- Matthew Barney in his series 'Drawing Restraint' acrobatically scaling his studio's walls and ceiling to paint all its boundary surfaces (Figure 3 top left).
- Robert Schad dancing around and through sculptural pieces (Figure 3 bottom left, Schad 2012).
- The choreographer William Forsythe tracing imaginary geometric objects into space with his body (Figure 3 right, Forsythe 2012).

The immersive visualization and production tool Google Tiltbrush [1], running on an Vive platform [2], are playfully explored to accommodate the students with the genreal experience of creating objects not with their hands only and via input on flat surfaces, but with their whole body through movement in space (Figure 4).

Those new experiences are discussed together with the new insights from the theoretical studies and used to create sculptural arrangements that would have been impossible or only extremely difficult to design without them. These sculptural arrangements at first do not try to be habitable architecture, so that the new possibilities can be most freely explored. As a next step, spaces fit for human habitation are designed in the immersive environments.

The designs are exported from the immersive environment to a more conventional 3D modelling software - in our case, Rhino (Figure 5). There, they are analyzed through 2D sections, horizontally and vertically and perspective renderings. Additionally, the sculptures and spaces are printed in 3D, both as fixed objects as well as sectional studies so that it is possible to study their interior.

Project and course structure

The research project and design course is structured as two strands of iterative steps which start out in parallel and fuse in mid-way:

Building a thematic foundation through study of theoretical and practical work, and building an experiential foundation through playful experimentation with technology. Those are brought together and continued to design first sculpture, then architecture.

We do not so much proceed sequentially, but iteratively, meaning that we do not follow a sequence of clearly separated subsequent steps where research is followed by experiment followed by realization once and in one direction only, but that such a sequence is gone through quickly and then repeated again and again. Thus, feedback loops are established between the different ways of working, and new questions opening up and problems occuring can directly be turned into new design possibilities.

Furthermore, and, from our point of view, probably most importantly, the students learn and get acquainted with a way of working that continually seeks to explore possibilities instead of merely applying a fixed set of learned skills.

Evaluation: Using the virtual reality spatial painting set-up (Input)

Upon first stepping 'into' the virtual space all students described a feeling of utter surprise as to how quickly and how much their perception 'accepted' the 'new reality' - even although seen on a screen, the displayed elements appeared not at all realistic, being rendered far too simply.

The input device Vive and Tiltbrush offer (2 hand-held multicontrol devices) were not easy to use at all. While tracing paths and shapes into space proved to be quite easy, changing parameters and tools turned out to be rather counter-intuitive. It remains to be seen if prolonged use eases the handling.

Regardless of the counter-intuitive controls and probably due to the convincingness of the virtual environment, the students quickly 'lost' themselves in it, easily almost giving up their balance while attempting to stretch their work and with it literally their bodies to their limits (Figure 6). This often led to a sense of dizziness resulting in the students having to assist one another to not loose their balance (Figure 7).

Occasionally, it proved to be worthwhile to not immerse oneself into the virtual space but rather to remain in reality, so to speak, and trace objects or persons situated there (Figure 8).

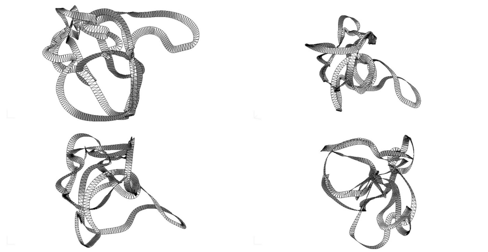

Figure 5
Google Tiltbrush imported into Rhinoceros 3D via fbx file format

Figure 6
Movement sequence of virtual sculpting, almost loosing balance

Figure 7
Dizzyness induced through self-abandoning sweeping movement, assisted balance

Figure 8
Non-immersive tracing

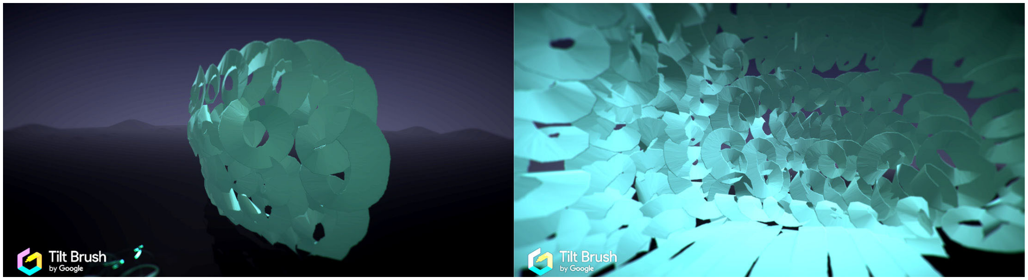

Figure 9
Self Cocooning: Tiltbrush Screenshot

Figure 10
Non-Immersive Trace: Tiltbrush Screenshot

Evaluation: Conceived spatial Objects (Output): Free Sweep, Self-Cocooning and Non-Immersive Trace

The result of much experimentation and play with the drawing software in the virtual space three types of spatial objects emerged:

1. *Free Sweep*: standing inside the empty virtual environment quickly prompted everybody to freely move, dance, jump around and use the controller for equally sweeping movements, both tracing and amplifying the figure produced in space (Figures 4, 5)
2. *Self-Cocooning*: subsequent to the free trace, students started to trace not an arbitrary sweeping movement, but enclose themselves in an almost woven line boundary. Cocooning themselves to define their own personal enclosure (Figures 6,7,9).
3. *Non-Immersive Trace*: After tracing one's own personal cocoon, the students started to work

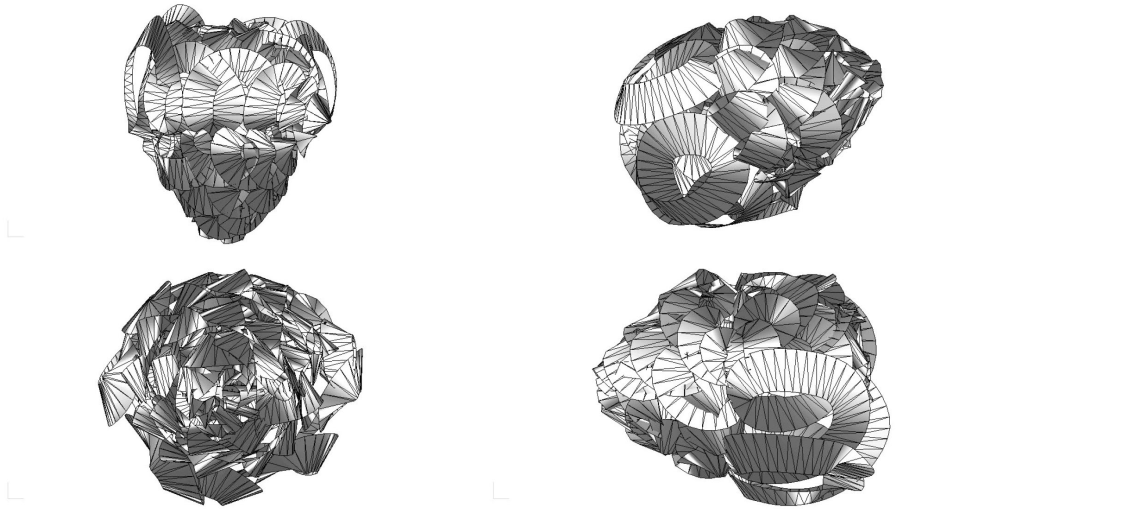

Figure 11
Self-Cocooning 3D model imported from Tiltbrush into Rhino via fbx file format

together and trace each other's personal spatial boundaries. For this, they left the immersion and traced around one another with the controller only (Figure).

In the immersed pieces Free Sweep and Self-Cocooning, the students quickly started to loose themselves in their own motion, challenging personal boundaries of space and balance. Like children lost in playful motion, the students turned, twisted, swayed and almost toppled (Figures 8,10).

From virtual painting to physical object

We discussed the virtual 'paintings' or objects in terms of transferability to physical 3D prints.

We decided to start with the Non-Immersive Trace and leave the Self-Cocooning and the Free Sweep for later. Reasons were the 'printability' and the complexity of the resultant object.

The Free Sweep would have required an unclear amount of stabilization as contrary to the virtual objects the the physical prints, as a matter of course, would be subjected to gravity. Although surmountable, the amount of work on the digital model to achieve this was the most unclear here and therefore left for a later stage.

Both the Self-Cocooning and Non-Immersive Trace consisted of much denser and more stable surface- or shell-like parts and therefore promised more resistance to gravity.

We decided to begin with the Non-Immersive Trace for it's greater complexity of overall shape.

Step 1:. The data from Tiltbrush was exported in the file format fbx and imported directly into Rhino (Figures 5, 11, 12).

Step 2:. The resulting 2D surfaces with thickness zero were offset in rhino to give them a spatial and therefore printable dimension.

Step 3:. The 'thickened' surfaces were subjected to boolean operations in order to fuse them into one object. This was tested for waterproofness as a preparation for printing.

Step 4:. The waterproof object was exported in the file format stl.

Step 5:. The stl file was imported into Makerbot, the customary software of the printers our faculty uses

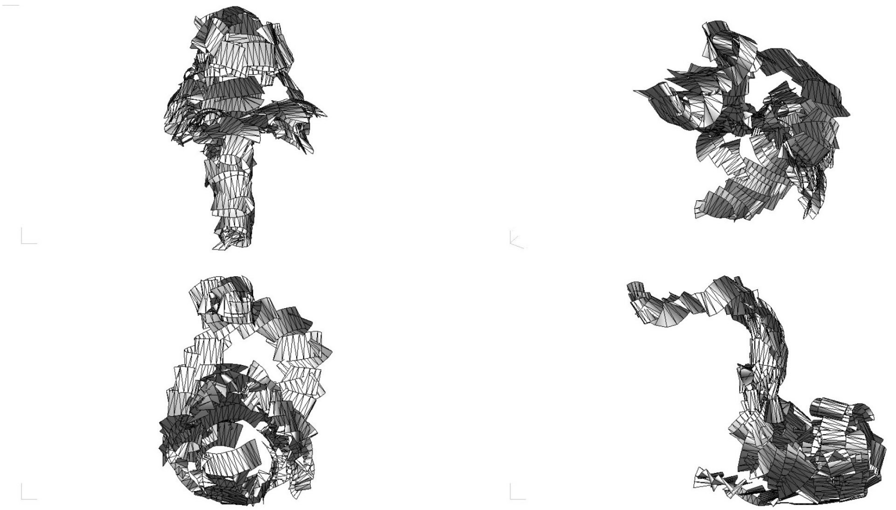

Figure 12
Self-Cocooning 3D model imported from Tiltbrush into Rhino via fbx file format

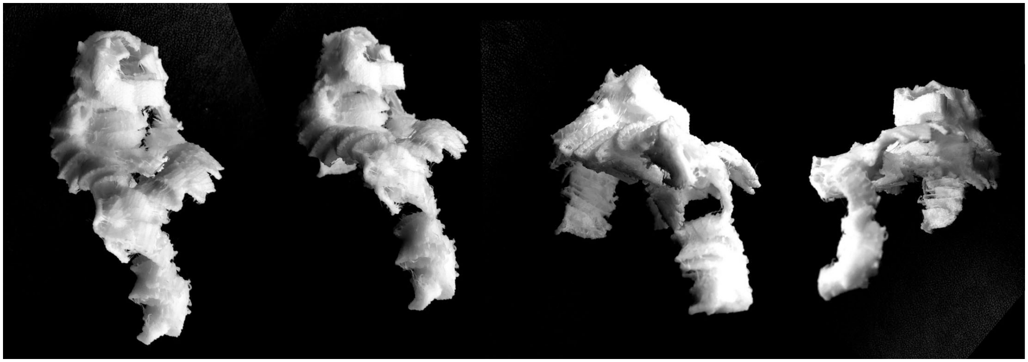

Figure 13
3D printed model of Non-Immersive Trace (Photograph)

[3]. Here it turned out that only the most recent version 3.10.1 of the software could not only display and analyze, but actually print the object.

Step 6:. The object was printed (Figure 13).

Although this very first test was printed rather small and therefore not very detailed, this first simple test for the sequence of transfer from virtual painting to physical object was successful and will be build upon in the future (Figures 14, 15).

Future development

We will extend the research into several directions:

- Introducing more than one actor into the immersive environment, thereby adding the element of joint play and continuous communication, together with the ability to inter-

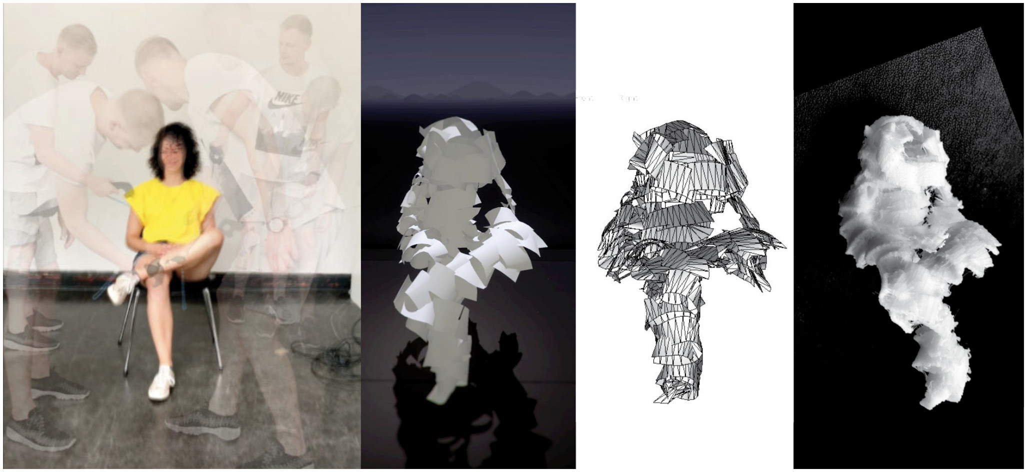

Figure 14
Non-Immersive Trace: Sequence from working wirking in real (left) via virtual space (middle left) via 3D model (middle right) to 3D printed physical model (right)

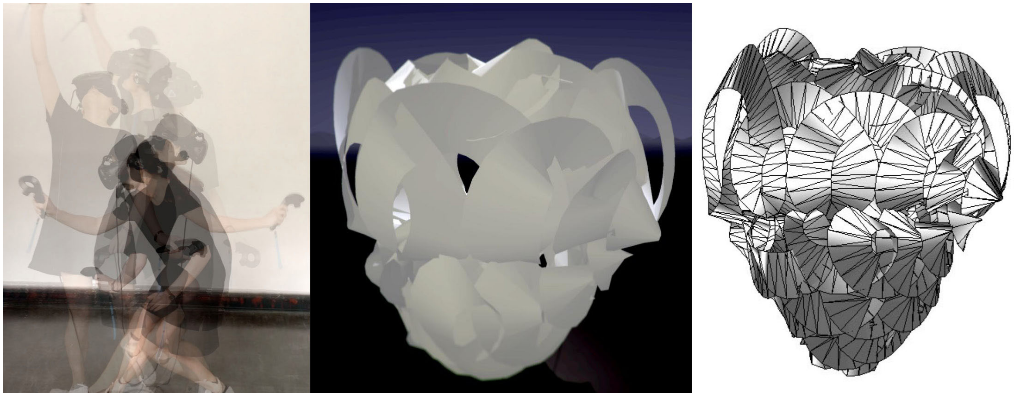

Figure 15
Self-Cocooning: Sequence from working working in real (left) via virtual space (middle) to 3D model (right)

act with partners that do not share the same physical space.

- Study scaling effects: scaling both the size of the manipulated objects as well as the size of the manipulating actors as well as time and strength of movement. We will incorporate study of the work of artists like Arne Quinze who builds large-scale spatial environments but is limited to the manual transposition from small-scale model to large objects self-built with the aid of technical machinery like lifters and cranes (Figure 16, Reference).
- Material properties: the virtual environments allow for specific creation of custom material properties and behaviour, and we intend to investigate the possibilities of working with materials that change over time, i.e. water, fire, vapor.

Figure 16
Arne Quinze building large spatial situations, directly or enlarged from small-scale models (middle) using devices like ladders (left) and cranes (right) ([4], [5])

- 1:1 Physical Output: We intend to output the resulting sculptures and spaces not only in scale model form, but 1:1, both as large scale 3D prints as well as abstracted geometries constructed from cardboard.
- Amplification of methods through inclusion of embodiement and exbodiement concepts: In the past years, both the importance of bodily movement for thinking as well as the employment of environmental factors or elements for thought processes have emerged as prominent fields of study in the cognitive sciences. The first under the title 'embodiement' (Adler 2002, Brodie and Elin 2012, the second under the title 'exbodiement' (Krakauer 2015, Mittelberg 2014). We intend to make use of the thought-improving factors of those concepts.

Acknowledgments
Many thanks indeed to the participating students Georg Diez, Desiree Goumou, Juliane Hildebrand, Yasmin Roth, Justin Rusche and Philipp Schneider and to the teaching assistants Anita Frank (B.Arch.), Stephan Griese (M.Arch.) and Marvin Hoyer (B.Arch.).

REFERENCES

Adler, J 2002, *Offering from the Conscious Body - The Discipline of Authentic Movement*, Inner Traditions

Balthussen, H 2014, *The Peripatetics - Aristotle's Heirs 322BCE-200CE*, Routledge

Brodie, J and Lobel, E 2012, *Dance and Somatics - Mind-Body Principles of Teaching and Performance*, Jefferson

Forsythe, W 2012, *William Forsythe: Improvisation Technologies. A Tool for the Analytical Dance Eye*, Hatje Cantz

Gros, F 2015, *A Philosophy of Walking*, Verso

Krakauer, D 2015, 'Five Short Stories About the Life and Times of Ideas', *Nautilus*, 23

Mittelberg, I 2014, 'The exbodied mind: Cognitive-semiotic principles as motivating forces in gesture as motivating forces in gesture', in Fernández-Villanueva, M and Jungbluth, K (eds) 2014, *Beyond Language Boundaries: Multimodal Use in Multilingual Contexts*, De Gruyter, Berlin

Nietzsche, F 1889, *Twilight of the Idols*, C. G. Naumann, Leipzig

Schad, R 2012, *Tanz*, Modo, Freiburg

[1] https://www.Tiltbrush.com

[2] https://www.vive.com/

[3] https://www.makerbot.com/3d-printers/replicator/

[4] https://www.flickr.com/photos/arne_quinze/sets/72157647767606992

[5] https://architizer.com/projects/bizarre-spaces/