INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
10-11 SEPTEMBER 2020, VIA DESIGN, VIA UNIVERSITY COLLEGE, HERNING, DENMARK

# NEW FOUNDATIONS: CRAFT, DESIGN, EDUCATION AND VR IN THE 21ST CENTURY

**Pete EVANS**[1] **and Carina SÖDERLUND**[2]
[1]Iowa State University, United States of America
[2]Mälardalens högskola, Västerås, Sweden

**ABSTRACT**
21st Century education and professional practice require novel engagement with ideas, technologies and toolsets. Virtual Reality (VR) and similar technologies are advancing rapidly, and protocols to understand, implement and measure the new values for design education which need to be further elaborated on. This paper discusses the impact of VR on craft and design in a university design class. A pilot was conducted to study students' experiences and opinions around VR in craft and design in an advanced CAD design course. The findings indicate improvement in design and communication from the students' perspective. This study suggests that VR can be an effective design tool integrated into design education.

*Keywords: Agency, empathy, craft, design, affordance, embodiment, actual, virtual reality*

## 1 INTRODUCTION

Virtual Reality (VR) is a widely available technology beginning to be used professionally in areas such as aerospace, engineering, engineering, product development and architecture. This paper focuses on VR in design education. Currently concept design includes two aspects, the making process, a very physical process, and the result of such process (the designed artefact). The making-process is multi-sensory. It includes the corporeal body and the designed artefact, which relate to qualities such as materiality, meaning, and emotional responses (as empathy or passion) [1]. While there has not been a direct interconnection between material and the designer's corporeal body in VR, it is relevant to reflect on how VR closes the gap between material and the user's presence in significant ways.
With VR and similar technologies expanding and advancing rapidly, the protocols to understand and measure the new values for design need to be established. Defining these fundamentals in educational pedagogy is essential. Connecting these fundamentals to design and the design process will advance larger educational and professional design aspirations. This writing is reflective around reasoning about VR and qualities of design and the design process, in 21st Century design education. When creating artefacts in VR, how does VR impact ideas and qualities of design and the making process?

## 2 RECOGNISING THE WHY

Professional domain and knowledge silos are being rapidly deconstructed by evolving technologies such as telepresence [2]. This dissolution of traditional disciplines by continued technological advancement is changing industries and professions. 21st Century design problems and innovation will require work outside disciplinary, academic and cultural boundaries [3] [4]. And the implications are dramatic: Will Richardson has suggested that by the 2020s more than half the (US) workforce will be "freelancers, consultants and independent workers" He also notes a major shift in mastering content (disciplinary knowledge) to mastering learning [5].
In practice, this is transitioning from siloed contractual relations to more project-centric collaborative models [6]. In education, this is reflected in a movement from passive lectures from the "sage on the stage" to more mentor/facilitator-based project-based learning, experiential models and co-creation based around individual and team interaction. Universal constructs [7] illustrate these newer criteria which include creativity, critical thinking, complex communication, collaboration, flexibility and adaptability, and productivity and accountability. A current "Portrait of a Graduate" also includes such attributes as future-ready, self-directed, engaged and innovative learners [8]. This situates well with John Seely Brown describing "agency" as active participation, creating and building as a principal

attribute of a student in a new educational model while inscribing "empathy" as a second requisite quality [9].
We argue for the fundamental reshaping of these educational and professional landscapes which likely require new foundations, aptitudes and skills. Today's culture has moved from a time of knowledge scarcity to an abundance of knowledge and available information through mobility and internet technologies. Even VR headsets are available for consumers. This change in knowledge and information access has precipitated a transition from filtered knowledge release (from knowledge silos and owners) to an unconstrained release of knowledge requiring filtering by (individual) users [10].
When recognizing the rapidly changing/advancing pace of technology evolution compared to human, business, educational and institutional evolution. As STEM (Science, Technology, Engineering and Math) practice realistically acknowledges "Technology" as pervasive among the other areas, telepresence, or (VR), can be considered as a way to maximize the interface, potentials and understandings of learning methods and professional practices.

## 3 THEN TO NOW – HISTORICAL DEVELOPMENTS / SCIENTIFIC ADVANCEMENTS

***Historical Developments*** VR has a literal history stretching back to the early part of the 20th Century. The words "La réalité virtuelle" by Antonin Artaud in his novel "The Theatre and its Double" about a theatre in 1938 may be the first time VR is used [11]. But it derives from the days of Greek theatre. The idea of "logos" was introduced as a way to transition direct active embodied participation to a "place for distant contemplation of the epiphany … to the same cathartic effect on the observer" [12]. This sets the stage for a philosophical development of being and seeing which evolved to phenomenology and embodiment today. These philosophical frameworks permit a base for the context and development of a new craft.
In 2014, Bret Victor presented Seeing Spaces [13] as a mixed-reality concept scaffolding tinkering to engineering to science as evolved thinking and doing in a contemporary engineering domain. The complement to science (pure scientific thought and discovery) is art (pure creative skill and imagination) while engineering (applied scientific principles in practice) is complemented by design (applied creative principles). Finally, and most important to this research is the foundation of these domains, tinkering (constructs of the hand and mind) and its complement of craft (special skill in making by hand).
Further elaborated in Humane Representation of Thought [14], Bret Victor illustrates the values of VR (and Augmented Reality (AR). Connecting these ideas to the development and impact of VR in relation to tinkering and craft begins to develop a better picture and potential of skills, knowledge, values and outcomes in today's design and engineering education and emerging practices.

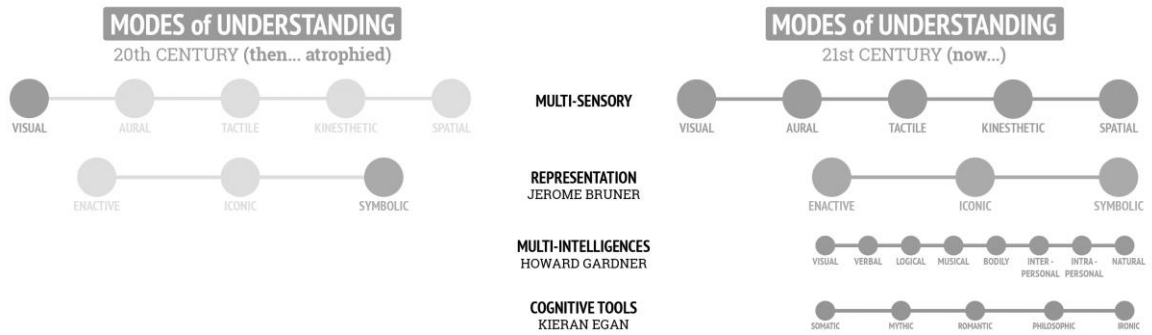


*Figure 1. 20th Century communication (left) v. 21st Century communication (right) showing multi-modal (fully embodied) potential, modified from Humane Representation of Thought, Bret Victor, 2014*

VR Pioneer Jaron Lanier advanced an important contribution in 2019. He wrote "post-symbolic communication" where "direct expression of thought" allows flexibility in shifting form and mode to a higher language of communication [15] (same concept in Victor's 21st Century multimodal diagram).
VR is often criticized as an authentic content and communication medium since its definition means less and not completely. Pierre Levy recasts this narrative by relabelling these somewhat opposing ideas of "real" and "virtual" to "actual" and "virtual." Levy positions the virtual as a more positive relationship

to the actual where potential and opportunity are less limited and even richer and more fluid than the actual [16]. As technology continues advancing VR, tele-present environments and an internet of things as potential new artefact, the relationship to craft (and tinkering, design, engineering, etc) becomes closer where the seeing, making and doing begin to have actual and virtual congruence. This relationship, actual or virtual, is articulated even as "direct contact" with (another's) existence. Where this direct "mind in action" reflects this relationship between the "self" and the "other" [17]. In this case, the "other" could be an object of interest (a thing), a person, or even a place.

***Scientific Advancements*** Recent cognitive psychology and neuroscience advances have also enhanced our understanding of philosophies like phenomenology and embodiment. Vision is now understood at a neural level with parvo and magno cells [18] [19] providing a much more nuanced view of how we understand artefact, focus and surrounding context advances ideas of perception and interaction for craft, design and learning.

Place, grid and border neural cells and networks have expanded the understanding of memory in both ego and allocentric representational frameworks [20] [21] including a 2019 study showing advantages this gives creative work [22].

Proprioception provides the mind and body with a connection to spatial conscious awareness. This receptor called the piezo2 [23] was discovered 10 years ago. Proprioceptive ability allows our body to function in space with our attention and awareness directed beyond and around ourselves. Proprioception can be triggered in VR as well as actual.

Sensory motor knowledge is also advanced. Jeff Hawkins, in his 2007 book *On Intelligence* [24], describes being as tied together through connections between sensing (somatosensory cortex) and doing (motor cortex being the adjacent complement) based within a mental construction of our physical world. Again, supporting a sense of presence in thinking and doing in both actual and VR.

## 4 A NEW CRAFT – TOOLS AND EXAMPLES

A new advanced Industrial Design CAD class was piloted in spring 2020 at Iowa State University testing some of these questions. With 16 students (half senior and half graduate level), four student-defined project briefs were iterated on throughout the term using a variety of digital tools for design and VR collaboration platforms. This supported two explicit goals for the students: (1) provide student choice to investigate appropriate digital design tools to advance their design area of interest and professional aspirations and (2) provide a variety of digital collaborative project design experience in emerging VR platforms. Agency, self-awareness and even empathy were implicit goals.

Utilizing the new Suprenant Ingenuity Lab with advanced design tools, the course began with a primary physical location with 5-6 VR devices traded off and circulated for immediate smaller-group sessions, shared orientations and experiences, and remote work in platforms such as Rumii, Sketchbox, KeyVR, Gravity Sketch and Glue. Students were provided example workflows for collaborative software destinations and navigated their own designs in their chosen software into required collaborative formats prepared for presentation and review. 14 different design software were leveraged for design and collaboration.

In a short course evaluation, students were asked if VR improves the (1) design process, (2) design communication, and if they (3) better understood how VR might be important in design. With 12 respondents, on a 5-pt Likert scale with 1 = "Not at all" and 5 = "A great deal", the Mode was 5 across the three questions and Mean was 4.42, 4.33, and 4.75 respectively. Additionally, students were asked if they were going to (4) continue developing their advanced digital design skills in the future and whether they had been able to (5) grow and pursue their area of interest in design in the course. Students again responded with a Mode of 5 for both questions and a Mean of 4.75 and 4.67 respectively. Four additional questions were asked and similarly supported this course work.

University design students even noticed subtle cues such as body language makes a difference even in VR for working together. That spatial engagement becomes meaningful with these types of interactions. Matthew B. Crawford describes this desired condition in today's world of distraction "joint attention" which has a natural scale to it, a co-presence, something that arises organically [25].


*Figure 2. Spring 2020: (Clockwise from top left) Student early in class meeting in virtual reality (Rumii), 3 students in VR, multiple projects in VR, student-designed VR-modelled car being discussed in VR (Glue), students in classroom rotating through available VR devices with some in VR desktop mode.*

Workflow today included actual and virtual white board ideation, individual and collaborative actual or virtual 2D/3D sketching, modelling and multi-dimensional bespoke artefact.

## 5 REFLECTION

Within an educational context the VR environment is a valid learning space to tinker, craft and collaborate. VR supports rapid digital iteration and prototyping of all things spatial matching our potential for a richer development process more visible and comprehensible to all stakeholders.

In practice, the VR environment is a design, engineering, collaboration and communication space. The VR-environment has qualities that offer us novel agency and empathy, for interaction with each other, spaces and designed artefact. It opens new possibilities to perceive the virtual artefact's relation to the body, and the interactions between artefact and body.

Students, for the most part, positively responded to very open briefs allowing them to focus forward on their path of development. Students felt improvements due to VR for both design and design communication. VR tools engaged the students directly, even when physically distant, where the immediate contact between faculty and student is more paramount. This distancing and virtualizing trend will likely continue, with tools available and necessary for more radical delivery of both pedagogy and projects in the professional realm.

The ability to solve future problems, both educationally and professionally, will require the right tools and communications to synthesize ideas and solutions. VR adds critical bandwidth to design and design communication, providing additional space for discovery, negotiation and resolution.

## REFERENCES

[1] Kälviäinen, M. (2005). Action, movement and bodily relationships in products. In L. Feijs, S. Kyffin, & B. Young (Eds.), Proceedings of the 2nd Conference on Design and Semantics of Form and Movement (pp. 84-89). Eindhoven, NL: Koninklijke Philips Electronics

[2] Susskind, Richard, et al. *The Future of the Professions: How Technology Will Transform the Work of Human Experts*. Oxford University Press, 2017.

[3] Blackwell, A.F., Wilson, L., Street, A., Boulton, C. & Knell, J. (2009). Radical innovation: Crossing knowledge boundaries with interdisciplinary teams. Technical Report. *University of Cambridge.* https://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-760.pdf [Accessed 2020, 9 March]
[4] Mainzer, K. (2011). Interdisciplinarity and innovation dynamics. On convergence of research, technology, economy and society. *Poiesis Prax*, *7*(4), 275-289. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3136705/ [Accessed 2020, 9 March]
[5] Richardson, W., Why School? (2012) How Education Must Change When Learning and Information are Everywhere, [Kindle Edition] Ted Conferences, Retrieved from https://www.amazon.com
[6] "Integrated Project Delivery: A Guide." *Integrated Project Delivery: A Guide*, AIA California Council, info.aia.org/siteobjects/files/ipd_guide_2007.pdf.
[7] *Iowacore.gov*, iowacore.gov/content/universal-constructs-essential-21st-century-success-0. [Accessed 2020, 9 March]
[8] "Portrait of a Graduate_CCR Copy.pdf." *Google Drive*, Google, drive.google.com/file/d/0B2Mln7afuZvtbHl4RVJnZWZrU2U5YmlDanNpNXV1T0RlM0Q4/view [Accessed 2020, 9 March]
[9] Brown, J. S. (2013) US Education Strategy Digital World. Retrieved July 10, 2017, from https://www.c-span.org/video/?312978-1/us-education-strategy-digital-world [Accessed 2020, 9 March]
[10] Mcleod, S. "2019 IASB." *Google Docs*, Google, docs.google.com/document/d/1lsdRemlkqir_6_CGj3U59Emjpy5eTAp1th9zTxkO0Ws/edit. [Accessed 2020, 9 March]
[11] Artaud, Antonin. *The Theatre and Its Double.* Grove Press, 1938.
[12] Holl, Steven, et al. *Questions of Perception: Phenomenology of Architecture*. A u Pub., 1994
[13] Victor, Bret. "Seeing Spaces." *Vimeo*, 10 Mar. 2020, vimeo.com/97903574. [Accessed 2020, 9 March]
[14] Victor, Bret. "The Humane Representation of Thought." *Vimeo*, 10 Mar. 2020, vimeo.com/115154289. [Accessed 2020, 9 March]
[15] Lanier, Jaron. "How Octopi Morph Colour." *Discover Magazine*, Discover Magazine, 12 Nov. 2019, www.discovermagazine.com/planet-earth/how-octopi-morph-color. [Accessed 2020, 9 March]
[16] Lévy Pierre. *Becoming Virtual: Reality in the Digital Age*. Plenum Trade, 1998.
[17] Merleau-Ponty, M., *Phenomenology of Perception.* London: New York: Routledge & K. Paul; Humanities Press, 1962.
[18] Coren, S., Ward, L. M., and Enns, J. T. (1999). Sensation and Perception (5th ed.). Harcourt Brace College Publishers.
[19] Jerald, Jason. *The VR Book: Human-Centred Design for Virtual Reality*. Association for Computing Machinery, 2016.
[20] Muller R.U., A quarter of a century of place cells. *Neuron.* 1996; 17: 813-822
[21] McNaughton B.L et al. Deciphering the hippocampal polyglot the hippocampus as a path integration system. *J. Exp. Biol.* 1996; 199: 173-185
[22] Nisha, Bobby (2019) The pedagogic value of learning design with virtual reality, Educational Psychology, 39:10, 1233-1254, DOI: 10.1080/01443410.2019.1661356
[23] Resnick, Brian. "The Silent 'Sixth' Sense." *Vox*, Vox, 26 Dec. 2019, www.vox.com/the-highlight/2019/11/22/20920762/proprioception-sixth-sense. [Accessed 2020, 9 March]
[24] Hawkins, Jeff, and Sandra Blakeslee. *On Intelligence:* Times Books/Henry Holt, 2008.
[25] Crawford, Matthew B. *The World beyond Your Head: on Becoming an Individual in an Age of Distraction.* Penguin, 2016.