LEARN X DESIGN 2021
Engaging with Challenges in Design Education
6th International Conference for Design Education Researchers
Shandong University of Art & Design | Jinan, China

Materiality of Space and Time in the Virtual Design Studio

Ruth M. Neubauer and Christoph H. Wecht
https://doi.org/10.21606/drs_lxd2021.08.214

Digital structures as well as time can be described as crucial material affordances of the virtual design studio space. We question the notion that digital spaces are inherently immaterial and intangible. We challenge the concept of presence and flexibility in the context of the virtual space, and claim that digital infrastructures can be as materially inflexible as physical worlds. Simultaneously we argue for the potential of understanding virtual spaces beyond binary conceptions of presence/absence. We use concepts of practice and materiality to analyse virtual spaces as distributed spatiotemporal structures that can be designed to afford flexibility. We are interested in the design of spatiotemporal spaces that on the one hand provide flexible learning environments and that teach on the other hand this understanding of materiality of virtual structures to its participants.

Keywords: digital; physical; hybrid; flexibility; work

Introduction

Digital collaboration spaces have been praised as opportunities for flexible working and learning. With digital tools, geographical locations can be overcome easily (Bohemia & Harman, 2008). This fact provides flexibility for people who have disabilities, care commitments, or other personal reasons for not being able to attend sites of working and learning either temporally or longer-term. Especially during the recent pandemic, when many learning and work sites were closed, this flexibility enabled a continuation of many activities in geographically distributed ways. However, shared studios being shut created a problem for designers. Physical environments are constitutive of creativity and important factors of learning in design (Gonçalves et al., 2019). The absence of physical meeting and working, with university workshops widely closed for on-site collaborations, has made it difficult to continue the traditional design studios. Design students were unable to meet with their teachers and peers in person, or work on projects that require machines and materials that are typically available at the design studio. Concerns are voiced that the digital space cannot be a substitute for onsite teaching and for the work with 'real' materials.

These sentiments about the virtual studio do not quite capture the quality of virtual structures: neither is there absolute flexibility, nor is there an absence of the real world, in the virtual space. In the dichotomy between the 'digital' and 'physical'/'real' there is a missed opportunity to conceive of the virtual collaboration spaces we inhabit as material structures (Devendorf & Rosner, 2017). We claim that these material structures can be designed to suit the needs of flexibility on the one hand, and can enable material learning on the other.

To help us overcome this binary divide between digital and physical spaces, we explore the concept of *presence* as an affordance of the virtual learning environment. We present our experiences of teaching a virtual design studio at the university. We explore and illustrate the materialities of digital tools and time schedules, which we inadvertently used to structure class. We review our structuring of the virtual class, and respectively the students' resistance against it. We aim to understand how virtual structuring materials can be used to design for people's needs and, in particular, around the concept of creating a flexible space for all participants. We discover time to be a critical material component of the virtual space. The enforced synchronicity of activity, such as live interaction through video, provides a rigid spatiotemporal material that does not allow much flexibility. We argue that understanding presence in the virtual space as a spatiotemporally distributed material condition, allows to design more flexible virtual learning environments.

Simultaneously does this treatment of virtual spaces provide a pedagogical potential to teach students the design of spaces with richer textured materials.

Learning Spaces

The design studio is a part of the curriculum of learning design (Julier, 2017; Tovey, 2015). It is a space for students to engage with their teachers, with their peers, and with the materialities of making. It also allows students to mimic professional design activity (Tovey, 2015, p. 63). Activities in the design studio encompass the design brief, the exploring of materials and of existing uses, the concept, the modelling, the critiquing and the prototyping of design solutions. In the course, where we teach, the design studio also encompasses the exploration of economic viabilities and the embedding of a design within wider networks of production and consumption, such as sustainability or novel business models. Learning in the studio is understood to be practice-based and reflective (Schön, 1983). Important aspects of the design studio are the "studio" itself, as a room that enables interaction as well as individual working, the "design tutorial" as the tutoring interaction between the students and the teachers, the "library", as the store of useful resources that students can draw on, and the "crit", as the critical review and evaluation of presented designs (Tovey, 2015, pp. 63–64). The engagement with materiality is key in design. The "doing and making" foregrounds design skill as an embodied knowledge (Shreeve, 2015, p. 87). The "reflective conversation" with materials enables the moves required to shape these materials (Schön, 1983). This physical engagement in the workshop or the studio is considered to be very important for learning designing. Even in design disciplines that consider themselves to design 'intangible' solutions, such as service design or experience design, the co-location with all stakeholders and the on-site engagement with the topic is considered to be important (Gothelf & Seiden, 2013; Knapp et al., 2016; Stickdorn et al., 2011). The interactions between the teachers, the students, and the materials are the fundamental structures of the design studio. For the virtual design studio, which has popped up ubiquitously during the recent pandemic, this centralises the question of what the 'structures' of learning environments—the interactions and the materials—are made of.

Embodied Learning

Virtual studios currently serve as platforms of interaction between teachers and students. However, embodied interaction with each other and with the materials of making is seen to be suffering. It is harder for students to get to the workshops, which are often physically located at the universities and have restricted access. Interactions with teachers are perceived as 'distant'. The guidance in using materials can only be done through, what is perceived as a 'translation', such as video meeting, remote presentation, extra cameras, screensharing, photos, or scans. Teachers cannot 'directly' demonstrate the work with the materials, and neither can they 'directly' guide the students' work and intervene accordingly.

In our course, we aim to teach how to move beyond the studio and how to extend the design space towards the communities who are a part of that space (Botero, 2013). The studio further seeks to get students to extend their own personal spaces and encourages the "getting out of the building", or "GOOB", principle (Gothelf & Seiden, 2013, p. 9). This may serve us as a vantage point when exploring the topic ahead.

We may question what it means to *teach* design and scrutinise the notion of *developing knowledge through embodied engagement*. In this context, the masterclass system has been criticised, which is based on the master-apprentice model of learning (Harman, 2016). Art and design education have traditionally been based on a system where an outstanding master as professor shows their craft to the students (Julier, 2000). However, in our own experience of studying, these professors were largely absent from the daily business of teaching. Instead, the learning spaces were much defined through the biographical story of being part of that particular learning space, and finding one's own professional identity and competences within the materialities of that space (Ghassan & Bohemia, 2015). This challenges the idea that students and teachers must be physically together at all times, in order to provide a space for creative learning. Research into the spatial qualities of the design studio has shown that creative spaces are made of a range of stimuli, activities, atmospheres and interactions that go beyond the teacher-learner relationship (Gonçalves et al., 2019). It is possible to take a more decentred approach to teaching in the virtual studio.

Reality and Material Structures

The matter of the virtual space also invites the question of its relationship with the *real world*. Currently, virtual engagements are perceived as mere translations of physical interactions. These digital translations are seen as representations, and thus as neat workarounds, of the 'real' engagement. However, digital space is more than just a translation or reflection of the 'real' space (Devendorf & Rosner, 2017). Research in digital

materiality has shown that information technology is not an immaterial space (Fuchsberger, 2019; Rosner, 2012; Smit et al., 2021; Taylor, 2015). Firstly, the digital space heavily relies on physical materials, if we consider the real restrictions of disk capacities, screen sizes, and battery lives of our devices, or the connections, cables, servers, the data centres, their heat and their air conditioning, that enable our data flows (Dourish, 2017; Taylor, 2015). Digital infrastructures have a very physical presence. Furthermore, virtual collaboration spaces are never digital-only. They are also made of desks that hold the devices we use, cameras and microphones to see and hear other people, chairs that hold the people participating, hands that hold devices, coffee mugs, paper and pens nearby, weather conditions that either give us good or bad internet connections, etc. Digital interconnections have real materialities that do have real effects (Dourish, 2017). Secondly, the representational materialities of digital infrastructures create social realities (Dourish, 2017). If we think of the example of the format of database fields, they can either support or restrict non-binary gender identifications, depending on whether they can store binary or multi-character values. Another example of the material effect of virtual data structures are the loss of thousands of Covid-19 test results before they could be processed—many to be assumed positive—due to the limited number of rows an Excel sheet can hold (Hern, 2020).

Information technology is material; virtual structures are real: they have real effects on our lives. To assume that virtual spaces are made of elastic and malleable materials that can create ideal interaction scenarios—perhaps even escaping the unforgiving 'real world'—means to turn a blind eye on the materialities that virtual spaces do have. We are instead invited to perceive the hybridity of our lives. Especially if working from home, we have kitchens nearby, our bedrooms, bathrooms and the people and animals we live with. Our virtual studios demonstrate to us the overlapping spaces of practices and identities – we are being students, teachers, friends, parents, partners simultaneously. In the light of this diversification of everyday practices, we are invited to reassess our ways of teaching, learning, and being, and our designing of learning environments. We take this as an opportunity to explore the materialities of the virtual studio, as part of the real world.

The Politics of Space and Presence

Virtual environments have enabled the flexible *presence* in spaces of working and learning (Bohemia & Harman, 2008). Flexible working and learning can be described as a *presence* that can be adjusted to one's needs. Originally, flexibility in the work place has meant for workers to be able to adjust traditional work hours from 9 to 5 o'clock, to suit other commitments such as parenting, while later it expanded to mean geographical location and also employment status (Erickson et al., 2019). Flexibility in its contemporary form does not only mean a flexible participation of the worker, but also a certain elasticity of the worker-employer relationship that suits the employer and new types of economies (ibid). These flexible working and learning spaces could be scrutinized as to how flexibility is constituted in these spaces.

Spaces can be viewed as territories (Yelavich & Adams, 2014, p. 80). Who is allowed to be present in a space, is determined by the rules and materialities of the space. For example, trains without wheel-chair accessible doors, or pubs without wheel-chair accessible toilets, make it harder for some people to be present in it. Digital structures that normalise working from home, learning from home, and even music concerts from home, have removed participation barriers for people with disabilities in the spaces of working, learning and social interaction (Ryan, 2021). Space has a political component to its design. Space, and the ability to be present in this space, as well as the rules of participation, are constituted through its material structures.

Understanding Spaces Materially

We are interested in understanding the materials of virtual spaces so we may design them flexibly for its participants. We therefore analyse the material ecologies that constitute these presences.

Material ecologies mesh as "artful integrations" to build the material worlds we live in and interact with (Suchman, 1994; Wright, 2011). These material worlds are made up of our homes and infrastructures, our rooms, our routers, our desks, and our devices. They are also made up of video images, sound, still images, and text representations that fill—as digital materials—the interfaces of video, chat, email, and whiteboard applications. These digital materials are the material structures that define our agencies (Haraway, 1991)—what we are able to do—for example, participating in a virtual studio space through speaking, showing something, hearing, learning something etc. Also, temporality is constitutive of space (Schatzki, 2010). The virtual design studio is also defined by time schedules, manifest in time tables and calendar entries. Time schedules define how we are present together as teachers, students, and colleagues.

Our virtual design studio space is made of spatiotemporal infrastructures that including the physical work materials such as rooms, desks and devices, our digital collaboration tools, and our time schedules.

The virtual studio space is also affected by our practices. When working or learning from home, our spatiotemporal structures of the studio space overlap with those of our personal spaces. Our personal infrastructures involve our homes and cohabitants, children, breakfasts, lunches, kitchens, fridges, heating, electricity, Wi-Fi, school pick-ups and drop-offs, shopping, personal calendars, … We have overlapping spaces for multiple practices. Some spaces can easily get reused. The kitchen may now be the place to eat and to work. The home may now be the place to work and to be with the children. Other spaces can get crowded, such as multiple people in the home using the same Wi-Fi connection, or multiple people trying to use the kitchen as places to eat and to work. Or homes simultaneously trying to be playground and office.
Practices intermingle and each practice follows its own organization principles (Gherardi, 2012). The overlapping of practices creates a density of relationships which may be difficult to disentangle. However, practices can be analysed as units that are distinct but interweave. Practices are units of analysis that describe socially understood distinct areas of activity (Shove et al., 2012). Specific to learning, we might understand these as "communities of practice" that demarcate what it means to be a practitioner (Wenger, 2000). Being a designer, as in the example of the virtual design studio, means to participate in the practice of design. In the learning setting, the teachers are understood as experienced designers while the students are novice designers. Even non-professional practices, such as cooking, parenting, home-schooling, are organized around their own aesthetic principles that reinforce how a practice is done and what a competent practitioner looks like (Gherardi, 2012). Social practices as a lens, are helpful in understanding how environments provide participants with the agency to participate.
The lens of *materiality* of digital and physical materials, together with the concept of *practices*, allows us to analyse the space of the virtual design studio. This lens is sensitive to the multiple materials, activities, and principles. We choose this lens to explore *presence* within a space. We use it to understand flexibility, and to design for a flexible presence in the virtual design studio.

The Experience of Being in the Virtual Design Studio

The data we draw on was collected during a research project that investigated materiality in the design studio. We, the authors, co-teach several undergraduate design studio classes, in which we use design as a method of innovation. The curriculum of the three-year undergraduate course comprises of design studio classes with practical working in the intersection of design, economy and society. A typical project outcome involves an innovative design, which could be a product or a service that is economically and socially viable. Being thrown into the situation of remote teaching by necessity rather than by choice during the pandemic, we initially organized our virtual studio very similar to the structure we had created for the design studio class at the university. During the semester we realized that this direct translation of the course syllabus had not worked well in all areas, while some elements translated well. Afterwards we sought to analyse the experience of the virtual-by-necessity design studio, in order to find out in what ways we could design a virtual-by-design design studio that would support flexibility, without compromising but rather exceeding our studio's normal quality.
The syllabus of the design studio IV is organized around practical design projects, comprising of the tasks of researching existing uses and practices, defining aims and objectives, exploring innovative service concepts through prototypes, and designing an object or service for transformative intervention. We gave students the task to design a sustainable clothing solution. We familiarized the students with methods of service design, such as empathy maps (Kalbach, 2016), story mapping (Patton, 2014), and crazy eights (Knapp et al., 2016). In particular, story mapping was introduced to them as a useful tool for creating an overview, the "whole picture" and a "mutual understanding" of the situation (Patton, 2014). Guest designers from the practice of service and UX design (user experience design) joined us for workshops and talks in order to bring practice-oriented knowledge to the class setting. They showed us how they use mapping in their practices, and techniques for identifying opportunities within these maps.

Tools

We were meeting online on the Microsoft Teams and Zoom app, using the video, microphone and chat. Each participant in this digital meeting had a video feed showing up in the interface as tiles next and underneath each other, and an audio feed with potentially overlapping sounds. Our own digital presence was defined by a video image of ourselves, and by the fact that we could see and hear other people's video and audio feeds. Students liked to turn their cameras off. Frequently, we discussed that it was a better experience if everyone turned their camera on. It would create the experience of a mutual space, was our idea. We often switched to Zoom, because Zoom had the feature of showing up to 25 tiles per screen, while Teams could at that point only show a maximum of nine. The disadvantage of Zoom was that chats and files, that were shared, weren't

stored, and that any structures set up for the meeting duration, such as break-out rooms, were gone afterwards. It was also not possible to move between rooms, unlike Teams which had permanent “channels” that could be accessed, and that had the ability to store chats and files. We further used Miro, a digital collaboration space with a whiteboard that permitted us to draw, where we created diagrams, uploaded files, links and images.

Rules for Togetherness

We wanted to create a space where we were present together and work together, so we felt it was important to see everyone. There were accepted uses of a disabled camera. There was a shared understanding that during official breaks it was OK to turn the camera off, for example over lunch. And it was possible to explain the disabled camera in other situations, such as being at another site of work, whether physically or virtually, being in transit, being ill in bed, attending to children, helping someone else, or taking pets out on a walk. The microphones we agreed to be off while someone was not speaking. The overlapping sounds, when they happened, were such painful experiences that the practice of turning off the microphone was perfected soon. For meeting and speaking in smaller groups, we used break-out rooms where each group had their own conversations. We even experimented with using in parallel Zoom for our large group meeting, and Teams for small group meetings, which allowed a permanent video feed with all participants, while restricting audio to the relevant group meeting only. The idea persisted, that video feeds and seeing each other at all times would reconcile the geographical distance and would encourage a mutual experience.

In Miro, the students were asked to create their personal ‘work desks’ in the virtual space, and they enjoyed creating these desks and decorating them individually. For group work they created group areas. Working in Miro also created a sense of togetherness through the indicator of who is present on the whiteboard. The presence of others in Miro was indicated through the cursors with names attached, and through icons with initials at the top of the screen. This co-presence, manifested through cursors and names, created a togetherness in one’s presence. On the other hand, for the teachers it was also a control mechanism to check who was present and who was absent. This was also perceived by the students, who reacted by signing in, when the teachers asked – “Where is everyone? I can only see 5 people!”. The teachers sometimes even made it a rule that students needed to sign-in before they would begin. The presence of cursors and names was used as a guiding principle that gave a reassuring feeling of being together, and it gave the teachers a handle on the structure of the class.

For us, the teachers, it was also good to know when we were by ourselves. Preparing a Miro board for class felt similar to preparing a room – such as preparing the materials on the tables and on the walls to be ready for when the students arrive. While preparing, it was reassuring to be alone (no other cursors and names visible) and to try out different things before making them ready to be seen and used. Similarly, through the participants list in Teams and Zoom the teachers could determine who was present. In video meetings, when we noticed that we were amongst ourselves, because students were in groups, we used this situation to coordinate our teaching activities and schedules. Presumably also for the students it made a difference, being by themselves or having teachers present. Like teachers, students might have had a close eye on the participant list during video meetings.

The rules about cameras, microphones, sign-ins, etc. turned out to be important control mechanisms of the space, materially creating its design.

A Flexible Space … for Some

Within the vast landscape of possible ways to set up a virtual studio, our studio emerged as the space that is was through the technical configuration, which was largely driven by the rules that we had set up. Setting up the technologies was challenging. For example, using Miro required the teachers to set up the space, get the correct licenses, add the students with their email addresses, and everyone then needed to sign-in, create an account, install the app, and begin learning how to use it. The unfamiliar technologies entailed a steep learning curve for all involved. In the light of these difficulties, the students reflected critically upon the usefulness of the method of story mapping, given the effort and labour it took them to generate it. They felt it was too laborious for the benefit it gave them, and they felt it was too big a task for the time that was allocated to the design studio.

We set out using the same time table which we had originally created for the studio, if it had taken place physically at the university, which was 11 days distributed over the semester with set start and end times. This schedule was made up of two studio classes, one focused on the teaching of the techniques of service design, and the other one on the practical applicability of service design. We, the teachers, began to shift around the start and end times of classes to accommodate for the ways in which some activities took longer during the

virtual studio than we had anticipated. And we also adapted the times to other virtual work meetings that had themselves shifted, presumably due to similar issues. Furthermore, as we, the teachers, working from home, were confronted with our home practices of parenting, sharing infrastructures with cohabitants, and other personal practices, we noticed that these influenced the ways we defined the studio time structure. For example, we kept the lunch time according to our own experiences of how long it would take to prepare it and feed the children. We experienced the necessity of keeping the time structure of the virtual studio flexible, and we used our own experience in order to create this time structure. In effect, the virtual studio usually started at 9 and lasted until about 2pm, 3pm, or 4pm and often longer. Lunch time was around midday and lasted between 30 and 45 minutes.

It soon emerged that our time structure, which we had at first translated directly from the university situation to the virtual situation, and then adapted in a flexible way, did not work for the students. We noticed negative sentiments and fewer and fewer students willing to turn the camera on. Eventually, a group of students approached us and told us that they really struggled. They were exhausted from the studio work, and they did not know 'where' they were – how much work they had left, and what tasks they needed to finish by what time. A studio space had emerged that was fluid, but it was not theirs, at this point, and they struggled to inhabit it.

As a constructive outcome of this emergency meeting, we managed to reorganise the time and task management. We created a map to make all tasks visible. We used the same mapping method which we had given to them as a design tool for the clothing innovation. Together, we created another map—a time planning board—with all activities that we had 'behind' us and that we had 'before' us along a timeline, with an indicator of 'now'. Through this activity we managed to create a shared understanding of the timetable structure and of the tasks that had yet to be done. It created a shared presence. The students participated in the structuring of the space and we thus created a space where we could be present together.

The Design of the Virtual Design studio

Virtual work and learning spaces have materialities, and they mesh with the materialities of our other practices, such as being parents, having pets to look after, or working at multiple sites. The virtual design studio is an opportunity to structure these meshing worlds more flexibly, using as the building materials the technologies and infrastructures we have.

In our virtual studio, we have identified the following practices to be interconnecting with the practice of learning in the virtual design studio space: A) work practices in other spaces both virtual and geographical (for students it is part-time work, for teachers it is other classes or collaborations, often internationally); B) other people's practices that partially share our spaces (sharing devices, infrastructures such as Wi-Fi or rooms, or account logins); C) caring for others such as children, sick, elderly, for ourselves, or for pets.

A virtual-by-design studio allows the participation in all these practices; it is designed to afford a flexible organization and configuration of space. Agency—what we are able to do—is configured through the material ecologies in which we participate (Suchman, 2012). If we view *presence* as a distributed form of being in a space, we are not caught up with the binary understanding of being *there* or *not-there* in a space, and we are able to structure *presence* in more subtly textured ways. We might not need a camera feed to assure that someone is present, and in order to create togetherness. A distributed *presence* allows us as teachers and students to be *present* in the virtual studio while we are also engaged in other practices, and may be *present* elsewhere too. A distributed presence does not need to diminish the quality of our presence and the quality of our learning. We even aim for exceeding the quality of learning in the virtual studio by enabling this materially flexible presence.

Presence in Spatiotemporal Distribution

What is a materially flexible presence? When we, the teachers, responded flexibly to scheduling studio times, lunch break, and end time, this timing was sensitive towards the situation of learning as it unfolded; as some tasks took longer. And it was sensitive to our other commitments as teaching employees of the university with multiple classes and responsibilities. And we were able to even adapt it towards our commitments as parents. The live video worked well for us teachers, because we were able to define the temporal structure of the day. However, it made the studio space inflexible towards the needs of others. We had intended to create an experience of togetherness through the live video, which we lacked at the time. But despite our geographically distributed locations, the temporal structure enforced a 'centralised' presence of everyone at the same point in time and space. The spatiotemporal structure of the space was not very flexible. The students responded by turning off the cameras as soon as they could. They sought to regain some agency over their space – withdraw

from the control that it entailed. They sought to regain agency over *where* they *were*. Their experience of presence in the studio depended on the spatiotemporal structure that had been created by the teachers. And this structure was unpredictable; it was flexible towards the constraints that arose in the teachers' practices, and thus it was inflexible and ad-hoc for the students.

'Being' somewhere is organized through the material affordances that a space gives (Gibson, 2015). Presence arises in the interaction with spaces (Suchman, 2007). We are interested in creating a virtual space that enables a flexible presence for students. The advantage of the virtual space over the physical university situation is, that a virtual space enables a spatiotemporally flexible presence, in which students can be present in distributed ways, so they can experience the learning activities through their own structuring input. Students can distribute their presence across their practices as they need to, if, for example, another class starts in 5 minutes in another city, a child needs attention, or the washing machine might be beeping, a lunch needs to be cooked, or a prescription medicine fetched from the pharmacy.

The virtual design studio facilitates activities of learning design. As the teachers of a virtual design studio, it is our responsibility to organize and structure this space well – to *design* this space well. As much as we *teach design*, we *do design*, when we create the learning space for our students. We have experienced a learning curve. In this paper we reflect on the experiences we have had. Our aim is to design the ideal virtual design studio that provides flexibility to its participants. The distributed view on the virtual studio provides a richly textured material to design this space. Simultaneously as students can be provided with the experience of participating in the virtual studio, they can also learn from adopting this view on virtual structures and how they organize and structure them well for themselves.

The Materials of Spatiotemporal Distribution

Interactions in the virtual space are grounded on the interfaces of the digital tools. These are made of *text* (read about one another and their work), *image* (see one another and their work), *sound* (hear one another), and *video* (seeing and hearing one another). Some materials can be *edited*, and some cannot. Interacting with these materials synchronously, during the same point in time, adds another material layer on them. Synchronous interactions in the virtual space are the least flexible, because they tie actions to specific points in space and time. Especially live video enforces a fixed spatiotemporal structure where interaction is temporally fixed in space. This means that *time* is a significant aspect in the virtual design studio. If text, images, sound or video can be interacted with independently from points in time—asynchronously—they can afford more flexibility. Asynchronous interactions can be spatiotemporally structured around other practices, and provide therefore more agency on behalf of participants.

Designing the Spatiotemporally Distributed Design Studio

Affordances—what actions are possible—emerge between a person and their surroundings (Gibson, 2015). "Signifiers" indicate the possible functions of a space (Norman, 2013). On the one hand, it is necessary to design the structure of the virtual space and the teaching interactions. On the other hand, the signifiers of interactions—what needs to be done, by when, and how—needs to be given. The students responded well to the map of our schedule that we created after our emergency meeting. It gave them a timeline of activities and indicated clearly where we were. Signifying structures such as these could be created in more detail, and relevant to each task. Here would be the opportunity to indicate whether a task can be completed in someone's own time or at a specific point in time.

The virtual studio landscape and its affordances—possible interactions—need to be signified clearly. This provides participants with orientation and a sense of *where* they are, giving them an experience of *presence* in a mutual space. Signifiers can indicate the possibilities of different interactions. The virtual studio designed in this way—designed for a virtual presence—would provide participants with the flexibility to organize their practices around these structures effectively.

When designing for spatiotemporal flexibility in the design studio, it is important to consider the key learning activities: To reference again the pillars of the design studio, it is necessary to design the "studio" as a space, and also the interactions such as the "design tutorial" – the guiding interaction between teacher and student, the "library" as the pool of resources, as well as the "crit" – the critical review on the student's work.

A design presentation – does it require a live video interaction? Probably yes, due to the exchange and the feedback through which these presentations become alive. Furthermore, these presentations provide a training opportunity for publicly presenting and pitching one's work. But it is possible to appoint particular times when these events take place, so it is possible to organize *around* it. A design tutorial – does this require a live interaction? If yes, does it always and with everyone? It might not be necessary for everyone to meet at

the same time. Videos and text tutorials that can be accessed asynchronously for a period of time may work just as well. Asynchronous content allows a structuring of tasks by the students themselves, perhaps even organizing their own small work groups. Providing a tutorial as a live event does enforce a presence at a particular time, but it does not ensure that everyone participates. Providing a tutorial to be accessible in one's own time, allows more flexibility and thus maximises the opportunities for successful engagement with the learning material. Spatiotemporal flexibility increases the quality of the design studio.

Togetherness was an important factor in our experience of the virtual design studio. Togetherness is enabled through the material affordances of the studio space. Activities that we do together as a studio class do not need to overlap temporally at all times. Text, image, or video content about the activities we undertake together, can give a material scaffolding to mutual activities, so that togetherness can be experienced in an asynchronous, open way.

There is much practical work to done in designing better virtual design studio spaces. Consideration needs to be given to each interaction. Above we touch on some of these considerations. Time shows to be a strong means of structuring. It is a material of design and it can be used selectively to maximize both learning quality and flexibility.

As teachers and designers of virtual studios, we can use these virtual materials to design for spatiotemporal flexibility in learning interaction. Creativity and personal creative development in higher education are encouraged when students can participate in creating their own learning spaces (Ghassan & Bohemia, 2015). If we design the spatiotemporal affordances of the virtual design studio flexibly—open to a spatiotemporal distribution according to personal needs—we provide the perfect learning environment for design students, giving them the best learning practice for their future work.

References

Bohemia, E., & Harman, K. (2008). Globalization and product design education: The global studio. *Design Management Journal, 3*(2), 53–68.

Botero, A. (2013). *Expanding design space(s): Design in communal endeavours.* Aalto University. Helsinki.

Devendorf, L., & Rosner, D. K. (2017). *Beyond hybrids: Metaphors and margins in design. P*roceedings of the 2017 Conference on Designing Interactive Systems.

Dourish, P. (2017). *The stuff of bits: An essay on the materialities of information*. MIT Press.

Erickson, I., Menezes, D., Raheja, R., & Shetty, T. (2019). Flexible turtles and elastic octopi: Exploring agile practice in knowledge work. ECSCW 2019: Proceedings of the 17th European Conference on Computer Supported Cooperative Work, London.

Fuchsberger, V. (2019). The future's hybrid nature. *Interactions, 26*(4), 26–31.

Ghassan, A., & Bohemia, E. (2015). Amplifying learners' voices through the global studio. In M. Tovey (Ed.), *Design Pedagogy: Developments in Art and Design Education* (pp. 215–236). Gower Publishing Limited.

Gherardi, S. (2012). *How to conduct a practice-based study: Problems and methods*. Edward Elgar Publishing Limited.

Gibson, J. J. (2015). *The ecological approach to visual perception: Classic edition*. Psychology Press.

Gonçalves, M., Thoring, K., Mueller, R. M., Badke-Schaub, P., & Desmet, P. (2019). Inspiration space: Towards a theory of creativity-supporting learning environments. *Conference Proceedings of the Academy for Design Innovation Management, 1*(1).

Gothelf, J., & Seiden, J. (2013). *Lean UX: Applying lean principles to improve user experience*. O'Reilly Media, Inc.

Haraway, D. (1991). A cyborg manifesto: Science, technology, and socialist-feminism in the late twentieth century. In *Simians, cyborgs, and women: The reinvention of nature* (pp. 149–181). Free Association Books.

Harman, K. (2016). Examining work-education intersections: the production of learning reals in and through practice. *European Journal for Research on the Education and Learning of Adults, 7*(1), 89–106.

Hern, A. (2020). Covid: How Excel may have caused loss of 16,000 test results in England. *The Guardian*. https://www.theguardian.com/politics/2020/oct/05/how-excel-may-have-caused-loss-of-16000-covid-tests-in-england

Julier, G. (2000). *The culture of design*. SAGE Publications.

Julier, G. (2017). *Economies of design*.

Kalbach, J. (2016). *Mapping experiences*. O'Reilly.

Knapp, J., Zeratsky, J., & Kowitz, B. (2016). *Sprint: How to solve big problems and test new ideas in just five days*. Simon and Schuster.

Norman, D. (2013). *The design of everyday things: Revised and expanded edition*. Basic Books.

Patton, J. (2014). *User story mapping: Discover the whole story, build the right product*. O'Reilly.
Rosner, D. K. (2012). The material practices of collaboration. ACM 2012 Conference on Computer Cupported Cooperative Work, Seattle.
Ryan, F. (2021). Remote working has been life-changing for disabled people, don't take it away now. *The Guardian*. https://www.theguardian.com/commentisfree/2021/jun/02/remote-working-disabled-people-back-to-normal-disability-inclusion
Schatzki, T. R. (2010). *The timespace of human activity on performance, society, and history as indeterminate teleological events*. Lexington Books.
Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.
Shove, E., Pantzar, M., & Watson, M. (2012). *The dynamics of social practices: Everyday life and how it changes*. SAGE.
Shreeve, A. (2015). Signature pedagogies in design. In M. Tovey (Ed.), *Design Pedagogy* (pp. 83–94). Gower Publishing Limited.
Smit, D., Neubauer, R., & Fuchsberger, V. (2021). *Distributed collaborative sensemaking: Tracing a gradual process.* ACM TEI International Conference on Tangible, Embedded and Embodied Interaction, Salzburg, A.
Stickdorn, M., Schneider, J., Andrews, K., Belmonte, B., Beuker, R., Bisset , F., Blackmon, K., Blomkvist, J., Clatworthy, S., Currie, L., Drummond, S., Hegeman, J., Holmlid, S., Kelly, L., Kimbell, L., Miettinen, S., Pérez, A., Raijmakers, B., & Segelström, F. (2011). *This is service design thinking: Basics - tools - cases*. Wiley.
Suchman, L. (1994). Working relations of technology production and use. *Computer Supported Cooperative Work (CSCW), 2*, 21–39.
Suchman, L. (2007). *Human-machine reconfigurations: Plans and situated actions*. Cambridge University Press.
Suchman, L. (2012). Configuration. In C. Lury & N. Wakeford (Eds.), *Inventive Methods: The Happening of the Social* (pp. 48–60).
Taylor, A. (2015). After Interaction. *Interactions, 22*(5), 48–53.
Tovey, M. (2015). Designerly thinking and creativity. In *Design Pedagogy: Developments in Art and Design Education* (pp. 51–66).
Wenger, E. (2000). Communities of practice and social learning systems. *Organization, 7*(2), 225–246.
Wright, P. (2011). Reconsidering the H, the C, and the I: Some thoughts on reading suchman's human-machine reconfigurations. *Interactions, 18*(5), 28–31.
Yelavich, S., & Adams, B. (Eds.). (2014). *Design as future-making*. Bloomsbury Publishing.

Ruth M. Neubauer
New Design University, Austria
ruth.neubauer@ndu.ac.at
Ruth Neubauer is a designer and design researcher in human-centred innovation. She has worked in the industry in Vienna, London and Brighton. Ruth graduated from the Academy of Fine Arts Vienna, and she has a doctorate from Loughborough University in Design Innovation. Her work comprises of research and teaching at various universities: New Design University in Sankt Pölten (A), University of Art and Design Linz (A), and Loughborough University (UK).

Christoph H. Wecht
New Design University, Austria
christoph.wecht@ndu.ac.at
Christoph H. Wecht is professor of management at the New Design University (NDU) in St. Pölten, Austria, where he also leads the bachelor's degree program Management by Design. Before that, he headed the Competence Center for Open Innovation at the Institute of Technology Management (ITEM-HSG) at the University of St. Gallen. He has authored or co-authored more than 80 scholarly and practitioner articles, conference papers and book chapters.