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# A Cross-device Spatial Workspace for Artifact-mediated Collaboration

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**Abstract**

In this paper we argue that the extensive number of artifacts created during design processes as well as transitions between physical and digital tools impose both a challenge and opportunity for artifact-mediated collaboration techniques. We present our approach which is based on a cross-device spatial workspace within a computation-augmented design studio setting.

**Keywords**

Artifact-mediated design, design tools, design process, design artifact visualization

**ACM Classification Keywords**

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**Introduction**

During design processes a variety of artifacts are used as a tool for inspiration, individual reflection and for communicating ideas within a group [3]. Within ideation activities physical artifacts like post-its, pictures, paper sketches, sketch books and whiteboards are often preferred due to their unique affordances and accessibility [7]. In design-critique, artifacts are usually presented to others in studio-like environments on pin boards or display walls. However, the extensive number

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of artifacts and their physical nature impose additional efforts for sharing and archiving them in digital repositories which is often required over the course of a design project or across different design projects.



**figure 1.** Interacting with physical artifacts during collaborative ideation activities. Note how the nature of physical artifacts facilitate reflection-in-action but also makes them hard to share and archive.

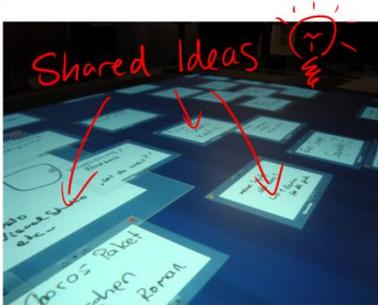
In many design activities, digital artifacts like videos, websites, digital images or prototype simulations also serve as important sources of inspiration. While these artifacts are capable of representing dynamics, enable rich interactions and are easy to share and archive, they do not have the unique affordances of physical artifacts. Digital artifacts are frequently hidden in file systems and therefore hardly visible and accessible within group work [8]. Bodily and social factors that are crucial for reflective design practice and collaborative

work [3,6] are often mistreated. We argue that traditional desktop-based tools are not capable of providing such qualities since they are often built for specific tasks like image manipulation, video editing, sketching or prototyping instead for the overall activity of designing. In contrast, physical artifacts are more versatile and allow for flexible use over different design activities. For example, post-its are frequently used tools in the overall activity of designing across different tasks like paper prototyping, stop-motion animation [2] or affinity diagramming [1]. Similar flexibility is yet unmatched with digital tools.

Due to this duality of representation and the different qualities for designers, transitions between physical and digital artifacts and vice versa are quite common. As a result of these transitions, the overall flow of the design process is harmed.

### **Our Approach**

We think that collaborative design is an interplay of physical, cognitive and social factors. Therefore, computational design tools should support these aspects in the overall activity of designing instead of focusing on specific tasks. As many cognitive processes are distributed over artifacts [4], we seek to bring the quality of physical artifacts to digital tools by augmenting artifacts with technology and by extending digital artifacts with additional physical affordances and flexibility of use. The resulting benefits will include improved artifact management techniques based on digital repositories, flexibility and reuse of artifacts as well as reduced costs of transitioning between physical and digital artifacts. We have four design principles for creating such a tool that we describe in the following.



- *Shared workspace as virtual pin board*  
We think that digital repositories and databases can provide an adequate technical infrastructure to share artifacts within design teams. They can improve accessibility of digital artifacts and allow archiving them for reuse. However, instead of hiding artifacts within spreadsheets or websites, the repository should be accessible via adequate visualizations that closely resemble physical practice. We explore the metaphor of a virtual pin board where team members can create and share artifacts as an interface to the repository which is implemented as an object-oriented database that is capable of synchronizing attached clients.



- *Spatial visualization of artifacts*  
One of the key characteristic of physical artifacts is spatial positioning. By leveraging the ability to physically align, juxtapose and compare different artifacts in space designers harness their spatial thinking abilities [9]. This is especially important within individual and collaborative reflection and synthesis phases. Within our virtual pin board we explore spatial arrangements that support designers in these tasks over a range of activities throughout the process (e.g. timelines, process maps, affinity diagrams). We believe that integrating a variety of artifacts from sketches, pictures and videos or even prototype simulations into our interactive visualizations will improve computational artifact management and may introduce a new flexibility of use. As the number of artifacts is extensive, we integrate advanced zooming techniques to navigate on the virtual pin board.



- *Cross-device interaction*  
As artifacts need to be accessible by multiple persons at the same time to facilitate efficient collaboration, we

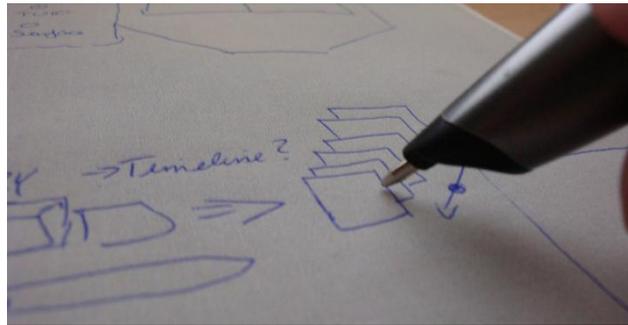
build our tool around a physical setting similar to a design studio. As one important characteristic of a real design studio is physical display space, our computation-augmented design studio features several large, high-resolution interactive displays in the form of two tabletops and one large interactive whiteboard with pen interaction. For individual work, we integrated graphic tablets and tablet PCs. Each device allows an independent view on the artifacts that are stored in the repository. However, manipulations on the artifacts like sketches and annotations are synchronized over the repository. The zoomable interface of the virtual pin board allows navigating between clusters and individual artifacts to focus on specific aspects while still preserving the context. We are attempting to design the interface in a consistent way that works across different devices and screen sizes. We also aim at designing intuitive cross-device interaction techniques.

#### *Physical affordances*

As digital artifacts on the virtual pin board lack physical affordances, we are designing their representation with the goal to reproduce some of the physical attributes. By facilitating multi-touch input on our tabletops and tablet PCs, we allow hands-on experiences when sorting, aligning and scaling artifacts. Physical attributes are also imitated by naive physic effects [5] that furthermore stimulate a playful interaction. Sketches and annotations can be created with digital pens on the whiteboard, graphic tablet and on tablet PCs. However, we think that stylus interaction does not have the same qualities as writing on real paper. Therefore, we integrated digital pen & paper technology from Anoto<sup>1</sup>. This technology enables us to create

<sup>1</sup> [www.anoto.com](http://www.anoto.com)

artifacts on real paper by still allowing instant digital access via the repository. Furthermore, digital artifacts can be printed on on physical paper for distribution and annotation in group discussions. We think that the tangible nature of these interactive paper artifacts can further improve flexibility of use across different design activities.



**figure 2.** Digital pen & paper technology allows to integrate physical paper into our cross-device workspace. Artifacts can be transferred from digital to physical representation and vice versa.

### Conclusion

We presented our motivation and approach for supporting artifact-mediated collaboration techniques based on a cross-device spatial workspace<sup>2</sup>. In future work we aim at developing techniques that connect to the concept of our tool over a variety of design activities. Therefore, we are confident that participation in this workshop will bring valuable insights on how to integrate existing techniques for artifact-mediated

collaboration and how digital tools may improve these techniques.

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<sup>2</sup> A video of our experimental tool can be downloaded here: [http://hci.uni-konstanz.de/downloads/shared\\_artifacts.mp4](http://hci.uni-konstanz.de/downloads/shared_artifacts.mp4)