Reflecting on Production Tools and Methods for Mixed Reality Design

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ABSTRACT

The workshop's emphasis on "reality-based" interfaces and understanding humans' skills and expectations from the real world pertains to our work on *mixed reality* experience design and the development of tools and methods to support that design process. Pulling ideas from media theory, interaction/experience design, cognitive science, sociology, and philosophy, we reflect on several new media experiences created in our interdisciplinary collaboration interleaving our accounts of the production tools and methods found to be most valuable. We share our preliminary thoughts towards methods for creating mixed reality experiences including forming a "studio" with appropriate content production tools and social configurations, conducting contextual inquiries within analogous design settings such as game and film production, and building future prototyping tools and methods to aid creative work in this medium.

Keywords

Mixed reality, augmented reality, design studio, design methods, authoring tools, sketching, video prototyping

INTRODUCTION

The next generation of human-computer interfaces will be determined, to a large extent, by the next generation of content producers, or creative individuals who can weave technology into meaningful designs for people. Here at Georgia Tech, a collaborative effort between the College of Computing and the School of Literature, Communication, and Culture is underway to create a design "studio" for mixed reality (MR) technology, a term we use to encompass pervasive computing, augmented reality (AR), virtual reality, tangible computing, and other "reality-based" interfaces. Akin to Milgram's continuum [22], we view the full spectrum of lightweight to heavyweight technologies as computational media. By developing the necessary design tools and methods for rapid design and prototyping, we begin to understand how humans' skills and expectations from the real world play out in both authoring spaces and collaboratively designed media experiences.

Our design work on new media experiences and the tools to support these endeavors is guided by philosophical foundations in phenomenology [9,10]. Merleau-Ponty argues that the human experience and our conscious actions on the world are mediated through our perceptions [21]. In mixed reality experience design we leverage cultural and social expectations, often based on previous media forms [1], to augment human modalities of perception for storytelling and other forms of art. We believe that both *technology* and *human perception* mediate our experience of the world and that mixed reality technologies are an emerging medium for communication and expression.

Our emphasis on design tools stems from Heidegger's notion of "ready-to-hand"; that tools are unconscious extensions of our bodies and that our primary concern is with the human activity [9]. As Dourish notes, "I act *through* the computer mouse (to operate menus and so forth); the mouse is an extension of my hand." [7] Engrained in our process of experience design and tool development is the continual discovery of how technology tools best recede to the background of consciousness. Ideally our tools will achieve the notion of *flow*, an optimal design experience somewhere between anxiety and boredom, expressed eloquently by Csikszentmihalyi [2]. We aim to provide useful tools for mixed reality designers, many of which take advantage of our natural human abilities.

In this workshop paper, we will discuss three different mixed reality experiences created through our interdisciplinary collaboration using our prototyping environment, the Designer's Augmented Reality Toolkit or DART [18]: the Voices of Oakland [3], AR Karaoke [8], and AR Façade. Our practical endeavors have provided insight into an emerging design craft for mixed reality, leading to reflections on specific tools and methods [5,18] and providing direction for further tools, such as a sketch interface for storyboarding AR experiences [27], partly inspired by work at Pixar [28]. We share our current thoughts towards the future of production tools and methods for mixed reality, emphasizing advances on video prototyping tools intended to help designers communicate situational context while iterating sketch content over time

RELATED WORK

Our design studio for mixed reality is similar to Pausch's *Building Virtual Worlds* project using the ALICE environment at CMU [25], in that we encourage intense, multidisciplinary design teams. Our objective is to support a spectrum of media technology, from lightweight to heavyweight, and to constantly work to evolve our tools and methods.

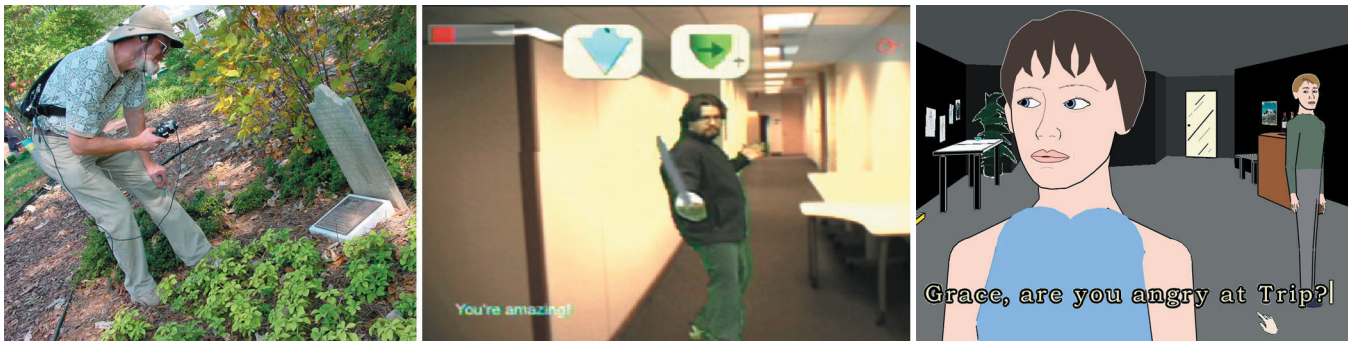

Figure 1 (a) Participant experiencing The Voices of Oakland audio tour. (b) A view from the head-mounted display in Augmented Reality Karaoke. (c) Screenshot from the desktop version of the 3D interactive dramatic, Facade.

Landay's thesis and the tools created by his students at Berkeley [12,13,15,16] imbue the philosophy of rapid, informal content creation we instill in DART. Our sketch actors are intended for early-stage mixed reality design. We hope to better understand this process so we can support design through all stages.

Our current investigation on video prototyping lead us to Mackay's exposition of video for multimedia system and augmented workspaces design [17]. We hope to learn from and enhance the current methods for video prototyping enabling early-stage sketching and iteration.

THE DESIGN OF MIXED REALITY EXPERIENCES

We will briefly describe three mixed reality experiences developed over the past few years, and then reflect on the tools and methods that have made those efforts possible. Integral to our collaboration is the prototyping environment used for most of our experiences, DART. We created DART in 2004 to enable designers familiar with Macromedia Director [19] to experiment with 6DOF tracking, live video, and other sensor information in a media rich environment. We will not only talk about specific technology-focused authoring tools in DART, but also particular social arrangements and how they aided the design process for mixed reality experiences.

The Voices of Oakland

The Voices of Oakland project (Figure 1a) is a location-sensitive audio tour set in historic Oakland Cemetery in Atlanta [3]. In the audio experience, we attempt to enhance the environment with dramatic stories from the lives of cemetery "residents", so that visitors can better understand the history of Atlanta and the South. We are particularly interested in exploring a blend of linear and non-linear storytelling as participants wander through this historic place.

To develop of The Voices of Oakland we instituted weekly afternoon work sessions among the interdisciplinary project group. These intensive sessions allowed designers to get help on technical questions and provided developers insight on how to improve the tools. For example, we built high-level support for the Wizard of Oz method and data visualization into DART; designers used these tools to iteratively evaluate the experience throughout its design [5]. This was important because it allowed for rapid content creation without relying on unpredictable GPS tracking. The social organization of the design environment facilitated the development of both the audio tour and the underlying tools.

Augmented Reality Karaoke

In Augmented Reality Karaoke (Figure 1a) users perform their favorite dramatic scenes with virtual actors [8]. AR Karaoke is the acting equivalent of traditional karaoke—the goal to facilitate an acting experience that is entertaining for both the actor and audience. The actor dons a tracked head-mounted display (HMD) giving her a first-person view of a movie or TV scene where the other characters are positioned in the physical space. The system prompts the actor to read lines from the scene and directs her to move around the space.

We produced Augmented Reality Karaoke through our course on MR Design, a cross-listed class pulling graduate and undergraduate students from computer science and design. Again, the social orientation of design played a role in the project's success, as students split into small, diversely skilled groups and developed sketch-based content prototypes in DART to be shared with the entire class. During the course we improved the sketch tools in DART to allow sketch annotations to be overlaid onto tracked video [27]. This method marks an improvement over importing sketch content from drawing tools such as Photoshop because sketching can happen more rapidly and in situ.

Augmented Reality Facade

We are currently just beginning the development of Augmented Reality Façade, a fully embodied AR version of Mateas and Stern's critically acclaimed 3D interactive drama, Façade [20]. Originally conceived for traditional desktop interaction (Figure 1c), players use the keyboard to navigate an apartment and type natural language statements to responsive characters in the midst of ongoing marriage troubles. The concept for AR Façade places the player in a physical apartment with a tracked head-mount display. The virtual characters now appear in the physical space and the player interacts with them by walking around the space and speaking aloud. The final experience is reminiscent of Murray's vision of Hamlet on the Holodeck [23], and

plays on our natural human abilities as social and physical creatures.

Unlike the two experiences described above, the AR Façade project is not designed in DART and does not have a fluid design space. Because of the massive AI engine and custom code, we are constrained to adding video and tracking support into the Façade code base, a task only suited for a savvy graphics programmer. To help us move the project forward, the designers on the team are developing a sketch-based storyboard of the experience inside DART that demonstrates the basic concept and allows us to work on design decisions in the physical space. We need to figure out the furniture layout, player's interaction with physical objects, lighting conditions, the ergonomics of the HMD, and microphones for listening to the player's communication with the characters. In this case, DART serves as a temporary prototyping tool to pre-visualize the experience, in similar vein to Peter Jackson's film production techniques [11].

POTENTIAL FOR DESIGN

Looking forward, we see potential for creative work across the spectrum of lightweight to heavyweight technologies into different contexts. Virtual Reality is too *heavy* to play a role in regular everyday life, but it could play an important role in defining future high-end entertainment, such as games and narrative experiences. On the other hand, pervasive sensors and displays integrate more seamlessly into existing contexts. We believe technology mediates at different levels of perceptual awareness and consciousness, that it's important to support creative work across all mediums. Towards VR, methods are being developed for designing more directly with the 3D content [26]. Ideally designers will work in the actual 3D environment, not on a 2D desktop, but challenges remain. Researchers still need to work out the gestural consistency of constrained 2D interaction. Towards pervasive computing, and other lightweight computer mediated experiences, researchers are working on tools to support prototyping of physical/digital devices [14], a design task typically split between an industrial designer and an interaction designer. In practice, designers have started adopting storytelling techniques to communicate the context of interaction [6]. Across the spectrum of media, there is room for improving the design process and providing more adequate tools.

PLANS FOR IMPROVING THE MR DESIGN PROCESS

Our plans for lowering the threshold for media designers exploring mixed reality follows two paths: 1) qualitative fieldwork looking at analogous design contexts, the history of computational design tools, and emerging practice in MR design, and 2) development of new tools and methods. Video prototyping methods are particularly interesting because they have the potential to influence a wide range of media.

Qualitative Fieldwork

Due to the relative novelty of mixed reality technologies, it will be difficult to conduct fieldwork let alone empirical evaluations. Design traditions in mixed reality have not been established, so it pushes our research to find alternate resources.

Study of Analogous Design Contexts

Our recent qualitative research of professional designers from industry reveals some of the emerging external representations and methods used for ubiquitous computing design [6]. The study focused mostly on lightweight technology, but outlined an interesting research strategy for informing the next generation tools. We hope to continue looking at the production of analogous media forms, particularly film, television, gaming, and photography for common representations, techniques, divisions of labor, and other applicable design issues. By performing contextual inquiries with professional designers in established environments we hope to inform the design of mixed reality.

Historical Review of Computational Tools

We can learn by studying the trends in media tools such as Photoshop, Illustrator, Director, Flash, etc. What were the technological and social factors influencing the evolution of these tools? How does tool assortment and interaction affect design craft? We believe a rich overview of media computation tools will help us understand the evolution of mixed reality tools.

Design Workshops and Experimental Vignettes

Perhaps most important to the study of MR design is to shape a flourishing tradition. We are integrating practices from schools of art, design, and architecture into our mixed reality design studio. Media designers will create experimental vignettes–short examples of structured interaction or display techniques–as building blocks for larger experiences. We will hold intensive design workshops and critiques with seasoned craftspeople. Craft practice, "getting our hands dirty" so to speak, has always taught us the most about the MR medium, so we will continue to push for more compelling experience design.

New Tools and Methods

We currently have plans to develop a number of tools for DART including added support for video prototyping, tangible manipulation and sketching.

Video prototyping (a.k.a. Replay Reality)

DART includes infrastructure for capture and replay of video and time-synchronized sensor data [4]. Originally developed to break the requirement for co-located design and testing of experiences in physical spaces, we realized this infrastructure supports storytelling narratives that can be iterated. Content can be developed and iterated within editable video scenarios and used to communicate design ideas for head worn augmented reality experiences or augmented workspaces. Video provides an effective early-stage representational medium, consumable by designers and potential users of the application.

Tangible Manipulators

We are exploring tangible manipulators for mixed reality, especially for positioning 3D content in augmented reality spaces. This conceptually taxing undertaking requires designers to perform complex transformations in 3D. Creating real-time tangible methods for placing content in the space, such the method proposed to the pervasive computing community [24], lowers the barriers for designers and exploits our natural ability to move around and point within a space.

Sketching in Space

Our preliminary work on annotation tools for DART [27] needs further development including more sophisticated sketch support and better methods for placing content into the world. We plan to tightly integrate our capture/replay and sketching infrastructure with the tangible tools for placing content. Our vision for "sketching in space" is a very lightweight, tablet-based tool for sketching concepts directly into a physical space. We will discuss the current progress of this work during the workshop presentation.

CONCLUSION

This work reflects on the design of mixed reality experiences through specific social orientations and production tools. As we push boundaries in this medium we think generalizable methods for MR experience design acroess the spectrum from VR to AR to pervasive computing will continue to surface. Our plans for qualitative research and tool development define a course of research, likely to be dissertation work for the first author. We hope the research on video prototyping proves to impact a wide range of designers in new media. Ultimately we want to study how mixed reality technology mediates our perception of the world, and how it affects the human experience.

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