Zachary O. Dugas Toups – Research Statement

In game play, manipulating the human-computer interface *is* the user's purpose, rather than accomplishing a task through it. Games are the purest form of human-computer interaction (HCI). Games function as tools for learning and social spaces [3, 4]; play impacts problem-solving methodologies, mental models of the world, and communication. Complementary mobile and mixed reality technologies enable interaction beyond the desktop, supporting human-human interaction, pervasive play, and education. The interweaving of play with human experience can impart learning[1] by providing fun environments in which to exercise skills, learn new concepts, and revive memory.

My research centers on developing game designs in the context of disaster education. I operate the Crisis Response Innovative Technologies Lab, a space mandated by the director of the Disaster Preparedness & Response division of the Texas Engineering Extension Service (TEEX) to promote the development of information technology, including educational games, in disaster response. My position within TEEX involves day-to-day interactions with expert responders, allowing me to develop a deep understanding of how crisis response is undertaken and how I can improve it with games and mobile information technologies.

My *long-term objective* is to discover novel ways in which game play can engage learning and memory while supporting collaboration. My first step investigates *zero-fidelity simulation* (ZFS) games in which participants learn to coordinate as a team. I am now extending ZFS into mixed reality, while developing mobile information systems for disaster response. My *media* for creating and evaluating games and information technologies include game mechanics, moments in game play when players make a decision to take action to which the game system responds based on rules [4]; lightweight sensors that enable mobile and mixed reality, such as the global positioning system and accelerometers; and small display and audio technologies, such as personal projectors and head-mounted displays.

RESEARCH ACCOMPLISHMENTS

My dissertation research *investigated fire emergency response work practice* through ethnography [5, 8] to develop team coordination education through ZFS games. This work is exemplifies my approach to research. We abstracted skills from practice to design the zero-fidelity simulation Team Coordination Game [5, 9, 10] (Figure 1). *Zero-fidelity simulations*[2] are operational environments in which participants exercise skills from practice in an alternative environment that does not directly re-create concrete aspects of the source world. Counter to the assumption that higher fidelity is better [1], we showed that players developed improved team coordination skills [5, 6, 7].

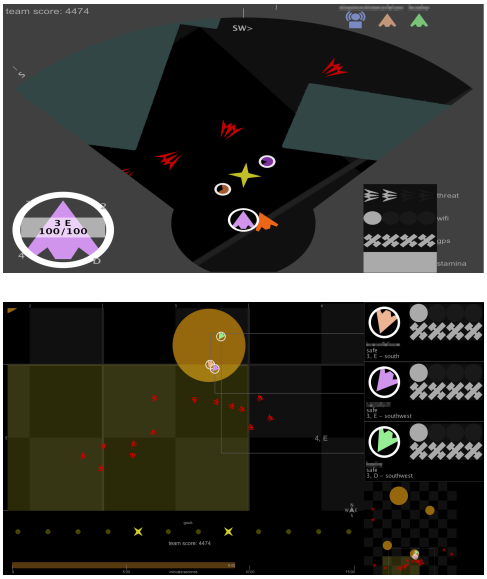

Figure 1. Cooperation in the ZFS Team Coordination Game. On top, the purple seeker cooperates with orange to collect a goal. The coordinator (bottom) monitors the situation and warns the seekers that threats are approaching. Information is distributed, so players must communicate.

Ethnographic Fieldwork. My ongoing research incorporates ethnographic investigation of team coordination in fire emergency response practice, and has expanded into the investigation of search and rescue and large-scale incident command. These observations uncover skills used by responders to communicate and maintain situation awareness, based on data from interviews and participant observation of burn training, incident command simulations, and urban search and rescue operations. Previously, we identified design principles that support team coordination learning [8]. One is *information distribution*, where each team member accesses alternative information sources from the same environment and is reliant on teammates. Another identifies the need to *mix*

[1] I avoid the term "serious games" because it I do not believe games need to be "serious" to be a legitimate form of education.
[2] Previously, we used "non-mimetic simulation"; we have revised to "zero-fidelity simulation."

communication modalities, so participants learn to dynamically select the most effective means of sharing information (face-to-face, radio), against the affordances and constraints of the task environment.

Zero-Fidelity Simulation Team Coordination Game. Based on the design principles for team coordination, we developed and instantiated the ZFS model through the Team Coordination game (TeC). The TeC game mechanics simulate the human-human interaction and information transformation properties of emergency response, but not its concrete environment. TeC players take on one of two roles over which information is distributed: seeker or coordinator (Figure 1). *Seekers* take action in a virtual world, while a *coordinator* observes a low-detail view of the same world. Team members communicate using either face-to-face or radio communication. TeC user study findings led to additional design principles for cooperative games [9] and simulation [5, 6, 7, 10]. I continue to iterate and build upon TeC, expanding its deployment into search and rescue classes, where it will educate and provide data on transferability into domains beyond the original fire emergency response.

Game Play Beyond the Desktop. Mixed reality enables freedom to mix communication modalities because members can dynamically distribute or collaborate. My present research develops a wearable computing platform for playing TeC (Figure 2). Seeker players move in the real world, while sensors track their locations and place them in a virtual world. The wearable platform shows the seeker's view on a head-mounted display. Radio hardware allows the team to communicate. The sensors, radio, computer, and interconnects are built into to an ergonomic, modular pack. Part of this project involves basic research investigating the value of different display modalities (head-mounted, hand-held) in outdoor environments. The completed system will be tested with search and rescue professionals at the Disaster City training ground [http://teex.org/disastercity].

RESEARCH AGENDA

My research agenda develops game play for education and memory, while connecting to the disaster response community. I propose three research projects: (a) advancing zero-fidelity simulation games, (b) hybrid casual/event-based games for community education, and (c) restoring memories through play. All projects are at the intersection of games and HCI.

Zero-Fidelity Simulation Games. I will develop new ZFSs for new target skills, such as decision-making under stress and navigation through physical environments. These designs will be applicable disaster response teams, military, and even day-to-day life. This avenue of research will also investigate the transferability of ZFSs across multiple domains with similar skill sets by deploying designed simulations with alternate constituencies. For example, TeC is being deployed with search and rescue professionals, but deployment with teams of programmers or sports players may aid team coordination within these groups as well, improving communication skills in very different disciplines. My research will also compare ZFSs against low- and high-fidelity simulations, to establish areas in which zero-fidelity is superior.

Hybrid Casual/Event-Based Gaming. I will investigate games that fuse casual, pervasive play with collaborative events. In such designs, short, day-to-day interaction with a game engages the player while impacting a later game event that is played in real time with multiple, co-located participants who cooperate. I hypothesize that this mode of play will be an effective means to educate communities to work together, or aid teams that must be re-combined on the fly. Emergency responders from diverse locations form one constituency; another is populations in disaster-prone regions who need to develop preparedness.

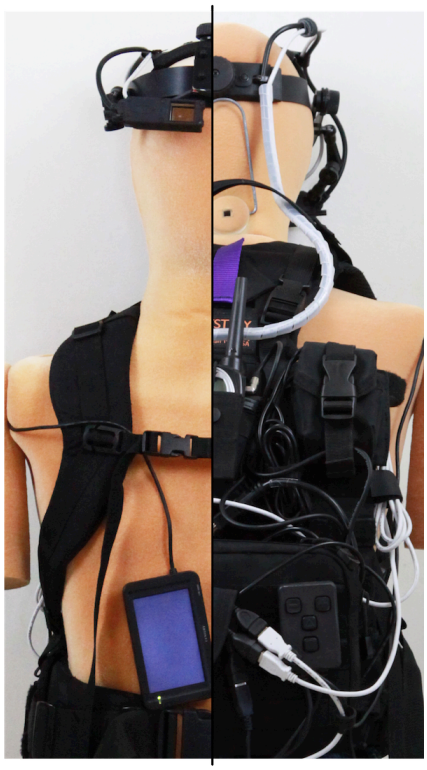

Figure 2. TeC mixed reality wearable computer front and back. The head-mounted display includes a forward-facing compass and GPS. The modular pack houses a netbook computer, radio, and custom radio controller.

Game Play to Stimulate Memory. I hypothesize that games can serve as a stimulus for recalling memory. I plan to investigate the use of game play as a probe of personal and collaborative history. In this work, participants will engage in both digital and tabletop games that they have played previously. Participants will capture memories through augmented game interfaces as they are recalled. Recorded memories will be combined with digital capture of game play, creating personalized visualizations that incorporate the captured memories. The artful visualization serves as a way of recalling the past, like a photo album.

GRANTWRITING AND SUPERVISING

Throughout my career as a student and postdoc, I have co-authored funded grants and co-directed a team of student researchers creating educational games. I worked closely with my Ph.D. advisor, Andruid Kerne, in writing two NSF proposals, IIS-0803854 and IIS-0742947 (>$600,000/4 years) by formulating questions, developing research plans, and synthesizing background research. I am co-PI on a new Social Computing Systems grant currently in review at the NSF.

As a graduate student and postdoc, I assisted in directing a team of two graduate students and one undergraduate in developing Mixed Reality TeC. As head of the CRIT Lab, I supervise an undergraduate student and advise one masters student on components of mixed reality as a part of my ongoing research.

CONCLUSION

My research accomplishments focus on developing game mechanics and interfaces for education. I discovered and employed design principles for teaching team coordination from a basis in emergency response work practice for zero-fidelity simulation. Through user studies with community members, I improved upon design principles for crafting simulations and cooperative games. Via experiments with emergency response students, I have shown that zero-fidelity simulation games are effective for teaching team coordination. My ongoing work investigates the value of mixed reality game play and the transferability of zero-fidelity simulation beyond its original domain.

I plan a series of projects in which participants learn skills and rediscover memory through collaborative game play by extending zero-fidelity simulation, building hybrid casual/event games, and stimulating memory through augmented game interfaces. These projects will provide valuable insight into the role of play in everyday and professional life. Each project will serve as a way to study computer-human and human-human interaction. I plan to explore game interfaces in terms of human-computer interaction. How are effective game interfaces designed? Game systems are the purest incarnation of HCI. Game interfaces pose an interesting challenge to the designer: much of game play involves *discovery*, which is at odds with the traditional need to *make visible* information in the interface. Each of the proposed projects will uncover valuable insights for the HCI research community.

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