Visioning Studies in Emergency Health Care to Support R&D of New Technologies

by Diane H. Sonnenwald

EDITOR’S SUMMARY
Given the risk and cost of proposed but unproven technologies, a method to project likely outcomes offers great value. Visioning studies deliver that opportunity by enabling potential users and other stakeholders the chance to explore new technologies. Goals include validating benefits, exposing unanticipated consequences, discovering hurdles to deployment and revealing considerations for funding. A visioning study was used to investigate 3D telepresence technology in emergency health care, enabling paramedics to work on a simulated trauma victim along with a remote physician. In another phase of the study, three groups of stakeholders viewed a brief video on the proposed technology and were interviewed to understand their thoughts on advantages, obstacles and potential fit. Through the visioning study, researchers were able to explore implementation of the technology and experience its potential benefits and challenges in a realistic test mode. Knowledge gained through visioning can lead to better-informed decisions and more effective use of limited resources.

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Significant resources are spent each year globally to support research and development efforts, and an ultimate goal of this research is to create new technologies that will improve lives and/or reduce costs. Funding agencies, foundations, citizen groups and businesses are often looking for evidence that the proposed technology will indeed accomplish one or both of those goals. Providing such evidence is especially important when the proposed new technology will require large amounts of intellectual and financial resources to be developed and deployed and/or is targeted for deployment in life and death situations, such as those that emerge in emergency health care.

But how can we know if a new technology will fulfill its promise without spending resources to create a working prototype and then to evaluate the prototype in meaningful ways? In some instances creating a prototype will require multiple years of effort and a fairly large amount of resources, especially if the prototype requires advances in multiple technological domains such as telecommunications, computer vision and computer graphics.

Furthermore, we know that investigating and understanding the perspectives of users and other stakeholders can lead to the discovery of new features that will enhance the adoption and use of a technology. The earlier these features are discovered and incorporated into the R&D process, the lower the costs of development overall because the cost to introduce and/or modify features usually increases as the R&D cycle progresses.

Thus the challenge is to investigate the potential of a new technology as early in its research and development cycle as possible to validate its proposed benefits; discover unintended consequences and unintended benefits; identify deployment challenges and solutions; provide insights regarding technology features and help inform funding decisions. To address this challenge we have been developing a new research approach called visioning studies.

Diane H. Sonnenwald is professor, chair of information and library studies at UCD in Dublin, Ireland, and an adjunct professor in computer science at the University of North Carolina at Chapel Hill. Professor Sonnenwald conducts research on collaboration and collaboration technology in a variety of contexts, including emergency healthcare, police work, industry and academia. She can be reached at diane.sonnenwald<at>ucd.ie.
A visioning study is conducted in collaboration with computer science and engineering researchers and stakeholders in relevant domains. It can consist of two complementary components. One component investigates task performance, comparing current task performance with future task performance as envisioned with the proposed technology. To do this task component an experiment incorporating simulation, observation, questionnaires and interviews is conducted.

The other component explores implications of the proposed technology in the larger domain context. It employs qualitative methods and includes showing each participant a video depicting the technology vision followed by open-ended interview questions seeking participants’ perspectives on issues that influence adoption and use of technology such as relative advantages, compatibility and complexity of the technology, the impact of social influence on adoption of the technology and best practices with respect to deployment processes [1] [2].

We conducted a visioning study to investigate the potential of 3D telepresence technology in emergency health care [3] [4] [5] [6]. An experiment investigating task performance and a qualitative study exploring implications of the technology for the emergency health care were conducted.

Trauma, i.e., serious physical injury, is a significant health problem, frequently referred to as the “hidden epidemic of modern society” because it is responsible for more productive years lost than heart disease, cancer and stroke combined [7] [8]. Today paramedics in the field collaborate with remote physicians in complex emergency situations via cellphone or radio. Results of medical tests, such as electrocardiograms (ECGs), may also be transmitted from the paramedic’s equipment to a remote physician. Future technology, such as 3D telepresence technology, could potentially be utilized for collaboration between paramedics in the field and physicians located elsewhere. Ideally, 3D telepresence could improve patient care through earlier diagnosis and treatment in complex trauma cases [9]. Research on 3D telepresence technology could lead to a system that presents physicians a seamless 3D view of a remote trauma scene, with the view dynamically changing as the physician walks around or changes position with respect to the 3D view. There would be no need for navigation tools that require user input or manipulation such as zooming or changing the angles of the cameras. A digital laser pointer could be developed that would be controlled by the physician and projected at the remote scene, enabling the physician to virtually point at objects in the remote scene. To understand the potential of 3D telepresence technology in emergency health care we conducted a visioning study.

We first conducted a post-test-between-subjects experiment to investigate task performance [5] [6]. In the experiment we compared current, near-term and future task performance. This was achieved simulating a complex emergency medical situation in which study participants, i.e., practicing paramedics, had to diagnose and treat a trauma victim. The trauma victim was in fact a METI human patient simulator, that is, a sophisticated computerized mannequin. Each study participant was asked to diagnose and treat the victim under one of three conditions: working alone (as currently typically occurs), collaborating with a remote physician using state-of-the-art videoconferencing (a near-term vision for paramedic-physician collaboration) and collaborating with a physician using a 3D proxy or surrogate (the long-term vision).

The 3D proxy was simple in its design, yet true to the vision of 3D telepresence technology. In the 3D proxy condition the physician was physically present in the same room as the mannequin and paramedic. The physician was allowed to freely move around in the room. However, the physician could not touch anything in the room and could only point to medical equipment and the victim using a laser pointer. This mirrors the 3D telepresence technology vision.

Results indicated that paramedics who participated in the 3D proxy condition performed fewer harmful interventions, reported higher levels of self-efficacy, found the information provided by the remote physician more useful and of higher quality and showed less variation in task performance times irrespective of years of professional experience in the 3D proxy condition compared to paramedics who collaborated with the remote physician using state-of-the-art 2D teleconferencing. These results are promising; however, technology adoption and use is significantly influenced by the interplay of multiple sociotechnical factors in addition to task performance outcomes [1] [2].
Therefore we conducted a second component of the visioning study that explored factors that may facilitate and/or impede adoption and use of 3D telepresence technology in emergency health care. We first created a 5-minute video illustrating the concept of 3D telepresence technology and its possible use in emergency healthcare situations. In the video we also invited the viewers to share their perspectives on the vision with us. We showed the video in interview sessions conducted with three types of individuals: individuals who might use the technology to provide emergency health care, including emergency room (ER) physicians, nurses, interns at large and small medical centers and paramedics; individuals who make decisions regarding technology purchases and adoption and who manage potential users of the technology, including ER and emergency services administrators; and individuals who would potentially support the technology, such as IT operations personnel. We asked these individuals to discuss what they perceived as the relative advantages (if any) of the technology, its potential fit with their current ways of working, features the technology should or should not have, best practices with respect to deploying the technology and so forth.

Results of this component are presented in two recent articles [3] [4]. Overall the study participants reported the technology could lead to improved patient outcomes and major changes in how paramedics perform their work and how they interact with physicians. The technology would make paramedics’ work visible in ways not previously possible. This could lead to increased prestige for the paramedic profession, increased learning, higher levels of trust and additional permissions to perform procedures in emergency situations. However study participants also reported the technology would require additional training, changes to existing financial models used in emergency health care and increased access to physicians. Legal issues and privacy concerns were also raised, as well as ideas regarding technical features.

The visioning study illuminated potential benefits from 3D telepresence technology in emergency health care, as well as technical features and organizational and social changes that appear to be necessary to facilitate the adoption and use of 3D telepresence technology in emergency health care. It uncovered potential synergies and conflicts with current social structures, facilitating the identification of enhancements to social structures and/or practices to derive additional benefits from the technology. This knowledge has influenced technical decisions and should, ideally, increase the technology’s rate of adoption and reduce its unintended negative consequences.

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Resources Mentioned in the Article

## Resources Mentioned in the Article, continued

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