Out of My Viewfinder, Yet in the Picture: Seeing the Hospital in Medical Simulations

Ericka Sue Johnson

Science Technology Human Values 2008; 33; 53 originally published online Dec 10, 2007;
DOI: 10.1177/0162243907306194

The online version of this article can be found at:
http://sth.sagepub.com/cgi/content/abstract/33/1/53

Science, Technology, & Human Values
Volume 33 Number 1
January 2008 053-076

10.1177/0162243907306194
http://sth.sagepub.com
hosted at
http://online.sagepub.com

Out of My Viewfinder, Yet in the Picture

Seeing the Hospital in Medical Simulations

Ericka Sue Johnson
Göteborg University

This research examines the integration of medical simulators into medical education. Training on a haptic-enabled surgery simulator has been observed with an eye to the context of the medical apprenticeship. Videotape of simulations and ethnographic observations at the simulator center are analyzed using the theoretical tools of legitimate peripheral practice and identity construction. In doing so, it becomes apparent that simulations are much more than just a forum for the transfer of specific medical skills. Although they may be designed to facilitate discrete aspects of surgical practice, when in use, the simulators are surrounded by the rich and varied social interactions that make up the medical apprenticeship. These social aspects contribute to the creation of medical practices out of simulator practices, so that working on the simulator can still be experienced as part of the situated learning otherwise conducted during the internship (clinical clerkship) of medical training.

Keywords: *Medical simulation, surgical simulator, situated learning, identity, apprenticeship*

Out of my video camera's viewfinder, the telephone rings and another instructor in the room answers it. I hear a voice from off screen ask the instructor I've been filming, "Lena, is she doing the test now?" Lena looks out of the frame to make eye contact with her colleague and answers, "yes." The other instructor says, "Mattias was wondering if . . ." (Figure 1). Lena

Author's Note: The author would like to thank Boel Berner, Minna Salminen, Ulf Mellström, Francis Lee, and the anonymous reviewers for their comments and criticisms on earlier drafts of this article. The research for this paper was conducted at the Department of Technology and Social Change, Linköping University. Parts of this work are taken from the author's PhD, reprinted with permission from Arkiv, Lund. Thanks are extended to Mentice for the use of figure 4. Support for this work was received from the Swedish Council for Work Life Research, Vinnova Dn. 2001-03705, and the Swedish Research Council, VR 721-2003-4398.

Figure 1
Instructor Watching the Simulation

then leaves the surgery simulation, and my viewfinder, and walks over to the telephone, where she starts to speak to the person who called. "You want someone who?. . . . Ummm, do you want to hold it on Friday or Wednesday? You don't have any exchange students, right? . . . And they have to write reports for that class, right? . . . Ok, bye." Meanwhile, the student continues on with her simulation (Figure 2). Having arranged a time to test a different group of students, Lena then comes back to the simulation, looks at the screen, and comments, "You've got one sphere left." The student keeps on working (Figure 3).

Figures 1, 2, and 3 are frames from a videotape I made during fieldwork at a medical simulator center in a large teaching hospital in Sweden. They were taken while I was videotaping simulations on a haptic-enabled minimally invasive surgery (MIS) simulator, studying how the students, instructors, and machines interacted. When I later came back to my university and started analyzing the video material I had gathered, it became apparent that much more than the surgical simulation had been caught on (and off) tape. The simulations were deeply embedded in the rest of the hospital's practices, situated

Figure 2
Instructor Speaking on the Phone

Figure 3
Instructor Having Returned to the Simulation

as part of the medical apprenticeship being followed by the students. This article examines just how this situatedness made itself known during simulations and what it means for the learning that the simulators are supposed to facilitate.

To analyze this, I examine how newcomers and old-timers are interacting around the simulators and the identity construction that occurs during their interactions. I use the theoretical tools of legitimate peripheral practice in apprenticeships (Lave and Wenger 1991) and identity construction as meaning making (Wenger 1998). Lave and Wenger suggest that learning should be considered as a socially situated activity, as a change in an individual's identity from a lesser competent member of a community of practice to a competent member. Their approach pays attention to the practice of actors in "formal and informal institutional structures," that is, in situations designed for learning and the workplace. This makes it particularly applicable to the training of new doctors, since the medical apprenticeship combines both elements of traditional, classroom teaching and work on the wards. The approach helps me discuss how medical knowledge is constructed in social practices, even in the simulator center, and how learning is a way of becoming a member of a community of practice, even when it is learning on a simulated patient. These are relevant observations to the study of simulators because simulators as such are sometimes purported to isolate practices and skills from the larger contexts in which they are usually embedded,[1] yet as this paper will demonstrate, the failure to isolate the simulators completely and the intrusion by the "real world" outside the simulator center help the simulations succeed as medical training.

My work is a complement to other studies of simulators that look at the way medical knowledge is incorporated in simulators. Many of these studies focus on the machines themselves and are usually conducted through collaborations between computer scientists and medical doctors. They tend to be concerned with the validity of modeled bodies, how advanced the computer algorithms and hardware technologies are, and how realistically the graphics or mannequins respond to the procedures being practiced (Gallagher et al. 2002; Gorman et al. 1999; McCloy and Stone 2001; Bradley and Postlethwaite 2003; Neumann et al. 2000; Pugh et al. 2001; Torkington et al. 2001). When studying virtual reality (VR) and simulators, the real context of VR use can be easy to forget, not least because the virtual space presented by the technology is so new and interesting. It can be tempting to focus on this space and the practices that occur in it, how we interact and maneuver inside the virtual, and how we construct ourselves and others in virtual spaces (Dietrich 1997; Herring 2000; O'Farrell and Vallone 1999; Sundén 2002; Turkle 1995).

Questions about how reality is constructed and what sort of reality it is are raised. In medical simulations, research on how the patient body is understood has approached these topics (Cartwright, Penley, and Treichler 1998; Johnson 2005). In science and technology studies (S&TS), many studies about computer technologies have looked at how the technology comes into being; the interactions between computer scientists, designers, users, and existing technologies (see Oudshoorn, Rommes, and Stienstra [2004] on virtual environments; Prentice [2005] on simulators; Voskuhl [2004] on speech recognition technologies). These studies have examined important aspects of how technology is imagined and the very real practices involved in creating it.

While acknowledging this work and the theoretical and practical implications of studying how technology is constructed, the research presented in this article has, instead, looked at the integration of new simulator technologies in medical education. It draws inspiration from the above-mentioned work about how technology is created through social practices and combines this with the situated learning approach. For, while I agree with Oudshoorn, Rommes, and Stienstra that "we should be careful not to replace a technological determinist view by a romantic voluntarism which celebrates the agency of users" when realizing that users are free to modify or ignore the "scripts" that designers give them via technological artifacts (2004, 55), I nonetheless think it can be useful to look at the way, in this case, simulators are being used once they are on the market and in the teaching hospitals, rather than just focusing on how they are made, who is making them, and what imaginings of the user they are based on.[2] For this reason, this is an article about how medical simulations are woven into the context of medical education; how they are incorporated into the situated learning that occurs in the medical apprenticeship. People external to the simulation appear and disappear, instructors and students are paged on their beepers, they communicate with others at the hospital on telephones and the internal intercom system, and all of these interruptions provide a display of appropriate social relations. The interactions with nurses, technicians, and even foreign visitors make visible hierarchies that the students are otherwise negotiating in their clinical clerkship. Thus, this article is about how the teaching hospital intrudes into the simulations and why these intrusions are beneficial to the integration of simulation training into medical education.

From the S&TS field, this research takes on board the importance of context when studying technology in use, which makes discussions of context and learning relevant to the study of technical artifacts like simulators, artifacts often otherwise studied (and even used) out of context. I hope to contribute

to the S&TS work that aims to understand learning in technologically medicated situations.

Method

This study relied on observations conducted at a medical simulator center, interviews with instructors and students, and interaction and conversation analysis of a videotape of simulator training sessions. My use of interaction and conversation analysis is inspired by C. Goodwin (1980, 1986, 2000), M. Goodwin (1998), Heath (1986), and Hindmarsh and Heath (2000). My use of video analysis of work and learning within the study of human-technology interactions draws inspiration from work practice studies and ethnographically based design studies of digital technologies (see Suchman et al. [1999] for a description of this field). My methods are informed by work practice studies that have applied ethnography and ethnomethodology to questions of how people interact with computers or other technologies (see Hughes et al. 1998/2003; Orr 1996; Sanne 1999; Shapiro 1994; Suchman 1987). Work practice studies have tended to observe the details of practice through the minutiae of conversation and interaction analysis (C. Goodwin 2000; M. Goodwin 1998). Videotaping in the field is used within work practice studies and its sister field of computer-supported cooperative work because of the way it makes work visible. Making work visible is, of course, much more a political issue than simply a way of conducting fieldwork (see Suchman 1995). By studying what is happening in specific workplaces, ethnographic methods are able to get at the practices occurring on the "factory floor." Ethnographic studies of work describe how things are really being done, not how workers or managers say work is done, or how designers or manual writers decided to describe it. Ethnographic observation has made apparent that there is much more happening in the workplace than people relying on instruction manuals and company policy documents to inform them of how to do things on the job and that much learning occurs in the social interactions between people at work (Jordan and Henderson 1995; Orr 1996).

These studies and their way of analyzing video material from actual practice open for a close analysis of practice while still acknowledging the importance of context. This approach allows me to take into consideration the fact that there was always practice going on outside the view of my camera. Sometimes this was audible on my videotape, like the instructor opening the door to the busy café outside when he went out to get an afternoon cup of coffee, while letting the students practice on their own. And sometimes

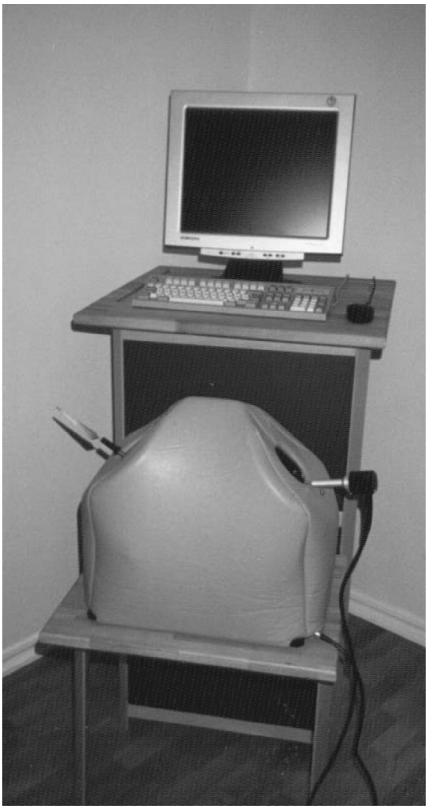
the action off screen was not audible, like when the instructors were conferring in the other corner in whispered tones. One of the benefits of videotaping was knowing that the camera was focused on the simulator's use, which meant that I could let my eyes look at other things going on, and not focus solely on the computer-student-teacher interactions (see Silverman 1999, 38). I would make a note of events occurring outside of my viewfinder, but I left the camera focused on the students and instructor using the simulator. There were parts of the room outside of my viewfinder and parts of the activity that I could not get on tape, and I could listen to the conversations that happened around the simulation: interactions with the outside hospital and other things that were "out of frame." The videotape became a complement to all of the other observations, the interviews, and the background material. By videotaping the simulations for later analysis while also observing other activity at the simulator center, I was able to see more than I would have if I only had been taking field notes or only would have been watching the video.[3]

Much of what I present in this article comes from a videotape of simulations and the observations I made of other events that occurred in the simulator center, as I let the camera record the simulations. I started to see more than just the user and machine in my viewfinder and off camera. As I "looked up" from the practice occurring around the simulators and saw what else was happening in the simulator center, it became obvious, as the strip at the beginning shows, that the simulator center was embedded in a teaching hospital and interrupted by various practices that occurred there. The teaching hospital had a way of barging in on the simulations, and as it did, even as it interrupted the simulation, it situated the learning occurring in the simulator center into the wider apprenticeship process that the medical students were undergoing. I was watching students and instructors conduct simulations. I was paying attention to the way they interacted with each other and with the machine. I was seeing them reconstitute patient bodies and medical practices. But I was also noticing aspects of hospital life going on around them, sometimes even disrupting the simulation. When making these disruptions a legitimate part of my material, it became clear that the simulation practice was made up of much more than just use of the simulator.

Training on Simulators

First, though, a few words about the technology. During my fieldwork at the simulator center, I observed and videotaped simulations with instructors and medical students using three different types of medical simulators: two

Figure 4
The Surgical Simulator



that relied on VR technology and were meant to simulate aspects of MIS, and one digital, full patient body mannequin that simulated a patient for anesthesiology training. The surgical simulations examined in this article were done on a haptically enabled VR simulator that allowed the students to maneuver in the knee, shoulder, and abdomen anatomies using the instruments of MIS (see Figure 4).

This simulator consisted of two handles sticking out of a green surgical blanket (in Figure 4 the handles are sticking out of a skin-colored covering). The handles represented a surgical tool and an endoscope and were attached

to haptic-enabled motors under the blanket that exerted pressure on them to mimic the feel of maneuvering through the inside of a body. These haptic motors worked with a computer program so that when the user pushed one of the tools against the virtual organs, he or she felt resistance from the organ. The camera that he or she manipulated generated "images" from inside the patient that were then shown on the computer screen in much the same way that MIS uses video feed to show the inside of the patient on a monitor in the operating room.

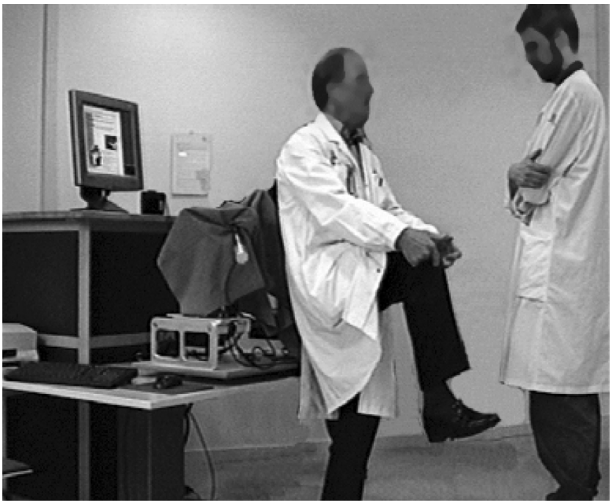
According to the designers and producers of the simulator, training on the simulator is meant to provide the opportunity to overcome orientation and instrument handling problems as well as hand-eye coordination difficulties. The marketing material for the simulator claims, therefore, that the skill level of the user can be improved because surgical techniques can be practiced repeatedly.[4]

While the simulator also has been designed to be used by surgical residents and practicing surgeons, the simulations I observed were done by students. The training was presented to the students as a nonobligatory part of a nine-week surgery course in the eighth term of medical school, but the students were encouraged to try the simulators to explore MIS. The instructors teaching at the simulator center, like Lena in the example above, were practicing doctors, and their intent was to teach the students the medical practices of MIS. Their goal was to get the students to understand *what* they were doing and to learn to *do* correctly.

Analyzing the instructors' and students' practices of using the simulators revealed how they reconstituted medical patient bodies out of the simulators and that these bodies then allowed medical practices to be reconstituted, thereby turning simulator practice into medical practice. An example of this can be seen in the following two images. In Figure 5, the instructor is explaining how the simulation will work to the student. "The optic enters here," the instructor says and points to his knee with his right hand, "and the probe enters here"; he then points to his knee with his left hand. "And the majority of blue spheres are in the lateral part. . . . So they lay in this area." He gestures to the area where the spheres will be found in the knee. "They are never over here"; using his hands, he gestures to another part of the knee. "They lay in the front part of the knee, in the central or lateral part. So it is there that you should look for them."

After having first pointed to his own knee to show how the tools entered the knee, the instructor then turned to the simulator and gestured to the space around the tools, explaining how the patient's knee was positioned there (see Figure 6). When this was done, the student stepped up to the simulator.

Figure 5
Reconstituting the Patient's Knee with the Instructor's Body



Once the patient's body was laid out on the imaginary operating table in front of the student, the student approached the instruments and patient with his own physical body, thus broadening the simulation beyond the images on the screen and the force feedback in the instrument handles, embodying the surgical practices for the student.

Reconstituting the patient's body into the simulation simultaneously served to repeatedly define the simulator as a body on which surgical practices were enacted *and* to create a surgeon's body out of the student. Understanding the use of medical simulators with the term *reconstituting* helps to show how simulated images and artifacts are constructed as medically relevant through practice. More detailed analysis of this reconstituting can be seen in Johnson (2007).

A Contaminated Simulation

I will now turn to how the simulator center practice is related to the rest of the students' medical education, practices both in and outside of the simulator

Figure 6
Positioning the Patient's Knee on the Simulator

center that are part of the process of constructing an identity as a medical student and future doctor. When learning is occurring in a setting that contains elements of a classroom, like the simulator center, students can still engage in this identity construction if the instructors are also members of the same community of practice, and I observed attempts on the part of the instructors to emphasize again and again that they were colleagues with the students, which both embedded the simulation in the situated learning of the teaching hospital and created an opportunity for the students to begin to take on the role of potential, peripheral doctors, even during a simulation.

Simulators and the Medicinal Apprenticeship

Medicine has had a long tradition of trying to relate theoretical knowledge with practical skill through the apprenticeship training (internship or clinical clerkship) that students engage in (Haas and Shaffir 1987; Hughes 1988; Sinclair 1997). Doctors learn by doing, and often by doing on real patients in the real hospital. Simulators, which have been developed in part to facilitate the practice of medical skills without subjecting patients to

student training, are based on the concept that one learns by doing. This can be seen in Prentice's (2005) study of the simulators and how they are developed, where she details the interactions between doctors and simulator developers as they adjust the haptic motors of a simulator to create virtual tissue that feels like a real body. Understanding medical skills as "things" that are learned through experience is related to the discussions about tacit skills and tacit knowledge, skills that an individual may have learned but that are difficult to articulate. In Prentice's analysis, she refers to Collins and Kusch's (1998) distinction between polimorphic and mimeomorphic actions, a distinction used to explore the way that machines and humans are different. The terms *polimorphic* and *mimeomorphic* further develop Collins's (1990) early dichotomy between human action and machine behavior by examining human action and determining that two types of human action exist, *polimorphic* and *mimeomorphic*. Polimorphic actions require an understanding of society. Mimeomorphic actions, on the other hand, mimic machine behavior (Collins and Kusch 1998, 1). With a nod to Polanyi's famous example of tacit knowledge, Collins and Kusch claim that riding a bicycle through an intersection (crossroads), when the rider needs to be able to make eye contact and sometimes communicate with motorists and pedestrians to maneuver successfully through the intersection, is an example of polimorphic actions. Simply balancing a bicycle, which can be done with a gyroscope, is a mimeomorphic action. Collins and Kusch claim that "polimorphic actions cannot be learned except through socialization or apprenticeship—mimeomorphic actions can be learned in other ways" (1998, 88). This acknowledgement of socialization, the use of the term *cultural skills* (Collins 1990), and discussions of tacit knowledge are steps toward recognizing that simulations are embedded in the social practices of medicine. If one were to use Collins and Kusch's distinction between mimeomorphic and polimorphic action to look at the simulations I observed, one could postulate that mimeomorphic skills are learned through use of the simulators: the manipulation of the optic tool in the three-dimensional space, for example. This could be compared to, and contrasted with, polimorphic actions that the students are learning by being socialized in their training, through the medical apprenticeship. The use of the simulators relies in part on "the social" in order for them to function as a part of the apprenticeship.

Collin's discussion of cultural skills in relation to tacit knowledge (Collins 1990) is a step toward understanding what role the social plays because it acknowledges its importance. However, it still leaves "the social" as an unopened black box, and it is that box I want to try to open. To do this, I have looked at the social aspects of the simulator training and tried to contextualize

these in their part of an apprenticeship training, examining "the social" that is occurring in the medical apprenticeship of which the simulator training is a part. I try to understand this with the concept of situated learning. Situated learning, and in particular the versions that I have chosen to work with (Lave and Wenger 1991; Wenger 1998), provides the tools for a detailed examination of the context and practice of learning skills. But, more importantly, it shies away from the term *skills*, which contains overtones of possessed and transferable elements, and instead begins to speak about knowledge as constructed in social practices and learning as a way of becoming a member of a community of practice. This line of thinking arose from anthropological studies of apprenticeship (see Coy 1989; Goody 1989; Lave and Wenger 1991; Wolcott 1982). It critiques the idea that knowledge can be divided, subdivided, and packaged as decontextualized commodities and the teaching methods based on that idea (Resnick 1991, 7).

Legitimate peripheral participation (LPP) is used to discuss and analyze how learning occurs and as a way to speak about the relationships between participants in communities of practice, to understand how a newcomer to a community of practice gradually becomes integrated into the practices of the old-timers. It is an analytical term that makes visible the way apprentices, as newcomers, are legitimate members of the community of practice, even though they are not yet full participants (Lave and Wenger 1991). The newcomer participates in the community's work practices, but that participation is peripheral. The newcomer is only gradually being integrated into the community, but the partialness of his or her participation is also accepted by the others in the community of practice (Lave and Wenger 1991, 36). LPP is thus an analytical tool for examining the process an individual undergoes in becoming a full participant, a full member in a community of practice in apprenticeships. This social process of becoming a full participant, and the LPP in which the learner participates, includes the learning of knowledgeable skills, but the term denotes a process much broader than the practice of learning a "skill." The learner is actually participating in the community, gradually changing position within it, and is always a member in it, though to varying (peripheral) degrees. Because the analysis emphasizes the shifting position of members within a community of practice rather than the traditional concept of learning knowledge, their work on learning and apprenticeship steers intentionally away from already loaded terms like *teachers/pupils* and *experts/novices.* They use the terms *old-timers/newcomers, full participants,* and *legitimate peripheral participants* to talk about and direct attention to how people and practice interact and change in social relations (Lave 1991, 68).

Examining learning through these theoretical tools also highlights identity,[5] the identity construction that occurs as an individual becomes a member of a community of practice in the workplace; how individuals learn what they need to know, what they do not need to know, and how to negotiate their position in the community (Wenger 1998, 149). Here, too, this identity construction occurs in practice rather than through being taught by teachers. Wenger's (1998) discussion of identity focuses on practice. Rather than tending to the debates about identity and whether it can be possessed by an individual or created in the social collective, Wenger looks at the interplay of the individual and the collective and ways identity is done. One of his main points is that identity is done when individuals negotiate what it means to be a member of a social community (Wenger 1998, 145). This negotiated experience, the way an individual defines himself or herself and others through participation and through reified practice, can be seen in the way an individual experiences the day-to-day events of his or her life; the actual events that occur, for example, in the workplace; and how those events are given meaning by the individual and others. Much of this happens in what Wenger calls "mutual engagement," or the expectations people in a community of practice have about how they interact and treat each other, and how they work together (1998, 152). Identity is also done in the practice of defining who the individual is in relation to both local communities of practice and larger, or global, communities (Wenger 1998, 149). Key to this concept of identity is that it is not something to be possessed or imposed; it is done. When I analyzed the videotape of the medical simulations, the way identity was being practiced in the context surrounding the simulations became apparent.

Situated Simulations

The surgical simulators observed in this study were embedded in a surgery course, and the training on them was integrated into the rest of the medical apprenticeship. Even though the simulations occurred in a separate simulator center, aspects of the students' medical apprenticeship were intentionally and unintentionally brought into the simulations. Because the simulation was embedded in their surgery course, which also involved shadowing doctors on the surgical wards, the students came to the simulator center in small groups with the other students on their course, and they had already met some of the simulator instructors earlier, in their role as practicing surgeons at the hospital. Thus, the stage was already set for mutual engagement in the simulator center.

The physical location of the simulator center in one of the country's largest teaching hospitals creates legitimacy for the simulations as such and for the medical practices being conducted on them. There are also other small but significant details resulting from this location that create legitimacy. The instructors were occasionally beeped and called on the internal intercom system. When this happened, as in the strip at the beginning of this article, they briefly stepped away from the simulation and spoke to other professionals about practical hospital business, like scheduled operations or meetings, right in front of the students, who overheard their conversations. And during the pauses and downtimes of a simulation, the instructors carried out small talk about the hospital and medicine with the students. The topics covered by the small talk may seem trivial to the teaching of the simulation, like a discussion about the great ski conditions at the last orthopedic conference, but this conversation constructed an identity for the instructor as a legitimate old-timer in the community of practice and the simulation as a legitimate part of surgical training, and "did" the surgical identity within the larger community of surgeons. Parts of the surgery wards were also woven into the simulation experience over and above the tools of surgery that made up the simulator. For example, while the students were training on the simulator, there was a video film of an MIS procedure playing in the room, so that those who were waiting for their turn could watch an example of the "real" thing being narrated by other surgeons.

Maintaining the role of coworker involves creating legitimacy as an actual medical practitioner in front of the students. The students must believe that the surgeon is knowledgeable enough and honest enough to be believed, and, more important for the study of simulator use, that the practices he or she is expounding upon are actually related to the "real" practices of the operating room. Creating this legitimacy is a multifaceted task, often done unconsciously, and often done by more actors than just the instructors immediately involved. Both the location of the center and the choice of instructors carry with them reputations built on external practices. The fact that the instructors are known to also be practicing surgeons who perform "real" surgical tasks gives their suggestions for good surgical practices extra weight.

The instructors' role as old-timer combines both teacher and colleague during the apprenticeship, a dual identity that could be observed in the simulator center as well. Rather than leaving that identity at the door and mantling the role of teacher, the instructors carried and displayed both roles. They made references during the simulation to their own work at the hospital. They spoke about their understandings of surgery even as they were teaching the students on the simulators. At times they commented on the films of real

operations showing in the room and voiced opinions for the students about the relative benefits of different types of surgeries. When, for example, during a simulation the instructing surgeons would name-drop about other famous surgeons in different countries, asking the students from those countries if they knew of these surgeons, they were emphasizing the shared professional community both the instructors and students have. Making conversation in these ways created an opportunity for the newcomers, the students, to feel as if they are part of the old-timers' community of practice already, though in a peripheral way. For the simulation, the fact that they maintained their medical practitioner identity and spoke with the students about how to conduct surgery in the wards as colleagues, indicates that the newcomer–old-timer relationship exists also in the simulation, instead of a student-teacher relationship between people from different communities of practice.

Sometimes the students, who also carried beepers and usually came dressed in their white coats, would be beeped, just like the surgeons. They dealt with this differently than the instructors did. During one presimulation lecture,[6] I observed a student's beeper going off a couple of times. He ignored this, as did his classmates. The instructor did not even acknowledge the beep despite the fact that it was very audible. Knowing which beepers to disregard is an example of participating in the practices of the hospital by attributing (very little, if any) attention to an element of their daily work practice at that specific moment. The students and instructor knew how to deal with the beeper in the context of a lecture versus in the context of other clinical practices. The student's beeper going off can be understood as the clinical practice intruding, or at least making itself known, in the "classroom." It is also a display of how the student negotiated his role as both hospital "staff" and medical student and an opportunity for the classroom activity and the person in charge of that activity, that is the instructor, to be positioned in a hierarchy of practices. It is an example of "mutual engagement" or how those involved practice identity through knowing what sort of behavior to expect from others in certain situations. The instructor took precedence over the beep. Yet when the instructors were paged, they would often answer the calls, providing the display of roles for others in the room. Managing the beepers displays appropriate social interactions, one of the aspects of entering the community of practice and part of the way new people become members of a community of practice in an apprenticeship. Newcomers learn who else is part of the community and the appropriate social interactions to have with them.

The instructors running the simulation brought their identities into the simulator center in various ways: they carried their beepers, had their identity

badges on, and wore the white coats that they otherwise wore when they walked around the hospital. These coats and the stethoscopes and the beepers attested that the simulation was situated in the hospital's larger, clinical practice. These were the clothes that the instructors wore in their roles as medical doctors, clothes and technologies that indicate and facilitate their place in the hospital's activities. According to Wenger (1998, 149), the practice of identity can be found in reified objects. In my material, this became visible in the display of these coats, stethoscopes, identification badges, and beepers, which are identity-conveying artifacts also present during the lectures students attended and the clinical practice. What is important to this study is that the participants' identities as students and instructors in the simulator center are not significantly different than when they are participating in other parts of the apprenticeship. The simulations are woven into their apprenticeship in part through these reified elements of identity, and understanding the simulations ought therefore to involve understanding the way identity is maintained and practiced in apprenticeship learning.

The Hospital Meets the Simulator Center

Because the simulator center is embedded in a teaching hospital, the hospital's context is not separate from the simulations. The "real" hospital, with all of its teaching and healing activity, was always present just outside of the simulator center's door, and the boundary between it and the simulator center was not watertight. The hospital sporadically intruded into the simulation, providing the opportunity for the students' experiences in the simulator center to also be situated in the identity constructing they were otherwise undergoing in the clinical clerkships. Momentary interruptions occurred often while I was there, like when other instructors would enter the room on different errands or with visitors who were interested in the surgical simulator. Viewed through the situated learning lens of legitimate peripheral practice, these interruptions allowed the students to observe and participate in interactions with other people at the hospital and others present.

An example of this occurring, which comes from a presimulation lecture in the simulator center, shows how interruptions present opportunities for learning appropriate social interactions, even in the context of the simulator center. Figure 7 is a frame taken at the moment when the door to the simulator center suddenly opened and a man in a white coat stood stock-still in the doorway, waiting for a sign from the instructor that it was okay to enter the room. The instructor looked at the person and waved a welcoming greeting to the man, who then stepped into the room (Figure 8). As he did, and as he

Figure 7
Standing Still in the Door

walked to the back of the room, the instructor gestured to the man and said to the class, "A simulator center can't function without an engineer. His name is Ole," at which the man smiled good-humoredly at the instructor.

What was most striking with this entry procedure was the way the technician stood still at the door until he was welcomed in by the instructor. The second time the same technician entered the room during the same presimulation lecture, the procedure was slightly different. That time, he opened the door while the instructor was in the middle of a sentence. The lecturer made brief eye contact with the technician and gave a slight nod, at which point the technician slid into the room on a kickboard.[7] The instructor glanced at him again but did not stop speaking. When the instructor was finished with his sentence, by which time the technician had entered and made it almost to the corridor adjoining to the simulated operating theater at the back of the room, the instructor said briefly, "Welcome," to which the technician replied, "Thank you." Allthough slightly different, in both cases the interaction clearly

Figure 8
Waving Permission to Enter

demonstrated who commanded entrance to the room and the appropriate way for this to be negotiated between an engineer and a doctor.

This method of entry and the interaction between the doctor and technician was starkly contrasted with how an unannounced group of visiting foreign doctors entered into the same room a few minutes later. Although the group knocked on the locked door, because they did not have the electronic lock code to come in, when the instructor quizzically opened the door, the foreign doctors barged in without introducing themselves or explaining what they were going to do. After attempting to greet them in Swedish, the instructor switched to English and deduced that they wanted to watch the simulation. But the doctors did not ask permission; they simply stated what they were doing and then stood at the back of the room, expecting the lecture's language to change to English and then following along when the simulation started.

Traditional approaches to learning with simulators would ignore these two scenes because they were unrelated to the information being taught in the simulation. But the situated learning approach combined with an S&TS respect for how technology is embedded in the social context allows for the inclusion of this disruption. The disturbances to the lecture by the entering engineer and the foreign doctors are an opportunity for the students to see

how the engineer and the doctors interact, to observe with the idea of eventually partaking in the social interaction that they as members of the medical community of practice will have. And according to situated learning, that is just as important for the would-be doctors as the skills they may learn from the simulator.

Conclusion

Analyzing my empirical data from the simulations has shown that they are composites of many different types of practices within which the students and the instructors interact with the simulator, and many of these are directly related to identity construction. Some of these practices are very similar to those one would find in the operating theater, practices that are reconstituted during the simulations, but others have to do with the placement of the simulation in a teaching hospital and the interactions students have with other medical professionals in the course of their apprenticeship, like their relationships with other doctors, technicians, each other, and the intercom system at the hospital. Yet, others are a result of interactions with different types of professionals who are involved in the simulation, for example, the engineer who runs the computers or researchers, like myself, who are interested in what they are doing.

In other work, I have explored the reconstituting that creates medical practice out of simulator practice (Johnson 2004, 2007), practice specific to the simulators. I make the point with this article that the interaction between hospital practices and simulator center practices is *also* an opportunity for learning to occur. Rather than viewing the disruptions and "falling out of character" that occur when the hospital interrupts a simulation as a negative event, the interruptions can be seen as an opportunity for the simulation to gain legitimacy within the context of clinical training and the apprenticeship that the students are taking part in. These are also opportunities for learning and identity construction.

The simulations were conducted in the hospital and during clinical course work that otherwise involved the students participating as professionals, doing the work of doctors. What the example that started this article clearly shows is that the simulation was also, to some degree, embedded in the work practices of the teaching hospital. This is, in part, a simple result of where the simulation took place. Situated in a university hospital, it is populated by the same personnel the students worked with on their course and is neither physically nor socially separated from their work practices, as the beepers

and doctor's robes indicated. In addition, the use of the simulators is being introduced into the clinically based apprenticeship part of medical training as a short element of courses that are otherwise dominated by clinical practice and that put the students in the hospital rooms, actually practicing medicine on real patients.

Lave and Wenger suggest that learning can be understood as moving from relative incompetence to competence within a particular community of practice. Therefore, the formal and informal institutional structures within which the learning takes place are relevant to how it occurs. In this article, I have examined a few moments in which the contexts of the simulator center and the hospital have intersected and the way these intersections can be a beneficial interruption to the medical simulation. These interruptions grant the students the chance to place themselves in relationship to others around them while they are becoming doctors and to make medical meaning out of the practices in the simulator center. Contextualizing the simulation in this way, rather than isolating it as a learning tool to be used by itself, gives the students a chance to participate in legitimate practices even when they are not in the operating room, which is what the use of a simulator is really all about.

The relationship between simulations and medical education is much richer than the deceptively simple idea that simulators can be a training environment for medical techniques. The combination of learning theories and the S&TS approach gives me the tools to examine this. My reliance on concepts like LPP and identity construction shows how relevant the context and embeddedness of a technological artifact is for learning. That technology is embedded in its social context is something we know and have long respected in the field of S&TS, in particular in research on knowledge and technology, but the use of these concepts from theories of learning demonstrates one way that respect for context and situatedness can be analyzed and be a valuable guide for studies of science and technology. As used in this study, they point to how and why the situatedness of a technological artifact is important and provide some theoretical tools that can be used to analyze the situated interactions of technology and people. The simulations are not occurring in an isolated, controlled environment for the teaching of specific skills, even if there is an element of that concept in the design of the artifacts and in the architecture of the simulator center. They are part of the real practices of the teaching hospital. And it is because they are embedded in the apprenticeship of the clinical clerkship, over and above the reconstituting practices, that the simulations are relevant to the students and the learning they are otherwise engaged in. When in use, simulators provide a forum for many aspects of medical practice.

Notes

1. See, for example, the special issue of *Medical Education* (Bradley and Postlethwaite 2003). This comment is most relevant for the teaching and training uses of medical simulators. One of the most common nonmedical training contexts for using medical simulators is in the display halls of medical conferences. It would be interesting to look at this very specific context of use in another study.

2. In the simulator practice, who is a user and who is a designer is not entirely clear. Company representatives, also interested in how their simulators "work," showed up at the simulator center from time to time, appearing in and out of my camera viewfinder, helping to fix the bugs that were still left in the simulator and running usability tests. Some of the surgeons who were instructing the students also had a double relationship with the simulator. While using it as an instructional tool during the simulations, they were users. But their relationship with the vendor of the simulator extended beyond simple feedback suggestions on the log-in interface. In some cases the instructors had also been part of the design process earlier, giving expert advice on the tissue tensions and pressure sensations being built into the technology (see Prentice [2005] for a close reading of this process during the design of a similar simulator). And, as users of new technologies, medical doctors are often enrolled in the process of technology development, being encouraged to conduct research on usability in conjunction with the product manufactures and designers.

3. I discussed the possibility of using two or more cameras with some of my colleagues. This may have helped me get even more material, but in the end, I did what I could with the equipment I had, and my analysis has focused on what I could see on the tapes and what I could observe myself in the field.

4. See www.mentice.com (accessed January 12, 2007).

5. *Identity* is a tricky and overused term, as Brubaker and Cooper (2000) make clear in their overview "Beyond 'identity.'" But, as used by Wenger, it is a large part of the communities of practice theory of learning and relevant to my material, so I am using it, though keeping to the narrow definition worked through in Wenger (1998).

6. This occurred during a presimulation lecture for an anesthesiology simulation.

7. The teaching hospital was large and sprawling, and many employees used kickboards to move around in it.

References

Bradley, P., and Keith Postlethwaite, eds. 2003. Simulation in clinical learning. *Medical Education* 37 (suppl. 1): 1-78.

Brubaker, R., and F. Cooper. 2000. Beyond "identity." *Theory and Society* 29:1-47.

Cartwright, L., C. Penley, and P. A. Treichler. 1998. *The visible woman: Imaging technologies, gender and science*. New York: New York University Press.

Collins, H. 1990. *Artificial experts: Social knowledge and intelligent machines*. London: MIT Press.

Collins, H., and M. Kusch. 1998. *The shape of actions: What humans and machines can do*. London: MIT Press.

Coy, Michael. 1989. *Apprenticeship: From theory to method and back again*. Albany: State University of New York Press.

Dietrich, D. 1997. (Re)-fashioning the techno-erotic woman: Gender and textuality in the cybercultural matrix. In *Virtual culture: Identity and communication in cybersociety*, edited by S. G. Jones, 169-84. London: Sage.

Gallagher, A. G., N. E. Seymour, S. A. Roman, M. K. O'Brien, V. K. Bansal, D. K. Andersen, and R. M. Satava. 2002. VR Training improves operating room performance: Results of a randomized, double-blinded study. *Annals of Surgery* 236 (4): 458-64.

Goodwin, C. 1980. Restarts, pauses, and the achievement of a state of mutual gaze at turn-beginning. *Sociological Inquiry* 50:272-302.

———. 1986. Gestures as a resource for the organization of mutual orientation. *Semiotica* 62 (1/2): 29-49.

———. 2000. Action and embodiment within situated human interaction. *Journal of Pragmatics* 32 (10): 1489-1522.

Goodwin, M. 1998. Games of stance: Conflict and footing in hopscotch. In *Kids' talk: Strategic language use in later childhood*, edited by S. Hoyle and C. T. Adger, 23-46. New York: Oxford University Press.

Gorman, P., M. Andreas, H. Krummel, and M. Thomas. 1999. Simulation and virtual reality in surgical education: Real or unreal? *Archives of Surgery* 134 (11): 1203-8.

Goody, E. 1989. Learning, apprenticeship and the division of labor. In Apprenticeship: From theory to method and back again, edited by M. W. Coy, 233-56. Albany: State University of New York Press.

Hass, J., and W. Shaffir. 1987. *Becoming doctors: The adoption of a cloak of competence*. Greenwich, CT: JAI.

Heath, C. 1986. *Body movement and speech in medical interaction*. Cambridge: Cambridge University Press.

Herring, S. C. 2000. Gender differences in CMC: Findings and implications. *The CPSR Newsletter* 18 (1): 3-7.

Hindmarsh, J., and C. Heath. 2000. Embodied reference: A study of deixis in workplace interaction. *Journal of Pragmatics* 32:1855-78.

Hughes, D. 1988. When nurse knows best: Some aspects of nurse/doctor interaction in a casualty department. *Sociology of Health and Illness* 10 (1): 1-22.

Hughes, J., P. Tolmie, T. Rodden, and M. Rouncefield. 1998/2003. *How to "represent" the workers: Understand the work of representations*. Lancaster, UK: Department of Sociology, Lancaster University. http://www.comp.lancs.ac.uk/sociology/papers/tolmie-et-al-How-to-Represent-the-Workers.pdf (accessed January 2004).

Johnson, E. 2004. *Situating simulators. The integration of simulations in medical practice*. Lund, Sweden: Arkiv.

———. 2005. The ghost of anatomies past: Simulating the one-sex body in modern medical training. *Feminist Theory* 6 (2): 141-59.

———. 2007. Surgical simulators and simulated surgeons: Reconstituting medical practice and practitioners in simulations. *Social Studies of Science* 37 (4): 585-608.

Jordan, B., and A. Henderson. 1995. Interaction analysis: Foundations and practice. *Journal of the Learning Sciences* 4 (1): 39-103.

Lave, J. 1991. Situating learning in communities of practice. In *Perspectives on socially shared cognition*, edited by L. Resnick, J. Levine, and S. Teasley, 63-82. Washington, DC: American Psychological Society.

Lave, J., and E. Wenger. 1991. *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

McCloy, R., and R. Stone. 2001. Virtual reality in surgery. *British Medical Journal* 323 (7318): 912-15.

Neumann, M., G. Mayer, C. Ell, T. Felzmann, B. Reingruber, T. Horbach, and W. Hohenberger. 2000. The Erlangen endo-trainer: Life-like simulation for diagnostic and interventional endoscopic retrograde cholangiography. *Endoscopy* 32 (11): 906-10.

O'Farrell, M., and L. Vallone. 1999. *Virtual gender: Fantasies of subjectivity and embodiment*. Ann Arbor: University of Michigan Press.

Orr, J. 1996. *Talking about machines: An ethnography of a modern job*. Ithaca, NY: ILR.

Oudshoorn, N., E. Rommes, and M. Stienstra. 2004. Configuring the user as everybody: Gender and design cultures in information and communication technologies *Science, Technology & Human Values* 29 (1): 30-63.

Prentice, R. 2005. The anatomy of a surgical simulation: The mutual articulation of bodies in and through the machine. *Social Studies of Science* 35 (6): 837-66.

Pugh, C. M., S. Srivastava, R. Shavelson, D. Walker, T. Cotner, B. Scarloss, M. Kuo, et al. 2001. The effect of simulator use on learning and self-assessment: The case of Stanford University's E-Pelvis simulator. *Studies in Health Technology and Informatics* 81:396-400.

Resnick, L. 1991. Shared cognition: Thinking as social practice. In *Perspectives on socially shared cognition*, edited by Lauren Resnick, John Levine, and Stephanie Teasley, 1-20. Washington, DC: American Psychological Association.

Sanne, J. M. 1999. *Creating safety in air traffic control*. Lund, Sweden: Arkiv.

Shapiro, D. 1994. *The limits of ethnography: Combining social sciences for CSCW*. Chapel Hill, NC: Computer Supported Cooperative Work, Association for Computing Machinery.

Silverman, D. 1999. *Interpreting qualitative data: Methods for analysing talk, text and interaction*. London: Sage.

Sinclair, S. 1997. *Making doctors: An institutional apprenticeship*. Oxford, UK: Berg.

Suchman, L. 1987. *Plans and situated actions: The problem of human-machine communications*. Cambridge: Cambridge University Press.

———. 1995. Making work visible. *Communications of the ACM* 38 (9): 56-64.

Suchman, L., J. Blomberg, J. Orr, and R. Trigg. 1999. Reconstructing technologies as social practice. *American Behavioural Scientists* 43 (3): 392-408.

Sundén, J. 2002. *Material virtualities: Approaching online textual embodiment.* Linköping, Sweden: Akademisk avhandling, Linköpings universitet, the Tema Institute.

Torkington, J., S. Smith, B. Rees, and A. Darzi. 2001. Skill transfer from virtual reality to a real laparoscopic task. *Surgical Endoscopy* 15 (10): 1076-79.

Turkle, S. 1995. *Life on the screen: Identity in the age of the Internet*. New York: Simon & Schuster.

Voskuhl, A. 2004. Humans, machines, and conversations: An ethnographic study of the making of automatic speech recognition technologies. *Social Studies of Science* 34 (3): 365-93.

Wenger, E. 1998. *Communities of practice: Learning, meaning, and identity*. New York: Cambridge University Press.

Wolcott, H. 1982. The anthropology of learning. *Anthropology & Education Quarterly* 8 (2), 83-107.

Ericka Sue Johnson is a researcher in the Department of Science and Technology Studies, at Göteborg University, Sweden. She is the author of *Situating Simulators: The Integration of Simulations in Medical Practice* (Lund, Sweden: Arkiv, 2004) and *Dreaming of a Mail-Order Husband. Russian-American Internet Romance* (Durham, NC: Duke University Press, 2007). Her current research examines pharmaceuticals and biomedicalized masculinities.