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Technology and Social Interaction: Notes on the Achievement of Authoritative Knowledge in Complex Settings

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Abstract: Within any particular social situation a multitude of ways of knowing exist, but some carry more weight than others. Some kinds of knowledge are discredited and devalued, while others become socially sanctioned, consequential, "official," and are accepted as grounds for legitimate inference and action. In this paper I explore the role of technology in the constitution of such authoritative knowledge by drawing on videotaped data from two complex, high-technology work settings: an American obstetrics ward and an airlines operations room. Videotapes were analyzed using methods of Interaction Analysis, a microanalysis of participants' activities in relation to each other, the physical space in which they operate, and the artifacts and technologies which play a role in getting their business accomplished. I use these cases as a means to illustrate some of the linguistic, interactional, and artifactually-based mechanisms by which, in high technology settings, authoritative knowledge comes to be distributed, displayed and used. An understanding of these mechanisms is crucial for the design of collaborative working and learning environments that are conducive to getting necessary business done in an efficient way while, at the same time, empowering their users.

Keywords:

authoritative knowledge (AK), conversation analysis (CA), video-based interaction analysis, birth knowledge, airlines operations

Within any particular social situation a multitude of ways of knowing exist, but some carry more weight than others. Some kinds of knowledge become discredited and devalued, while others become socially sanctioned, consequential, even "official," and are accepted as grounds for legitimate inference and action. In this paper, I explore the role of technology and social interaction in the constitution and display of such authoritative knowledge by drawing on videotaped data from two complex, high-technology work settings: an American obstetrics ward where a baby is delivered and an airline's operations room where a plane switch is orchestrated. I will argue that the "ownership" of the artifacts necessary to accomplish the work simultaneously defines and displays who should be seen as possessing authoritative knowledge and, consequently, legitimate decision-making power.

I have chosen these situations not because of a special interest in American obstetrics or in airlines' operations, but rather because these two cases provide particularly telling examples of work settings where the business at hand is collaboratively accomplished and technologically mediated. Furthermore, I have good video data for both of them, which are essential for doing the kind of close analysis that I hope will make my point. My argument thus does not hinge on whether American births generally look like the one I describe; nor am I making a case here that distributed access to the artifacts of work is typical for airlines' operations rooms or even for communication and control centers. The conclusions I draw apply to American hospital births and airlines operations rooms only to whatever extent particular births and particular operations rooms partake of the social and material features outlined below. Where there is a different social organization and

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different distribution of technological resources, different characteristics will prevail. Nevertheless, this analysis is at least suggestive for work settings that share the technological, social-interactional, spatial, and organizational characteristics of the cases described here.

In my first example, a woman laboring in a high-technology hospital is ready to push her baby out. However, what her body tells her, what she knows (and displays) by virtue of her bodily experience, has no status in this setting. What counts is the technologically and procedurally based knowledge of the physician, which is inaccessible to the woman, but without which the birth literally is not allowed to proceed. Competing kinds of knowledge held by the woman and other participants in the scene are jointly suppressed and managed. In this case and others like it, authoritative knowledge and attendant decision making is hierarchically distributed.

In my second example, I describe ongoing work activities in an airline's operations room. Here, access to and familiarity with the crucial technologies is distributed across participants. The knowledge required to get the work done is continuously jointly produced and is displayed for inspection and appropriation by whoever may need it to further the collective work. The routine decisions required in this setting emerge through mutual consultation. They are produced collaboratively and with multiple inputs, in unremarkable fashion. I will argue that in this case and in cases like it authoritative knowledge is horizontally distributed. One of the aims of this report is to elaborate the notion of authoritative knowledge introduced in a series of earlier publications (Irwin & Jordan, 1987; Jordan, 1977, 1987a, 1989, 1993; Suchman & Jordan, 1988).

Authoritative Knowledge

For any particular domain several knowledge systems exist, some of which, by consensus, come to carry more weight than others, either because they explain the state of the world better for the purposes at hand ("efficacy") or because they are associated with a stronger power base ("structural superiority"), and usually both.

Sometimes equally legitimate, parallel knowledge systems exist and people move easily between them, using them sequentially or in parallel fashion for particular purposes. But frequently, one kind of knowledge gains ascendance. The legitimization of one way of knowing as authoritative devalues, often totally dismisses, all other ways of knowing. Those who espouse alternative knowledge systems tend to be seen as backward, ignorant, or naive trouble makers. Whatever they might have to say about the issues up for negotiation is judged irrelevant, unfounded, and not to the point (Jordan, 1989). The constitution of authoritative knowledge is an ongoing social process that both builds and reflects power relationships within a community of practice (Lave & Wenger, 1991). It does this in such a way that all participants come to see the current social order as a natural order, i.e. the way things (obviously) are. [1]

The devaluation of non-authoritative knowledge systems is one mechanism by which hierarchical social structures are generated, maintained, and displayed. The French anthropologist Pierre Bourdieu writes insightfully about the role which formal education may play in the devaluation of folk knowledge in a class-structured society:

> [Formal schooling] succeeds in obtaining from the dominated classes a recognition of legitimate knowledge and know-how (e.g. in law, medicine, technology, entertainment or art), entailing the devaluation of the knowledge and know-how they effectively command (e.g. customary law, home medicine, craft techniques, folk art and language, and all the lore handed on in the hedge-school of the witch and the shepherd …) and so providing a market for material and especially symbolic products of which the means of production are virtually monopolized by the dominant classes (e.g. clinical diagnosis, legal advice, the culture industry, etc. (Bourdieu & Passeron, 1977, p. 42)

In the medical field, Paul Starr (1982) gives a compelling account of the historical transformation of authoritative medical knowledge in America. Well into the twentieth century, medical care was provided by a multi-stranded, pluralistic medical system within which the knowledge held by barber surgeons, homeopaths, folk healers of various kinds,

midwives, and other empirically based practitioners was considered authoritative by different parts of the population. A series of events culminating in the Flexner Report of 1910 resulted in establishing allopathic professional knowledge as the dominant form – a transformation which quickly delegitimized all other kinds of knowledge, putting the newly defined medical profession in a position of cultural authority, economic power, and political influence. Starr introduces the idea of "cultural authority" which refers "to the probability that particular definitions of reality and judgments of meaning and value will prevail as valid and true" and argues that the acquisition of cultural authority by doctors had the consequence that they came to be in charge of "the facts," that is to say, have the authority to define when somebody is dead or alive, sick or well, competent or not (Starr, 1982, pp. 13-15).

The process whereby the authority of any particular knowledge system and the power relations supporting it and benefiting from it are perceived not as socially constructed, relative, and often coercive, but as natural, legitimate, and in the best interest of all parties is termed "misrecognition" by Bourdieu and Passeron (1977). Others as well have pointed out that this process makes the achieved order of the world appear to be a fact of nature, with the consequence that the dominant positions in that order are also a fact of nature, and hence cannot be changed. The best way to avoid change or revolution is to make change or revolution literally unthinkable.

Authoritative knowledge is persuasive because it seems natural, reasonable and consensually constructed. For the same reason it also carries the possibility of powerful sanctions, ranging from exclusions from the social group to physical coerciveness (Davis-Floyd, 1992; Irwin & Jordan, 1987). Generally, however, people not only accept authoritative knowledge (which is thus validated and reinforced), but are actively and unselfconsciously engaged in its routine production and reproduction.

It is important to realize that to identify a body of knowledge as authoritative speaks, for us as analysts, in no way to the correctness of that knowledge. Rather, the label "authoritative" is intended to draw attention to its status within a particular social group and to the work it does in maintaining the group's definition of morality and rationality. The power of authoritative knowledge is not that it is correct but that it counts.

I want to further point out that when I, as the analyst, say that somebody "has" knowledge, authoritative or otherwise, this constitutes for me a commitment to try to come to an understanding of how participants in a social setting make that fact visible to each other, ratify it, enforce it, elaborate it and so on, since I see knowledge not as a substance that is possessed by individuals but as a state that is collaboratively achieved within a community of practice. By authoritative knowledge, I mean, then, the knowledge that participants agree counts in a particular situation, that they see as consequential, on the basis of which they make decisions and provide justifications for courses of action. It is the knowledge that within a community is considered legitimate, consequential, official, worthy of discussion, and appropriate for justifying particular actions by people engaged in accomplishing the tasks at hand.

As Heath and Luff (1991) have pointed out, in order for people to work together, there must be a publicly available set of practices and reasonings which are developed and warranted within a particular setting, and which systematically inform the work and interaction of participants. In all social groups people provide justification for what they do, reasons for why they do what they do in this way and not another, or why, when trouble arises, it should have been done in a particular way. Authoritative knowledge is about accountability in a community of practice that produces and reproduces itself even as it produces and reproduces its version of authoritative knowledge. By authoritative knowledge I specifically do not mean the knowledge of people in authority positions. To the extent that such persons are members of a community of practice, they will share the local version of authoritative knowledge with other members, but it is the local production and display that is of importance for the present analysis. Authoritative knowledge is an interactionally grounded notion. What I am interested in here is how participants in

particular work environments make visible to themselves and to each other what the grounds are for their proceedings. I thus forego theoretically derived notions of authority and knowledge in favor of investigating how participants deal with such issues in actual work situations. In the following sections, I contrast the authoritative knowledge in use in two high technology settings: a labor ward and an airlines operations room. These particular cases vividly illustrate the ways in which technology and technology-based procedures become a resource for the collaborative production and display of authoritative knowledge.

The Labor Room

The Setting

The first set of data for this analysis comes from a large research project on the dynamics of care during the second stage of labor which was carried out in a perinatal center of a western city between 1986 and 1989.[2] The protocol for the project included videotaping of women's labors from about an hour before the birth of the baby through an hour afterwards. In addition to these videotapes, I had access to a summary of the medical record and the transcript of an interview conducted with the women about four weeks postpartum. While the birth I will be analyzing was not atypical for births in that particular hospital, its typicality or lack thereof is not what matters for my analysis. Rather, I use this birth as a means to illustrate the complex interaction between the material resources of this particular workplace and the social relations that characterize it, in an attempt to point to the mechanisms by which, in high technology settings, authoritative knowledge comes to be distributed in particular ways. I do intend to claim that my argument holds for settings that are like this one in regard to hierarchically organized ownership of the salient technologies, be they labor rooms or not. What I am specifically not claiming is that births in American hospitals are always or typically conducted in this way. The point here is not to indict American birthing practices, but rather to show what happens when technology-dependent knowledge becomes hierarchically distributed. About nine minutes of the transcript of this labor are included as appendix A. Most examples that illustrate my analysis are drawn from this segment.

The people present in the labor room with the woman are, initially, her husband and a nurse technician who has been taking care of her throughout the labor. The husband appears intimidated by the scene. He comes to the woman's bedside when she calls him but gets out of the way when the medical team move in. The nurse is in a delicate position. She is the liaison (not to say interface) between the woman and the physician who will perform the delivery. As such she needs to assess the woman's state within a small range of error in order to be able to call the physician in time for the crucial stages of the delivery that require his presence, but not so early as to waste his valuable time. Throughout the labor, she is very much preoccupied with the electronic fetal monitor (EFM), a machine that plots the strength of uterine contractions against the fetal heart beat. The EFM is widely believed to give early warning of intrauterine difficulties, even though it has never been shown that routine EFM treatment improves birth outcome (Leveno et al., 1986; Prentice & Lind, 1987). It is positioned at the bedside in such a way that the nurse can consult it in the same glance with which she looks at the patient. Since the woman's medical chart has been placed on top of the fetal monitor, the activity of making periodic entries in the chart also involves turning to the machine.

The Story of This Birth

The woman on the tape has gone to a large, inner-city hospital. She has been in labor for 10 hours. She is 25 years old and this is her second child. She is in bed, flat on her back, attached to an IV pole through an intravenous line that goes into her left hand; she is connected to the electronic fetal monitor through wires coming out of her vagina. The videotape is started about half an hour before the baby is born. In the preceding hours,

during the first stage of labor, the woman's cervix has slowly opened up so that the baby's head can pass through. She is now in the second stage of labor. During this stage, women experience increasingly powerful urges to push which become progressively more irresistible until the baby is finally expelled.

In this particular case, however, the woman is not allowed to push. Every effort is made to keep her from giving in to the overpowering impulse to bear down. She is asked to suppress the urge long enough for the physician to come in and pronounce her ready. The physician is paged several times but does not appear. Meanwhile, the woman is doing Lamaze breathing, a learned type of breathing intended to help her last through the contractions without pushing. The pattern sounds something like "he he he hoo", "he he he hoo." The visible and audible breathing pattern women are taught provides a convenient standardized metric by which the degree to which they are in or out of control can be assessed by themselves and by their attendants. The nurse makes every attempt to help the woman remain within acceptable behavioral norms by breathing with her in the Lamaze pattern. As time goes on, the woman's distress and pain become more and more pronounced.

The nurse leaves for a short while to see about paging the doctor herself. A nursing student (who has been running the camera) takes her place until she returns. A woman medical student comes in. She and the nurse agree that the woman should be checked. The medical student performs a vaginal examination without asking permission or explaining what she is doing. The examination is inconclusive both in the sense that the medical student cannot feel what the state of the woman's cervix is and in the sense that even if she knew, it wouldn't matter because she cannot give the official permission to push. The physician finally arrives together with a male medical student. He examines the woman and declares that she is ready to push. The staff prepare her for the delivery. They put her feet in stirrups and swab her down with antiseptic solution. The husband is told to take his place at her head. The woman medical student puts on gloves to deliver the baby. The physician stands ready with a suctioning tube. As the head emerges, he suctions the baby's nose and mouth. The child is delivered by the medical student who announces that it's a boy. She immediately gives the baby to a pediatrician who dries, suctions and Apgar-scores him, out of the mother's line of sight. The camera remains mostly on the baby being processed. Quick cuts to the mother show her in pain. Presumably the placenta is delivered. Finally, several minutes after the baby is born, he is given to his mother to hold. She touches his cheeks gingerly, with one finger. After a while mother and father slowly peel away the layers of clothing to take a peek at their baby. The mother begins to smile. Her face is transformed.

Access to Technology and the Hierarchical Distribution of Knowledge

What is massively evident on the tape is that, throughout the labor, participants work hard to maintain the definition of the situation as one where the woman's knowledge counts for nothing. They all know that she "cannot" push until the doctor gives the official go-ahead. Within this particular knowledge system, it is believed that only the doctor can tell when a woman is ready to push – information he gains from checking the dilatation of the cervix during a vaginal examination. This fiction is maintained collaboratively, by agency of the woman herself, her husband, the nurse, the medical student – in the face of the fact that anybody who cares to look or listen can see that this woman's body is ready to push the baby out.[3] However, what the woman knows and displays, by virtue of her bodily experience, has no status. Within the official scheme of things, she has nothing to say that matters in the actual management of her birth. Worse, her knowledge is nothing but a problem for her and the staff. What she knows emerges not as a contribution to the store of data relevant for making decisions, but rather as something to be cognitively suppressed and behaviorally managed. In the labor room authoritative knowledge is privileged,[4] the prerogative of the physician without whose official certification of the woman's state the birth cannot proceed.

How is it, then, that the participants in the labor room display to each other and to themselves, that authoritative knowledge is held by the physician and that the woman's knowledge does not count? If technology is seen not only as a collection of complex gadgets and machinery, but also as the methods and techniques developed in the communities of practice that use these technologies, then we see that technologies create particular kinds of social spaces within which certain activities are more or less possible and more or less likely. In the present context, I am particularly interested in the ways in which technologies are socially situated, that is to say, are given meaning in and through social interaction, are appreciated for their symbolic value as well as their use value, are owned and displayed by different segments of a community of practice, and are used to express power, expert status, and other socially meaningful relationships between people.

Modern obstetric environments are full of technologies of different kinds, and women who have gone through prenatal medical care have become familiar with a great deal of it during their pregnancy. They know about screening and stress tests, ultrasound examinations, electronic fetal monitoring, and the like. They also know that just beyond the doors of the labor room is an operating room where C-sections can be performed.

In spite of such exposure to obstetric technology, it appears that the woman (whom one might consider the central actor) is inert with respect to the technologies salient in the setting. None of them are ordered, operated, or interpreted by her. She apparently understands little about the role of the intravenous drip of oxytocin that has been increasing the strength of her contractions nor does she know how and why such an increase was ordered. Similarly, there is no evidence that she actively processes the output of the fetal monitor, in spite of the fact that it is right next to her bed and that there are times when it contradicts her experience. One might say that the artifacts and procedures which make up professional obstetric practice are arcane to her. She doesn't look, she doesn't touch. She is passively tethered to the IV pole on one side of her bed and to the fetal monitor on the other.

The nurse, on the other hand, is very much involved with the machinery. It provides for her a level of reality which her unmediated observations, her direct experience of the woman's state, do not. Throughout the labor, she looks to the EFM for information about the course of the contractions. We see her eyes glancing at the machine, often just when the woman is in greatest distress. In this setting, checking with the machine is not an occasional event but an ever present phenomenon.[5]

The Medical Staff as Gatekeepers. As a member of the medical team, the nurse is an expert reader, interpreter, and user of the information the EFM machine provides. The laboring woman is not, and no attempt is made to explicate the role of EFM information in decision making about the conduct of her labor. Other artifacts and procedures important for the conduct of birth are even less transparent and at the same time more restricted as to who can legitimately and consequentially employ them. For example, only the physician can do the vaginal examination on the basis of which the woman will be ''allowed'' to push the baby out. It is interesting that there are others in the room who are known to be competent to do that examination, such as a nurse standing off camera. But she says she doesn't want to do it because the physician would have to repeat it anyway. The nurse knows that she doesn't need to check because it doesn't matter. In so far as her knowledge is not, cannot be, consequential in this setting at this time, it has no status. In other words, it is not so much the information that the woman is ready to push which is necessary here (that information, as we have seen, is amply available), but rather, this information has to be produced by the right person in order to become authoritative knowledge. Though everybody knows that the woman is ready to give birth, that information counts for nothing until it is legitimized by the physician. Within this system, only the physician can give the go-ahead. It is this gatekeeping function that is acknowledged by the participants when they agree that it would be futile to do a vaginal examination now.

One might ask, why are nurses allowed to perform dilatation checks at other times during labor? It appears that progress checking is one of the functions of the auxiliary staff which contributes to the proper staging of the main event. By reserving the certification to the physician, however, the system also assures that the birth does not proceed without him, which is, after all, an ever-present threat.

The requirement that it be the physician who decides when the woman can push has a further consequence. The nurse notes the time of the pronouncement, and it is this time that officially determines the beginning of second stage. In this particular case, the baby is born six minutes later which makes the official duration of second stage, as noted in the medical record, six minutes. One can judge from all the behavioral signs that the second stage, in fact, began quite a bit earlier, at a time when the physician who is required for certification was simply not present. This artificial punctuation of the labor process produces prejudiced statistics which, by entering into computations of average length of second stage, become normative for the management of labor. Birth attendants practicing in home settings argue that hospital-based data are skewed in the direction of shortening the normal stages of labor.

The Status of the Woman's Knowledge. In this labor room, there coexist two versions of reality, two alternative claims to relevant knowledge. The woman presents hers verbally and bodily. She knows she has to push and says so clearly.[6] She also expresses it in the visible, almost superhuman effort she marshals to suppress the urge to push. But every time she tries to get her desire, her expressed knowledge about the state of her body acknowledged and made the basis for proceeding with the birth, her version of reality is overridden, is ignored, is denied, or, most frequently, is side-tracked, deflected, and replaced with some other definition of reality. Something else is offered up as being more relevant, as might happen to an obstinate child whose parent opts for distraction rather than confrontation. This phenomenon is massively present as an inspection of any part of the transcript will reveal. A typical set of examples might look something like this: [7]

Woman:	I gotta push NOW	→	Nurse:	you can pretty soon
Woman:	I can't	→	Nurse:	look at me
Woman:	I can't	→	Nurse:	all you can do is try
Woman:	HOO:::::H::::: (pain sound)	→	Nurse:	its almost gone
Woman:	I can't	→	Nurse:	take a cleansing breath
Woman:	I can't	→	Nurse:	let's just say you can
Woman:	I just wanna push	→	Nurse:	I know … it'll feel better for you to push, but in the meantime I don't want you to.
etc.			etc.[8]	

The woman is instructed to override what her body tells her and to act and feel otherwise. How is that "misrecognition" of her own interests accomplished? More specifically, how can a person be enlisted in the incredibly difficult enterprise of resisting such powerful bodily impulses?

One strategy is to encourage her to do the patterned Lamaze breathing. When the woman cries out that she cannot control the pushing urge anymore, the nurse bends over her with direct eye contact and makes the official "he he he hoo" sounds, forcefully suggesting that that is the way to control the painful urge. The woman, in desperation, pours her wrenching bodily experience into the making of the permitted sounds, the officially sanctioned language of distress in this situation. As long as she produces the magic incantation "he he he hoo", no matter how desperate – in so far as these are the officially sanctioned sounds and not an idiosyncratic outcry – she is seen by herself and those around her as "not out of control," "collaborating," "a good patient." [9] And by holding on to those sounds and not giving in to uncontrolled breathing, writhing, and screaming, the woman expresses her desire to be a good patient while, in the modulating of the "he he

he hoo'' through clenched teeth or with sobbing outbreath, she can nevertheless express her pain and misery without being censured for losing control.[10]

So it is the case here that the nurse and the other bystanders in the room (i.e. the woman's husband, the medical student, the nursing student who operates the camera, and a second nurse who had been paging the doctor) understand clearly that this woman is ready to push. Yet this knowledge counts for naught. It has no status and no consequences. The woman is spoken to consolingly, encouragingly, soothingly, or firmly, as her behavior requires, often in a kind of singsong voice that is close to the inflection familiar from kindergarten and grade school teachers. The attendants' pseudo-intimate voice emphasizes the childlike status of the woman. The staff are nice to her because she cannot help it if she lapses into unapproved behavior. As with small children, they may even have to physically restrain her on occasion, but they do it for her benefit.

Another way of controlling the woman's behavior is by straightforwardly giving orders:[11]

	Hus:	you want some ice?	woman pats her face rhythmically with washcloth, indicates ''no''
21.17[12]	Wom:	I just wanna push	
21.19	Nur:	I know it won't be long it'll feel better for you to push but in the meantime I don't want you to okay?	speaks to woman without looking at her while writing in chart leans towards woman and whispers – emphatic

As things become more difficult, the nurse uses a large number of unmitigated imperatives, such as: ''look at me;'' ''come on;'' ''breathe with your mouth;'' ''take a cleansing breath;'' ''take a deep sigh;'' etc. The nurse also indicates correct behavior with such praise as ''good,'' ''perfect,'' etc., a clear indication of who in this situation holds the knowledge that counts. These evaluations are similar to those used by teachers in schools and reinforce the woman's childlike position.

Information derived from the machine serves as a resource and a justification for negating and redefining the woman's experience. For example, at 20.10 the nurse, consulting the monitor, tells the woman what she should be feeling:

> [the contraction] is at the peak ...
> it's going down ...
> it's a smaller contraction ...
> almost gone ...

The nurse's characterization contradicts the rising, not decreasing, pain visible in the woman. So we have in this scene simultaneous but conflicting claims about what the woman's body is up to. The nurse's knowledge is machine based; she can see the contraction fading away. But the woman is falling apart because her experience is quite otherwise. What we get here is a negation of what the woman's body tells her by what the machine tells the nurse.

Staging the Physician's Performance. The physician's unquestioned status and authority rest, in the last analysis, on a societal contract which accords him that authority. What I am interested in here is how, for participants in this delivery (the woman, her husband, and the medical staff) this authority is not only displayed but in its implementation is interactionally achieved. It becomes visible in the ritual deference paid to the superior status of medical knowledge. It is also displayed in the way activities in the labor room are orchestrated, unfolding in the manner of a dramatic theatrical metaphor. As the labor progresses, there is a palpable buildup of tension, though not, as one might expect, foreshadowing the moment the woman gives birth, but rather leading up to the entrance of the physician without whom the delivery literally cannot proceed. His entry is eagerly awaited. He is paged, with increasing urgency, at least four times in the 12

minutes before he finally appears.

Then he sweeps in with his entourage, a male medical student holding his white coat. Without a glance at the woman he walks over to the fetal monitor, cursorily checks the output and then confers briefly with the nurse and the male medical student. The team take their position as if on a stage or in the battlefield, around the lower end of the woman's body, essentially dividing her into two parts: the "interaction end" at her head, to which the husband is delegated, and the "business end," where the important work of getting the baby delivered takes place.[13]

The physician performs the long-awaited examination standing up, looking away over the woman, with the nurse gazing up at him. This is an achieved arrangement. One can do a vaginal examination standing up or one can get down to the woman's level as midwives are wont to do, looking at her, talking to her as they do the exam. This doctor's attitude and stance, and the framing that is done by the team, are meaningfully produced; it is not that the world is that way "naturally." Nor is this kind of framing of the physician restricted to this labor room or labor rooms in general. It is common in medical interactions that have staff of various ranks present (as, for example, attending physicians, nurses, residents, and medical students during walking rounds). Kirkham, observing labors in hierarchical hospital settings, notes the staff "waiting on" the doctors in what she calls a pattern of "dancing attendance." She also notes that such actions inevitably reinforce the situation which led to them (Kirkham, 1988).[14]

The team frame him not only physically but also shadow him verbally. They explain, highlight and interpret his actions to the woman with whom he does not communicate directly. The medical student explains: "He is checking to see if you can push, okay?" (27.58).

The team takes up what the physician says, repeating his words, translating them, pointing out their significance:

28.10	Doc:	Yeah	to nurse
		she can push	
	Nur:	can she? plus one?	looking up at doctor
			getting ready to write
	Doc:	yeah	
		plus two	nurse writes in chart
	Wom:	Oh: NO::::	in pain
28.15	Nur:	you can push	to woman, with relief, like a good news
		it'll feel good	announcement

The repetition of the physician's words by the staff highlights, like a theater chorus, what is to be considered important. The physician's professionalism, on the other hand, is expressed in his totally impersonal attitude towards the woman. He treats her as an object, a performance that is made possible by the fact that others isolate and shield him. He never has to deal with this woman as a person. The only time he addresses her before the birth Is when he says "let me check you before you get another contraction" (27.49). The woman, in that she makes no interactional demands on him, collaborates in this construction.

Participation Structures in the Labor Room. Students of interaction, from Goffman (1963, 1981) to Goodwin and Goodwin (1996), Heath (1986), Jordan and Henderson (1995), Kendon (1985, 1990), Sacks (1992), Suchman (1987) and others, have noted that important social "work" is done through participation frameworks – fluid structures of mutual engagement and disengagement characterized by bodily alignment (usually face-to-face), patterned eye-contact, situation-appropriate tone of voice, and other resources the situation may afford.

What is striking in the labor room is that the laboring woman, who might be seen as the

focal participant, has only limited access to the various participation structures we observe. She is primarily engaged in dyadic interaction with the nurse, or, occasionally, with her husband. But these sometimes intense interactions are always in the service of the business at hand: dedicated to maintaining the current definition of reality by preventing her from letting her bodily experience gain ascendance. These dyadic interactions appear to be the only legitimate type of interaction for her. She does not enter into other kinds of participation frames. As soon as other people enter the room, such as the woman medical student or later on the physician with his entourage, the laboring woman is virtually excluded from any sort of engagement in talk or activity. Neither the physician nor the students introduce themselves to her. The physician never looks at her, doesn't address her until he stands ready to perform the vaginal examination, and then he simply announces what he is going to do – a type of statement to which the most appropriate response is silent compliance.

The nurse is involved in a number of different participation frameworks, shifts which are indicated by changes in body posture (e.g. straightening up, turning away from the woman and towards the door) and, maybe most significantly, by voice quality. There is a reciprocated, bantering tone in her interaction with the medical student, an enthusiastic, dramatic inflection when she asks the physician: "can she [push]?" even as she speaks to the woman in a multi-modulated parental voice.

In this setting, social interaction, beyond that required to maintain control, is done without the woman. Business gets done with her as an object but not as an actor. At the height of the drama when she is in great pain and barely able to control the pushing urge, the nurse and the medical student have a little chat, engage in a little private chuckle (26.35). The woman's head comes up from her pillow as if trying to see, as if trying to make a bid for inclusion or at least for acknowledgment of her plight, but to no avail. Her physical position is such that even eye contact is not easily initiated and, at any rate, there is no opening for her in the participation structure that is already set up.

Once the doctor enters, the staff interact as a team of which the physician is the focal member and from which the woman is specifically excluded. No input is solicited from her; talk is not produced for her overhearing or participation. No explanations are given. They do the business of examining her and preparing for the delivery amongst themselves. The woman is the object to be prepared and to be delivered.

The result of this systematic objectification of the woman is that there are two different enterprises going on in the room. The woman is desperately struggling against the sensations of her body, cajoled and parented by the nurse who, in turn, has one eye on the medical team. The second, quite separate enterprise is to deliver the baby which is the business of the staff. For all practical purposes, the woman has nothing to do with that nor has she anything to say about it. She is not giving birth, she is delivered.

When the doctor finally announces that she can push, the announcement is directed to the medical team and not to the woman. The doctor says: "she can push," and the nurse relays the message: "he says you can push," as if doctor and woman were not in the same room. The woman has become an object to be reported on, rather than an actor to be engaged. In the ways in which participation structures are set up in the labor room, her exclusion is ratified, executed and displayed over and over again. This is one of the mechanisms by which she is denied any say in the conduct of her labor, by which she is given the message that she doesn't count. The formal and informal professional participation frameworks of the labor room specifically exclude her.

We have seen, then, that in the labor room several different kinds of knowledge are actually present, but the only kind that counts is the knowledge delivered by the physician. This knowledge is communicated downward along a hierarchical structure of which the woman is the most distal member. All major decisions are reserved to the physician who is in charge of "the facts," the knowledge on which rational decision-making is to be based.

In the following discussion I consider another kind of situation, one in which there is also a great deal of reliance on complex technology, but where access to that technology and competence in technology-based procedures is shared. As a consequence, authoritative knowledge is horizontally distributed. Unlike the labor room, analysis here does not reveal a competing version of reality, a conflicting "non-authoritative" way of knowing. Rather, as far as we can see, there is only one kind of authoritative knowledge present in this situation.

The Airlines Operations Room

The Setting

My second set of data comes from another technology-rich environment, the operations room of a major airline in a metropolitan airport in the western United States. "Operations" or "ops" is the communications and control center which organizes an airline's ground operations. It is the locus for the coordination of all activities having to do with the arrival and departure of planes, such as the movement of passengers and baggage, fueling of planes, provisioning with meals, cleaning and servicing of planes between flights, and the like.

Our evolving understanding of the work of ops has been informed by ethnographic fieldwork carried out by members of an interdisciplinary research team. In addition to video tapes filmed over several months, the data corpus includes field notes on many hours of participant observation, interviews with key informants, and the analysis of work-related documents. The present analysis focuses particularly on four hours of videotape filmed on a weekday afternoon and evening in order to document routine activities in one of the ops rooms we studied. Appendix B includes a transcript of 4 ½ minutes from that tape. As much as possible, examples for the discussion which follows will be taken from that brief segment.

Our fieldsite is a hub for Atlantic Airlines.[15] At certain times of the day a flock of planes from all corners of the country descend from the air, roll into Atlantic's eight gates, exchange passengers, baggage, and crews, are serviced with fuel and food, and go out again to different destinations. One can think of the ops room together with its associated work areas (the ramp, the gate, the baggage area, etc.) as a pulsing organism which periodically sucks in planes, people and objects, takes a deep breath, and then expels them again – hopefully on schedule. At the height of such "complexes," when all of the airline's gates are busy, the activity level in the ops room is at a pitch, only to relax again as the complex fades away. There are nine such complexes in the course of a working day.

The ops room is a multi-party, multi-task work environment, characterized by a mix of communication technologies arranged along the walls, with operators seated to face them. Thus the normal working arrangement is not face-to-face but back-to-back communication among co-workers (see figure 1).[16]

Information about the state of the world comes into the windowless room through audio, video, and paper documents, over radios, phones, computer screens, printers, video monitors and, every so often, from another employee wandering in from the ramp or the gate. This information is taken in, processed, and then sent out again in the form of data and directives tailored to the needs and activities of other parts of the system, such as pilots, fuelers, baggage loaders, maintenance workers, and so on.

Some of the information the ops room processes comes from headquarters in a distant city, e.g. instructions about how much fuel to put into an airplane, where to load the baggage, etc. Other information comes from planes and pilots, either by voice over the radio or through a computer system installed in most planes. Thus ops workers communicate not only about technical operational matters such as a problem with a fuel gauge or a plane's ETA[17], but also about such mundane issues as a new seat cover needed on an incoming plane because a passenger threw up, or the location of a forgetful pilot's

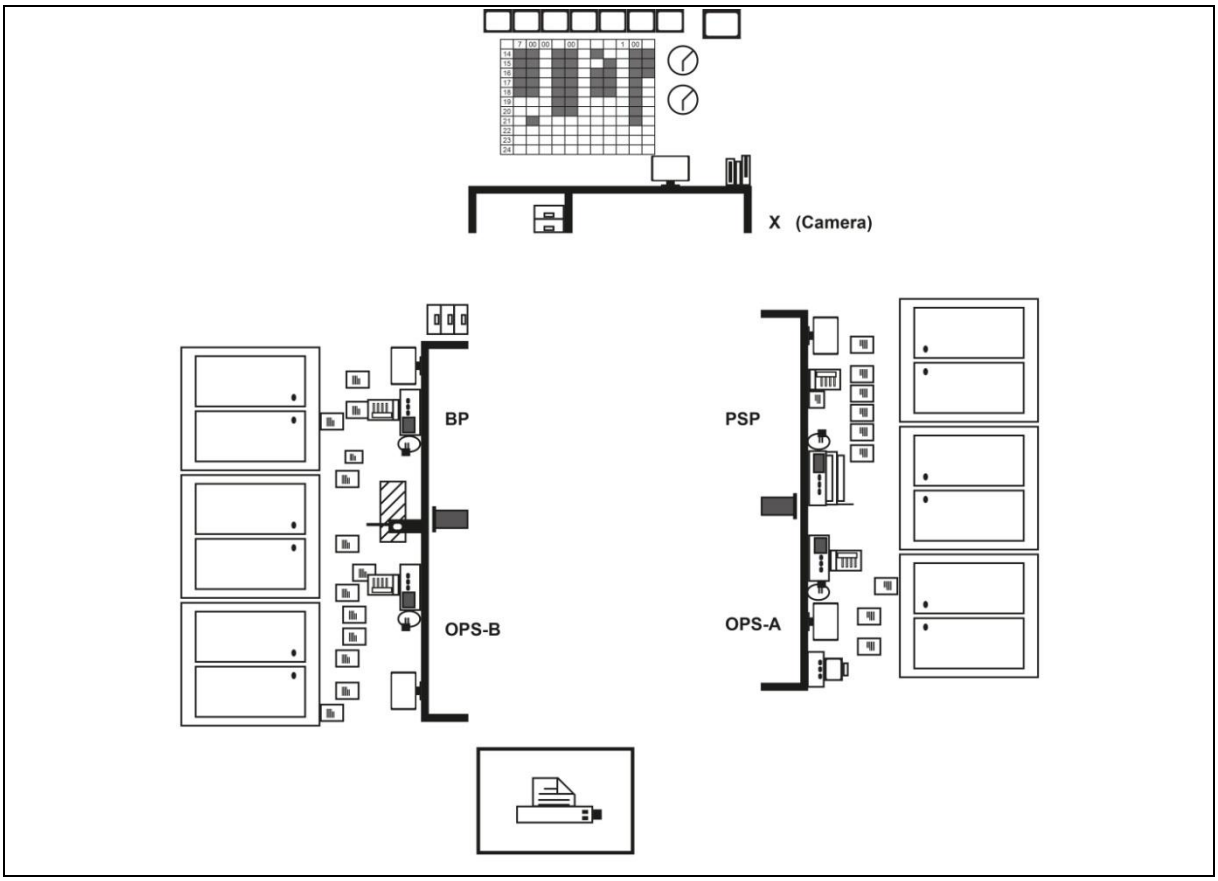

Figure 1. Technology and positions in the ops room.

keys. In addition to cockpit crews and headquarters, ops workers are also in frequent radio communication with gate agents and with the ramp area where the ground crew stands ready to push the exit stairs up to the plane, take care of baggage transfers, etc. (see figure 2).

Ops workers have visual access to the remote gate area through a bank of eight video monitors mounted high up on the back wall of the ops room. These show the situation at each gate via a camera facing the incoming airplane. The camera controls are located above one of the workstations, so that operators can zoom in on a particular plane or pan from one side to the other. This bank of monitors is frequently consulted since it is one major source of information about the state of the real world (as compared to the ideal world of schedules).

In addition to processing information directed specifically at the ops room, there are also information streams aimed elsewhere in the system which the ops room monitors: the two printers are constantly spewing out printed messages that must be scanned for relevance and either discarded, filed, communicated, or otherwise processed. In the auditory sphere, open channels for Tower and Ground Control provide a stream of announcements about planes approaching, landing, on the ground, taxiing, and so on. This somewhat facile description of information processing in the ops room glosses over the fact that "information" does not "come in" in any simple sense, nor is it processed and sent out again as if it were a substance to which an ingredient or two have been added. Rather, in observing activities in the ops room, we witness the moment-by-moment construction of locally meaningful and consequential information out of the special resources this environment provides. For example, we recognize as a collaborative achievement and an artful practice the process by which workers pick a particular set of noises out of the dense "sonic soup" of incoming messages or recognize a particular set of symbols on the screen – but not another set – as relevant to certain ongoing or projected actions.[18] Here, what a given message could mean is a function of what needs to be done with it, of the

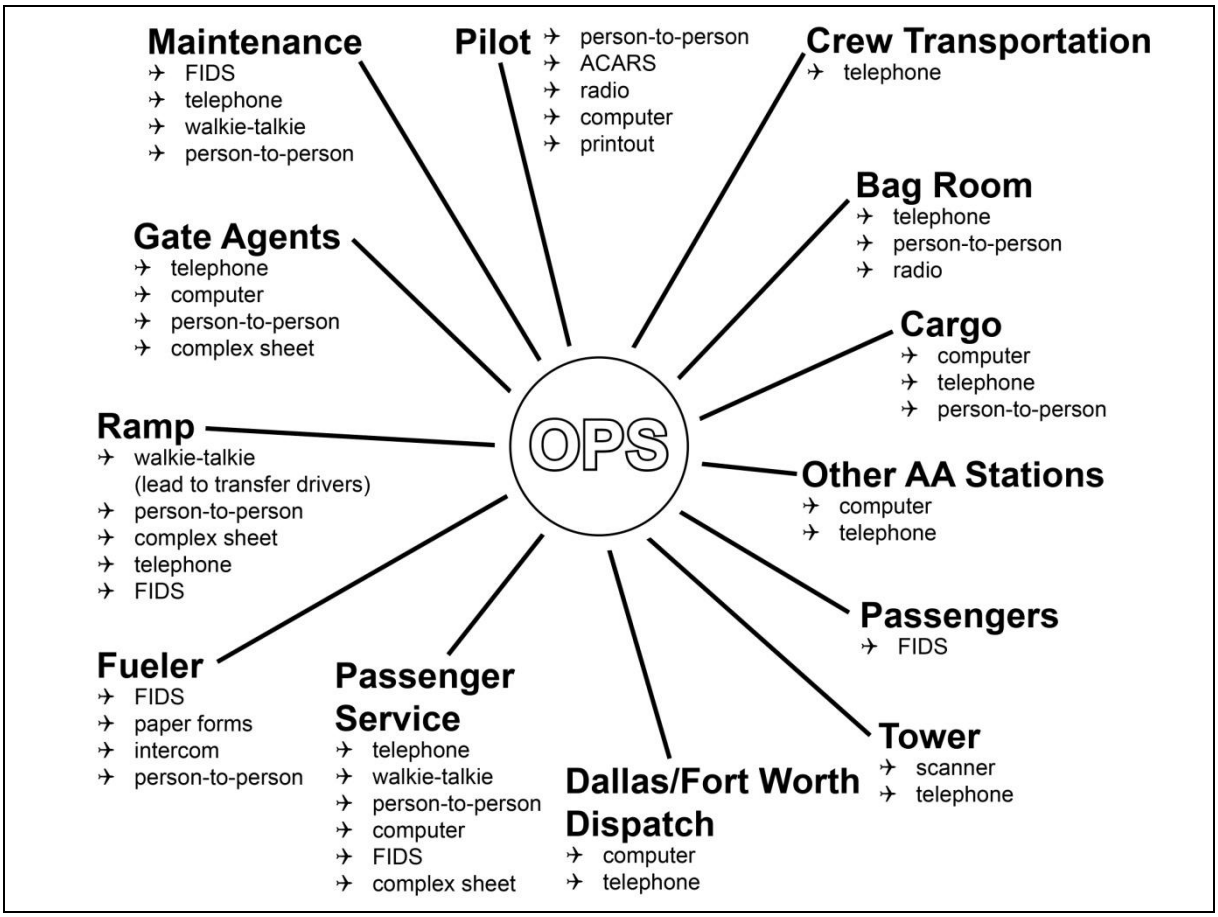

Figure 2. An ops-centered view of the world.

ways in which this information enters into the routine activity sequences that make up the work day. What counts as relevant information, then, is worked out on the spot, in the course of doing the work, and is different at different times and for different ops room workers. In this particular ops room there are four operators and a supervisor (SUP), each of whom has specific responsibilities. For present purposes it suffices to note that the Passenger Service Planner (PSP) communicates with gate agents and ensures that passengers whose planes have been delayed or canceled are rebooked. Operations-A (OPS-A) talks to jet pilots, either by radio or through an onboard computer, while Operations-B (OPS-B) talks to the pilots of Atlantic Hawks, the airline's small commuter planes. The Baggage Planner (BP) communicates with ramp personnel who are in charge of servicing the airplane and moving baggage.

On the day in question, a "routine anomaly" occurred: a series of planes had to be switched around in order to divert one particular plane to a repair facility. Such unscheduled plane swaps are not uncommon, yet are not part of the normal daily working routine. Routine anomalies stand in contrast to major, unforeseen, one-of-a-kind problems that require crisis level measures. Routine troubles may occur with or without advance warning.[19] In this particular case there was ample advance notice, so the problem could be handled, to a large extent, prospectively. Yet, while the desired outcome and, in some ways, the general procedure for achieving that outcome, were clear to everyone involved, the details for handling the contingencies emerging in this particular case had to be worked out as the day progressed. The very working out of such problems contributes to the further domestication of trouble in that it adds to the repertoire of resources available to the team on a next occasion.[20] Much of the videotaped record is concerned with the orchestration of deviations from the usual routine which became necessary because of the switch. The hours preceding the event were shaped by a joint effort in the ops room to come to a shared understanding about what needed to happen and to communicate that

understanding to other personnel who would be carrying out the switch itself as well as instituting various remedial procedures necessary to deal with the ensuing fall-out. The transcript provided in appendix B deals only with a small fraction of those. It is not particularly important that the reader understand the technical details of the switch. As a matter of fact, most any other stretch of this tape would have served just as well to make the points I am going to make. The narrative account which follows is provided, in conjunction with the transcript in appendix B, in the hope of giving the reader some access to the data on which my analysis is based.

The Story of the Three-Way Airplane Switch

On this particular day, aircraft #677, coming in from SEA as flight 1018 and scheduled to go out to SNA under the same number, developed a problem with one of its fuel tanks.[21] Since the facility specializing in the appropriate repair is located in Los Angeles, a decision was made by headquarters to reroute #677 to Los Angeles by assigning it to flight 1091 which had a Los Angeles destination.[22] The original flight 1091 aircraft, #656, was to take out flight 909 to SEA because the aircraft of 909, #676, which had come in during an earlier complex, would be needed to take out 1018 to SNA, the flight which the damaged airplane could not complete (see figure 3).[23]

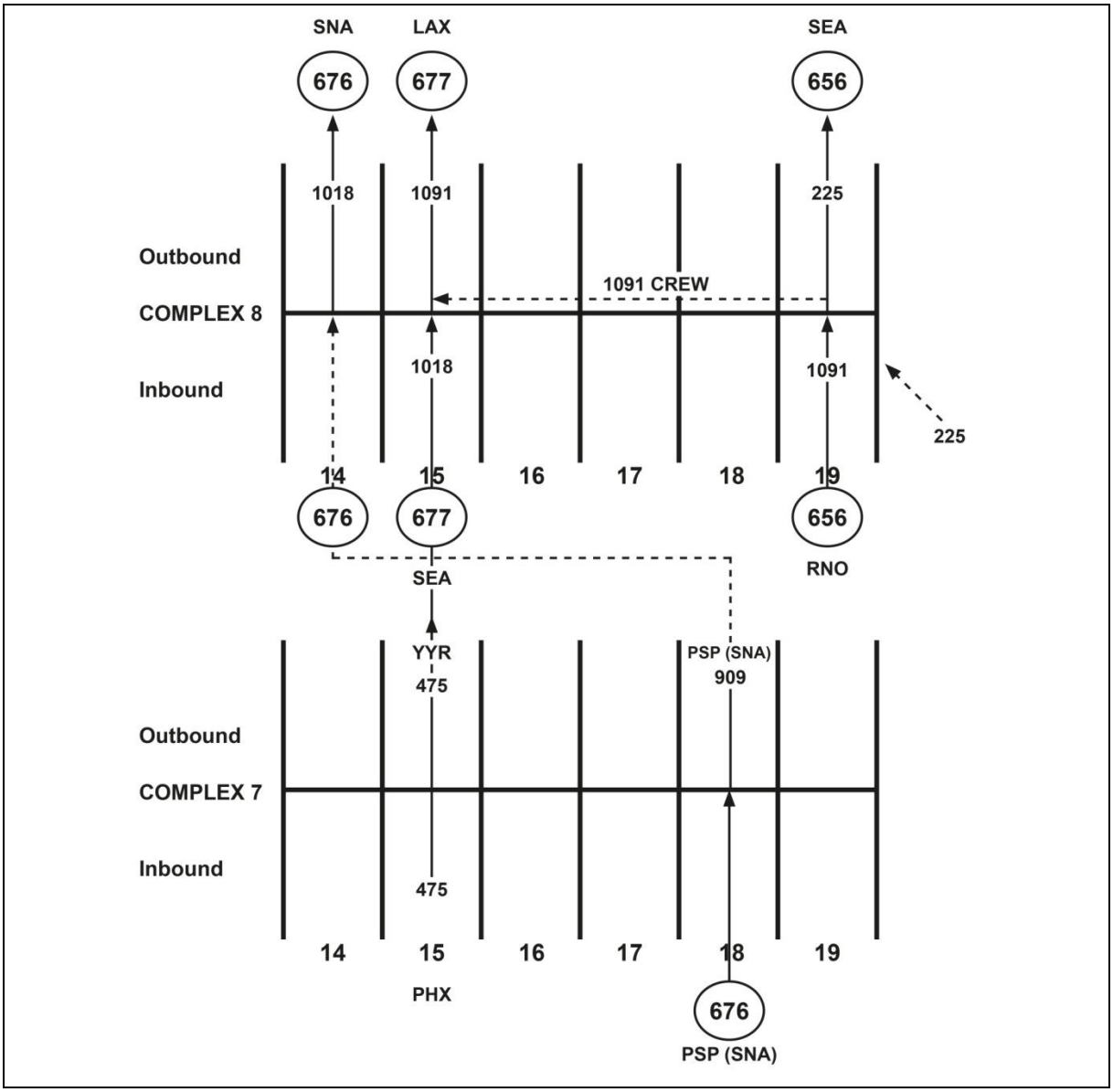

Figure 3. The three-way airplane switch.

So during complex 7, aircraft #676 which comes in as flight 909 does not go out. Rather, passengers and baggage are held till complex 8 when their flight goes out on aircraft 656. Their original plane, aircraft #676, is towed during the slack period between complexes from gate 18 where it arrived during complex 7, to gate 14, from which it will leave during complex 8. The transcript excerpt in appendix B refers to this period between complexes 7 and 8.

As the transcript shows, other flights are affected by these maneuvers. For example, gate 15 needs to be freed for incoming flight 1018 which has just radioed that it will arrive early on this particular day. An extra set of rear stairs has been provided to speed up passenger boarding for outgoing flight 475 but it turns out that these extra stairs can't be used because the Marriott provisioning truck is in the way. Another set of issues revolves around flight 225 which, during the time represented on the transcript, is still in the air but scheduled to arrive at gate 19, with an expected departure time of 19:26. Gate 19, however, at that time will be occupied by aircraft #656 which will take out the delayed flight 909 from complex 7 at 19:40. The crew of flight 225 has to be notified of the fact that they will have a lengthy wait on the tarmac until they can pull into the gate.

In addition, there are other flights arriving and departing which are not directly affected by the 3-way switch but whose demands need to be satisfied as well. For example, at 7:06:29, the supervisor announces the departure of flight 1147 from the gate. A few minutes later, at 7:08:48, OPS-A reads "the numbers" to flight 1147 which is by now taxiing to the runway, waiting to take off.

Access to Technology and the Horizontal Distribution of Knowledge

In contrast to the labor room where there is a division of interest between those who deliver a service (the medical team) and the recipient or object of that service (the woman), in the ops room there is no such distinction. All participants have a similar orientation to the work that is to be accomplished. Here, in contrast to the labor room, access to information-producing artifacts and procedures is not privileged. There is no single technology relevant to the business at hand that is restricted to a particular person or to the occupant of a particular position within the team. We observe all of them, supervisor and operators alike, manipulating the camera controls, talking on radios and phones, looking at computer screens and printouts. While not all of them use all of the technologies with equal frequency and competence (for example, the supervisor is a slow typist), no technology is reserved to one person. This uniform access to the salient artifacts in this workspace constitutes and displays a shared distribution of responsibility and accountability, in fact a joint constitution and constant re-constitution of shared ownership of the work. In the following sections I draw attention to the ways in which the characteristics of the various communication technologies and the organization of the social interaction within the physical workspace provide for the horizontal distribution of authoritative knowledge within a collaborating team.

Joint Production of Shared Information. The ops room is a place where information about the current state of the world collects. The "world" at issue is the world of planes in the air, on the ground, and at the gates and their state of readiness in regard to passengers, baggage, fuel, food, and crews. The work of ops consists in comparing this de facto state to an ideal state as reflected in schedules, and then initiating adjustments of various kinds which bring the current state more or less in line with the ideal state.[24] The ideal state appears in ops documents as SKED, i.e. scheduled time of arrival or departure, the standard against which performance is measured. Approximations to the ideal state are achieved through coordinated efforts between participants in ops-internal operations and between ops and the associated locales which their directives affect.

Though each operator has his or her particular set of tasks and responsibilities to carry out, most of the information coming into the ops room is relevant not to one particular operator but to several or all of them. In like manner, what information goes out and in

what form it goes out is of shared concern. For example, the delay of one plane commonly pulls in its wake disturbances in the departure of others, and it is extremely important that emergent information of this sort be available to everybody in the room as it develops since each of them may be called upon to use that information for updating other parts of the system. By contrast, the woman in the labor room is not a recipient of information about her state as it becomes available through technologies and procedures. The nurse takes her blood pressure without communicating the results; she consults the fetal-monitor without telling her what she sees; when the medical student does a vaginal examination, she tells the nurse in medical jargon what she finds, but not the woman. The staff act as if the only piece of information that could be at all relevant to the woman is whether she can or cannot push. Beyond that, the only information she gets are vague projections like: it'll be soon.

As part of their working routines, ops workers are constantly oriented to determining the "picture," i.e. assimilating and in turn making available to co-workers, information about the current state of the world. As a matter of fact, one might think of them not so much as occupied with the enterprise of gathering information for doing their own individual jobs but rather as engaged in updating the group's collective take. The process of forming and updating their picture of what is going on in the material world of planes, crews, and passengers requires the integration of multiple streams of representations in symbolic, auditory, and iconographic modes into a coherent and in some sense efficacious picture of the relevant material world. This integration is a strikingly interactional achievement and appears to lie at the very heart of successful coordination and control operations in high-tech environments (Heath & Luff, 1991; Zuboff, 1988).

It is no surprise, then, to find the layout and social relations of the ops room organized for the social production and utilization of information. The internally barrierless physical setting and the characteristics of the communications technologies employed are such that much of the incoming and outgoing information is for multiparty listening and shared viewing. Because of the physical arrangement of the work setting, ops room workers are a party to both sides of their co-workers' radio communications; they overhear their phone calls as well as radio information from the Tower and from Ground Control. Furthermore the bank of monitors on the back wall of the room provides a common, public display space where a visual representation of the state of the world at the gates is publicly and simultaneously available to all. The work environment is thus alive with symbolic, visual, and auditory activity which is screened and variously appropriated by workers for their own or co-workers' requirements. In this regard unrestricted access to the various communication technologies is crucial. At the same time, individual work stations make it possible for operators to follow their own paths of activity for stretches at a time.

The often unconscious details of work practices which have arisen in this environment come to support the joint production and use of information. For example, a common feature of communication in the ops room is an initially curious habit of ops room workers to make statements and requests which are, so to speak, launched into the room, offered To Whom It May Concern, rather than being addressed to anyone in particular. Such "outlouds" often generate no immediately visible or audible reaction. This stands in contrast to what we expect in multiparty conversations where speakers, even when they have not specifically addressed another person, count on a response from somebody in the group. If no response is forthcoming, this constitutes an awkward or otherwise implicative "noticeable absence." Under the working conditions of the ops room, on the other hand, certain verbal statements produce no verbal response and this seems to present no problem. In particular, we see no remedial action occurring, such as repetition, apology, and the like.

On closer observation, these outlouds do have consequences. On occasion, somebody in the room self-selects to provide a direct verbal response to the speaker, though often with a considerable time delay. On other occasions, no response is forthcoming for the original speaker, but rather the topic is taken up and verbally relayed, usually in modified form, to

some party outside the ops room. On still other occasions, no verbal response is forthcoming, but some other kind of action takes place which can be seen as responsive to the original statement.

For example, at 7:05:02 [25] the Passenger Service Planner (PSP) says, more or less into the room:

7:05.02	PSP:	That's the last of the people there. He said catering was originally in the way back there, so …	turns to speak into room [re flight 475 at gate 15]

Nobody reacts verbally, but the supervisor goes and manipulates the camera controls, presumably to see for himself if the boarding process is complete. In spite of the lack of overt verbal reaction to the announcement, it is important to realize that the PSP has just provided a critical piece of information relevant to everybody in the room. He was talking about flight 475, a flight that needed to be processed as quickly as possible in order to make room for incoming flight 1018 at gate 15 (see figure 3). Ops had ordered an extra set of rear stairs to expedite passenger boarding, but somehow these had not been used. Apparently the food service truck had been in the way. What PSP is saying now is that there is no further problem and flight 475 can depart immediately.

It is not uncommon that a statement just floats in the room, without visible reaction. Yet there is ample evidence that the originators of such outlouds monitor their fate. In the example below, the PSP's announcement that all passengers have been boarded on flight 475 does not get taken up by the Baggage Planner. PSP follows up with a verbal and physical escalation, showing that he expected BP to do something in return. (For clarity, the excerpt below contains only the exchange between PSP and BP. The full transcript can be found in appendix B.)

7:05.02	PSP:	That's the last of the people there.	turns to speak into room
		He said catering was originally in the way back there, so …	[re flight 475 at gate 15]
		you might wanna tell the ramp-uh	[re flight 475]
		they can go in and probably plan to pull those stairs up (while xxxx)	steps over to BP, who is listening to the radio with headphones and does not react; goes back to his station, looks up at monitors again.
7:05.21	BP:	Okay, yeah, they'll, they'll be told to hold out there at that gate	still talking on radio to crew chief at gate 15
7:05.26	BP:	Sorry, Dave, what (was that)?	swivels on chair towards PSP, now acknowledging his earlier request
	PSP:	We didn't end up using the rear stairs.	turning to BP
	BP:	Oh.	
	PSP:	I guess Marriott's was in the way earlier so-uh and that's the last of the people; we can go ahead and put those rear stairs up.	
7:05.33	BP:	On fifteen?	[re 475]
	PSP:	Fifteen. yes (x)=	

At 7:05.11, PSP follows up his earlier statement which was directed into the room, when he realized that BP had not shown the appropriate reaction. He takes a step in her direction, physically putting himself into her transactional segment (Kendon, 1990) to draw her attention. BP, in fact, does come around after finishing her radio conversation to get the relevant update on the state of the world.

We also find not uncommonly that along with announcements, requests for information are addressed to the room. Sometimes a respondent self-selects to provide an answer. For example, at 6:11.40 (not on this transcript), the PSP says: "Is that two-eleven I see out there at the gate?" In response, the Supervisor goes and manipulates the camera controls, then responds. What addressing such requests to the room does is to signal that some part of the group is not in on "the picture." A response then might consist of a verbal update or a physical action that produces the required information. So we begin to see that in the environment of the operations room, outlouds that have no specified addressee are common and consequential. In generating appropriate actions by one or several respondents, broadcast statements and questions that elsewhere might be taken as random babble or mutterings, can be seen to fulfill important and specifiable functions.

Heath and Luff (1996) found a similar phenomenon in a London Underground Control Room. This is initially all the more curious as there are only two operators. They mention that the Controller frequently engages in what they call "self-talk," a technique that allows him to undertake quite complex changes to the timetable while simultaneously passing information to his colleague who is in charge of updating passengers over the public address system. They note that these outlouds not only provide the necessary technical details to the second operator but also the reasoning used by the Controller in making the particular changes. Other investigators have also found this curious habit in place in work environments where there is a premium on the joint co-construction of the state of the world.

I would suggest, then, that requests which are addressed to the room work because knowledge here is socially distributed. That is, it is embodied in the system as a whole. Requests are produced for the room not so much because workers don't know where the information they need is located and therefore don't know whom to ask, but rather, asking a question as an outloud acknowledges that anybody could hold the answer, given the distributed access to the information-producing technologies and social networks. The answers to questions addressed to the room are produced by co-workers as they become less occupied and able to pay attention

Given the non-hierarchical distribution of informational resources in the ops room, wide ranges of questions can potentially be answered by anybody. Under such circumstances, the selection of the entire group as a recipient ensures that the individual in the best position to respond can self-select, either verbally or with some appropriate nonverbal action. It is thus an extremely efficient, context-sensitive device for accomplishing the continuous updating that the system requires for efficient operation. What we have here, then, is an allocation mechanism that, rather than following a hierarchical distribution of authoritative knowledge, allows the accessing of that knowledge in the most efficient possible way. While the absence of the physician and his authoritative knowledge can bring the ongoing work of the labor room to collapse, the fact that the supervisor might not be there is, for the routine work of the ops room, not a problem. Common access to the salient technologies ensures that, in spite of specialization within a division of labor, any one of the agents is a potential source of information.

Interestingly, it is not only verbal information that is produced "for the room." This is also the case with visual information. We observed operators manipulating the camera controls to display information that is as much or more in the service of a co-worker's needs as their own. In contrast to other communication technologies (on individual video screens or at the other end of a telephone call), verbal outlouds and visual displays are located in a public space, a space that in this environment is actively exploited for the joint updating of the state of the world.

While the hierarchical distribution of authoritative knowledge characteristic of the labor room allows for only one person, or class of persons, to hold the relevant information, the arrangement in the ops room maximizes the potential number of agents available. It also minimizes the chance that the information requested will interrupt other ongoing business since it is provided by an agent who self-selects to respond to the query,

presumably on the basis of an in situ judgment of a not-intolerable work load of his or her own. One could speculate, then, that outlouds constitute a low-technology method of first choice in complex situations of this sort where cognition is socially distributed and knowledge acquisition is a palpably social process.

Joint Error Detection and Joint Problem Solving. A consequence of the shared access to the relevant technologies and the public production of information in the ops room is that participants are constantly engaged in monitoring each other's information needs. They ask each other for help, they offer assistance, and they provide their colleagues with unsolicited pieces of information they have picked up and consider useful.[26]

In the following interchange (not on the transcript). OPS-B requests information from PSP, who is just then manipulating the camera. PSP immediately complies and scans for the needed information:

07:01.59	OPS-B:	How many-uh, David, how many Hawks are out there?	PSP is standing, manipulating camera controls; OPS-B is sitting at his station. Both are looking up at bank of video monitors.
07:02.06	PSP:	Looks like one's taxiing out	Still looking up at monitors; supervisor enters
07:02.10	PSP:	still four ...	eyes still on monitors
	OPS-B:	one's here (xxx)	looks behind supervisor to see the monitors
07:02.25	PSP:	looks like two ... three ... four? at least four there, Randy, and one's taxiing out, so uh-five there. There's five there.	continues to inform OPS-B who is writing

About thirty seconds later PSP corrects his response and informs OPS-B:

07:02.54	PSP:	Actually there's six there now, Randy.

In an earlier example, at 7:05.11, we observed PSP suggesting to the BP that she might want to tell the ramp to pull the stairs. Here help was not requested by the BP, yet PSP provided the information on his own initiative, judging it to be important. An inspection of the transcripts reveals that information and other kinds of help are volunteered on numerous occasions in this environment By contrast, in the labor room available skills of idle coparticipants cannot be used to move the birth ahead. In spite of the fact that there is a nurse present who could do the required examination, the examination is not done because what she might find out is irrelevant to the work to be accomplished.

Constantly engaged in monitoring the state of the world, ops room workers may well notice problems in a co-worker's sphere and be able to initiate a corrective. In the following excerpt from the transcript, OPS-A, talking to flight 1091, gives the crew false information about where they need to go when they come in. The supervisor, who has been wandering around the room, without saying a word draws OPS-A's attention to the mistake which OPS-A then promptly corrects:

7:05.13	OPS-A:	Okay. You'll be looking for aircraft six-seven-six which is here and it's-uh being pulled into gate fourteen right now, so the airplane will be here when you get here.	[to pilot of flight 1091] [false information] turns head, looks up to check info on video monitor

7:05.25	SUP:		swivels on heels, walks back to OPS-A, taps him on shoulder (or points to schedule?)
	OPS-A:	Roger?	
7:05.29	OPS-A:	I'm sorry, disregard. Six-seven-seven. Fifteen.	[to pilot of flight 1091] [corrects mistake]

It is also interesting that the joint, collaborative way in which people share information and go about handling problems in this setting affects the conversational tone that characterizes talk in the room. People typically use mitigated forms of talk. For example, when PSP informs the BP about needing to pull the stairs this is done in a rather polite, non-directive manner:

> You *might* wanna tell the ramp uh they can go in and *probably* plan to pull those stairs up.

There are few direct imperatives; rather we find requests, suggestions and undemanding recommendations for action. This style is shared, to a very large extent, by the supervisor as well who, except in highly charged situations, does not tend to give straight directives either. A typical example for supervisor-worker interaction occurs at 7:03.35 when he makes a request of the form: "Dave, you wanna see if you can find out ..."

In general, there appears to be a prevailing ethos in the ops room which encourages all participants, regardless of rank, to contribute whatever knowledge and expertise they might have to solving the problems the room faces. Given that ops, against the background of its daily and complex-specific routines; nevertheless perpetually has to deal with new and novel problems, nobody's contributions are excluded by virtue of their status in a hierarchy. Openness to multivocality is part of an ethos that values collaboration beyond individual prominence. It is supported by equal access to and use of the work-relevant technologies and is displayed in the joint ownership of the resultant authoritative knowledge.

Mutual Delegation and Assumption of Tasks. Participants in the ops room are not only attuned to each other's information needs, they also actively assume a co-worker's task when that person is otherwise occupied. This is facilitated by what one might call "naturally occurring multi-skilling," distributed expertise in handling the crucial technologies. There are multiple occasions when one operator is temporarily away from his or her work station and another simply slides over to pick up an incoming call, make a required entry, or answer a question. In contrast to the labor room, where division of labor is strictly enforced to the point that even persons competent in a task do not carry it out if they don't have the appropriate job classification, mutual assumption of tasks here is accepted and expected. It is one of the ways in which impasses and bottle necks are largely avoided.

The supervisor seems to incorporate assumption of other's tasks as an integral part of his role in the ops room. For example, at 6:04.10, in a sequence occurring about an hour before the transcript segment (see appendix B), PSP is busy on the phone negotiating the airplane switch, making sure that all parties know what to expect. The supervisor, without saying a word, sits down at PSP's workstation and types, probably making an entry in the computer to update the data base that people might consult. At 6:08.31, PSP terminates his phone call and makes an announcement to the room regarding the switch: "Unfortunately tonight, all three of these flights have through-people that have to get off." Then he turns to the supervisor, thanks him in a soft voice for his assistance, and goes on with the business of alerting co-workers to the impending switch.

At 7:09.10, OPS-B, who has been staring at the video monitor, announces, also into the room, that "475 has pulled the stairs." This is an important piece of information which updates the room about the state of that plane as well as the state of gate 15, which is now

ready for incoming flight 1018. We see that the announcement is consequential; PSP acknowledges it with: "kay", while the BP picks up the radio control from her lap and says into the radio: "475 locked up (and away)," alerting the ramp crew. It is interesting that this crucial piece of information is supplied by OPS-B, the one person who has no direct interest in it since his job consists of dealing with the Hawks, the small commuter planes.

Over and over again in the course of a shift do we see such instances of cooperative work, such contributions to "the picture." We find an orientation to joint ownership of the work and a shared accountability which transcends responsibility for individual tasks and thereby contributes to the collaborative construction of what counts as authoritative knowledge in the ops room.

Participation Structures in Ops. Considering how work is accomplished in the ops room, it comes as no surprise that participation structures are fluid and often overlapping. As contingencies arise and are taken up for notice or action by co-workers, new alignments are constantly created and recreated. Thus we find multiple participation structures that are generated, maintained, and disassembled in response to the requirements of the business at hand.

An interesting feature of activities in the ops room is that there is much interaction that, beyond physically co-present co-workers, involves other parts of the organization in more or less distant places. As we have seen, the work of ops as a communication and control center prominently consists of collecting incoming information, restructuring it in some way, and passing it on again to appropriate recipients. As a consequence, much ops work is necessarily and unavoidably linked to work spaces outside the ops room itself. A look at figure 2 makes clear the multiple, technology-supported linkages to the outside world. The various communication technologies afford a rich variety of social relations and social interactions with a diverse assortment of people, some of them known in person, others familiar as, for example, a voice on the radio. Ops workers, in fact, spend most of their time maintaining extended linkages and exchanges with remote co-workers, only to turn back to interaction with co-workers in the ops room as they conclude an externally oriented exchange. Especially during high workload periods, the default activity for ops workers is preoccupation with and orientation to the outside through their work station. This primary involvement provides the background against which interactions with physically co-present colleagues are produced.

The "time-out" character of in-room interactions becomes visible in the many instances where participants in cross-room communication assume "torque positions" – turning head and torso towards another participant while indicating, in that they do not swivel around all the way to face the other worker, that they imminently intend to go back to their prior activity (Kendon, 1990; Schegloff, 1998). So interaction with co-workers in the ops room is often displayed as an interlude in the ongoing work with externally located co-participants. In that regard, the ops room (and work situations that are structured in similar ways) provide an opportunity to extend the notion of participation frameworks – originally developed to describe face-to-face interaction – to situations where significant exchanges routinely and necessarily take place with persons in technologically connected remote work spaces.

In contrast to the situation in the labor room where the conversation between the medical staff specifically does not allow easy entry for the woman, there is no principled exclusion of individuals in the ops room. All co-workers participate fairly equally – that is, without structurally provided restriction – not only in the flow of communication directly related to work but also in the informal kinds of exchanges that appear in the interstices between tasks or when things slow down between complexes. Stories and jokes appear to involve all those present – as tellers, recipients, and commentators – without exclusion. As in the example below, evaluations of ongoing activities and of problems solved are typically expressed in terms of the work accomplished by the team, rather than as praise or blame directed towards an individual.

7:08.29	PSP:	That sure worked out good to get that airplane moved, didn't it?	glances up at monitor, then turns to OPS-A [re ... 676]
7:08.32	OPS-A:	Huh?	
	PSP:	that plane got over there without getting in anybody's way?	again looking at monitor
	OPS-A:	Yeah.	
7:08.35	PSP:	'ts great.	
7:08.37	OPS-A:	We got lucky that one-eighty-four took a small mechanical (snicker)	[184 was at gate 16] [re 676]

In this light, we see "for the room" statements and questions as one of the mechanisms by which participation structures are displayed as joinable, by which, so to speak open invitations are issued that anyone can take up.

Another difference to the labor room is found in the noticeable absence of the kind of centripetal orientation we saw around the physician which, in multiple and detailed ways, spotlighted him as the focal member. The supervisor in the ops room, on the other hand, is much more likely to be found wandering around between the various work stations, volunteering information and pitching in with required tasks. This is not to say that there is no difference between supervisor and ops workers. The supervisor's authority becomes visible in tight spots, situations where everybody's attention has to be focused on a particular problem. He then orchestrates the coordination of activities by giving direct orders. There are also many non-reciprocal interactions that make the difference in rank clear. For example, the supervisor corrects workers, but we did not see a worker directly correct the supervisor. He has greater freedom of movement than the others: the normal working arrangement has him wandering around, looking at the other workers without being necessarily looked at in turn; he is often standing whereas the others are mostly seated; he can tap someone on the shoulder without being tapped on the shoulder in turn, and so forth.[27] What I want to point to here, then, is not that there is no difference in authority but rather that this kind of nonhierarchical management style produces, and is itself an expression of, an environment in which all participants collaborate in the production of authoritative knowledge. Given that this locally and jointly constructed authoritative knowledge is the basis for decision-making, it is clear that such decisions will mostly emerge from the situation, rather than from the supervisor in the role of gatekeeper.

Authoritative Knowledge and Technology in Two Settings: A Comparative View

I have described two complex, multi-activity, high-technology work settings which differ in how they construct and distribute the knowledge relevant to getting work done. In the labor room, ownership of authoritative knowledge is limited to the authorized staff and distributed differentially and hierarchically among them, while the central participant, the woman in labor, is excluded. In the context of the labor room, medical knowledge is not only privileged, but also supersedes and delegitimizes other potentially relevant information sources such as the woman's experience and the state of her body. This kind of knowledge is suppressed and delegitimized by all participants, including the woman herself. Professional medical knowledge is displayed as based on privileged technical procedures – machine output and test results interpreted by nurse and physician specialists – that provide legitimization for the management of labor and delivery.

By comparison, participants in ops have equal access to the salient communication technologies and procedures, and though there is a pragmatic and historical division of labor, necessary work routines are not privileged. Technology-mediated information is

available for examination and use by whoever needs it. People mutually assume tasks when the situation calls for it. We also noted differences in the style of conversations that take place in the two settings. In the labor room imperatives are addressed to the woman and evaluative assessments of her performance are made, in much the same ways adults treat children in schools. In the ops room, under normal working conditions, people tend to use mitigated language; address requests, not orders, to others; use "we" instead of "you" in describing actions to indicate the shared responsibility; and phrase evaluations in terms of the jointly accomplished work. In contrast to the labor room where much energy has to be expended on suppressing the rival knowledge which is constantly threatening to seep in, here there is no competing knowledge. Rather, the success of the enterprise consists precisely in maximally taking advantage of the different perspectives contributed by team members towards the shared view of the world that constitutes the basis for decision making in this setting.

In spite of the fact that in both settings there are people in formal leadership positions – the physician in the labor room and the supervisor in the ops room – the way participants' statuses are treated differs. There is a clear hierarchy in the labor room. Checking the woman's cervix and deciding whether she can push are duties reserved only for the physician. He does not participate in the earlier stages of the labor. He is awaited. He is paged a number of times, and when not found, every attempt is made to stifle the woman's real need to push the baby out until the doctor can perform the examination and authorize the next stage of the delivery. The woman's body's natural responses are systematically erased and then reconstructed under the disinterested tutelage and coaching of the medical staff. This has the effect of taking away any notion of achievement from the woman, so that, indeed, as the nurse says, they (the medical staff) will "finish this up and have that baby." In the ways in which the woman is led to collaborate in the violation of her body, the abnegation of herself, the misrecognition (in Bourdieu's sense) of her own interests, in all these ways "the way power circulates in the world" (to use Foucault's words) is displayed.

By contrast, the supervisor in the ops room comes in when an extra hand is needed, but he does not make a grand entrance. He tends to slide in and out of the ops room, interweaving with the activities of others, often simply seated within earshot at his desk. Participants do not focus on him in the way they do on the physician; there is neither anticipation nor grossly deferential orienting. He is not framed in the central position, but rather moves in and out of the interactional frameworks of the ops room as the situation requires. He appears to take responsibility for monitoring the situation and is often seen walking around the room, ever alert to what the room requires, making himself available to assist whoever needs him. While he clearly takes charge in touchy situations, the ordinary decisions of the daily work routine emerge out of what is known by everybody about the current state of the world. The supervisor's key competence is the ability to coordinate resources. In contrast to the physician, his primary function here is not that of decision maker or gatekeeper. Rather, he offers an example of what a non-hierarchical management style could look like. Production and use of authoritative knowledge are clearly shared.

The preceding analysis raises a number of issues. For example, is there any sense in which either horizontal or hierarchical distribution of authoritative knowledge is "better?" But to decide this, one first has to answer the question, better for what purposes? In the sense of "more efficient"? Of lower emotional, cognitive, financial cost? Greater satisfaction for participants?

In looking at two settings with different types of authoritative knowledge distribution we have seen some of the consequences. Other questions arise: How common are these types? What other kinds are possible? Is change possible and under what conditions? What changes would (have to) happen in the labor room if the woman's knowledge were to be given a legitimate role? What would happen if in a redesign of the ops room some technology became privileged?

If the two settings are seen as communities of practice what possibilities do they offer newcomers intending to become competent participants? What implications has the differential distribution of authoritative knowledge for legitimate peripheral participation?

As we think about the design and redesign of technology support for human activities, consideration of the role of technology in the production of authoritative knowledge is crucial. It might be particularly interesting to pay serious attention to what it would take to build systems which are sufficiently participatory so that conflicting knowledge systems do not come to grow up.

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Notes

[1] Insofar as authoritative knowledge is unselfconsciously constructed, displayed, and used by participants in their daily interactions, it is similar to Garfinkel's notion of common sense, which he defines as

> the socially sanctioned grounds of inference and action that people use in their everyday affairs and which they assume that other members of the group use in the same way. Socially-sanctioned-facts-of-life-in-the-society-that-any-bona-fide-member-of-the-society-knows depict such matters as ... distribution of honor, competence, responsibility, good will, income, and motives among persons; frequency, causes of, and remedies for trouble; and the presence of good and evil purposes behind the workings of things. (Garfinkel, 1959, p. 57)

Authoritative knowledge differs from Garfinkel's common sense in that, under certain circumstances, it comes to be possessed and exercised by a privileged group.

[2] The project "A Comparison of Supported versus Directed Care during the Second Stage of Labor" was supported by grant # 1-R01 NR 01500-03 NCNR, NIH, DHHS, and directed by Joyce Roberts.

[3] It is worth mentioning here that in less hierarchically organized obstetric systems such official certification is not necessary. In Holland, a country that has vastly better outcome statistics than the U.S., it is a combination of what the woman says and observations of her state by her midwife that determine when it is time to push.

[4] By "privileged" I mean to suggest that access is restricted.

[5] For example, during an arbitrarily selected five-minute segment of the tape we see the nurse look at the EFM 19 times. It would be well to keep in mind that there are alternative sources of information on the state of the labor: one can monitor the woman's experience by observing her breathing and the rising and ebbing tensions in various parts of her body. With a hand on the woman's abdomen it is possible to gauge the

strength of her contractions directly while a simple fetal stethoscope provides information on the fetal heart beat. These are, in fact, methods used in less technologized and less hierarchically organized settings.

[6] Within 17 minutes of the birth of the baby, the woman explicitly states on eight occasions that she has to push. On another 16 occasions during that time, she indicates her inability to resist the urge to push with pleas like: "I can't, I can't."

[7] For an explanation of transcript conventions, see appendix A.

[8] There is much evidence that non-answers of various sorts are a common strategy for dealing with women in obstetric settings. For example, Kirkham, who observed 113 labors, describes similar responses in labor wards in the UK. She cites the following as a typical pattern: Woman: "How long?" Nurse: "Not long." Woman: "How long is that?" Nurse: Silence. End of conversation. Or changes subject (Kirkham, 1988).

[9] We can speak of the woman as "losing control" – and see her as "losing control" – only if we subscribe to the view that she should shape her behavior according to what the medial staff require of her at this time. Within another framework, e.g. one that sees pushing as precisely what her body should be doing at this stage, she would simply be doing what she is supposed to be doing. I find it personally disturbing that I myself did not see the absurdity of this formulation until it was pointed out to me. This is just one of the ways in which, to use Harvey Sacks' expression, culture has us by the throat.

[10]Subscribing to the "he he he hoo" generates a double bind for the woman. If the pain gets so intense that she cannot maintain the pattern, her abandoning it tells her and her attendants not only that she is now "out of control" but also that she did it, that by abandoning the Lamaze breathing she made herself lose control. The common reprimand: "If you had done your Lamaze, you wouldn't have lost control" is true by definition.

[11]For the transcripts from which this and all following examples are taken please see appendices A and B.

[12] The numbers in transcripts represent (hours:)minutes.seconds since the start of the videotape.

[13]I first drew attention to the operational bifurcation of the woman's body in hospital deliveries in Jordan (1987b).

[14]Kirkham contrasts "waiting on doctors" with "waiting on the labor," which, she says, good midwives do when they are in charge of birth. They take their cues from the woman in labor, whereas for the vast majority of women whose labors she observed, the cues they gave and indeed their specific requests were ignored. Midwives and occasional doctors who waited on the labor, on the other hand really listened to the woman. Such listening is rare in most hospital settings because the staff's primary responsibility appears to be listening to and waiting on the doctor.

[15]All proper names are pseudonyms.

[16]I am indebted to Charles Goodwin for this figure. I am indebted to Klaus Rögner and Matthias Kating for their assistance in re-formatting the manuscript.

[17]ETA: Expected Time of Arrival.

[18]Bregman, in a recent book entitled auditory scene analysis: The perceptual organization of sounds, suggests a mechanism he calls auditory stream segregation in which pitch plays a major role. He notes that mixing a spoken word from one speaker with the babble from many others buries the frequency characteristics of the word in a spectogram, yet a speaker may still be easily understood if the pitch of the utterance is sufficiently different from the pitch of surrounding conversations (Bregman, 1990).

[19]A problem that occurred in this ops room without advance warning is analyzed in Suchman and Trigg (1991). A plane's exit stairs had become inoperative and in that case resources had to be mobilized on the spot.

[20]Barley (1988) gives a detailed account of this process in a different professional community. He describes how the operation of initially experimental, unfamiliar technology becomes routinized and absorbed into the standard practice repertoire of a professional community. A salient part of this process is the routinization of anomaly, i.e. learning by experience which kinds of troubles tend to re-occur and what range of resources can be assembled and held available for their solution. Similarly, Koenig (1988) analyzes the processes involved in "the social creation of 'routine' treatment" as new methods for therapeutic plasma exchange are introduced. In these studies and others of a similar vein it becomes clear that the relevant knowledge is not available through formal instruction but is co-constructed within communities of practice as actors appropriate the new technologies and what they afford.

[21]Ops room personnel may refer to the same plane by three different numbers: the flight number (e.g. 1018), the gate number (e.g. 15), or the aircraft number (e.g. 677). The latter uniquely identifies the plane as a physical object to which plane-specific performance and repair statistics can be traced.

[22]In ops room parlance, "677 takes out 1091."

[23]I am indebted to Teresa Lewandowski for this figure.

[24]This insight into the gap between the world as it should be and the world as it actually is encountered and managed by on-the-ground actors has remained a guiding principle in our understanding of systemic issues in corporations and other large organizations (Jordan, 2011; Jordan & Lambert, 2009).

[25]For complete transcript segment and explanation of transcription conventions used see appendix B.

[26]Again, we find striking parallels in Heath's work in the London Underground Control Room where there is a similarly pervasive orientation to updating "the room" (Heath & Luff, 1996).

[27]I am indebted to Phil Agre for some of these points.

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Appendix A:

Transcript of Labor Room Activities

Wom:	Woman in labor
Nur:	Obstetric Technician
Hus:	Husband
Y:	female voice off camera
YMed:	female medical student
Doc:	physician

UPPER CASE	emphasis, loudness	(xxxx)	inaudible material
a :::::::	lengthened sound	(coming)	transcriber's guess
[ ]	untranscribable sounds	[	overlapping talk

Note. much of the talk and other verbal productions are overlapping. Overlaps are not consistently indicated on transcript.

Numbers on transcript represent minutes and seconds and correspond to the following format on tape: xx.MM.SS.xx, e.g. 00:19:09:16 appears in transcript as 19.09. We are 14 minutes from the birth of the baby, 19 minutes after videotaping started.

		Talk	**Activity**
19.09	Wom:	o:::::h::: [	
	Nur:	try not to curl your toes	nurse rubs the woman's toes, then leans over her, looking briefly at EFM, hands behind back
	Wom:	I can' hhh I can', I feel like I gotta push	
19.13		hu::::h	
	Nur:	you can pretty soon oka::y:?	intonation as if speaking to a child
	Wom:	N::O:::W hu:::h hu::::::h, hu:::::h, hu::::::h	woman obviously in pain
			nurse moves hand next to woman's face
			woman wipes her face with a washcloth

19.20	Nur:	I'm gonna have them come and check you and we'll see if you can. Oka:y? Do the same thing use this rest period in between 'khay?	
			nurse looks towards door, then looks at EFM; exits
19.29			
	Wom:	[pain sounds, stressed outbreaths]	breathing slowing down, turns head towards husband
		K:E:N:: uh o::::::::h::: [	
19.39	Hus:	right here	husband comes and stands next to woman's bed, leaning towards her
	Wom:	[rapid pattern Lamaze breathing he he he hoo	nurse comes back in, glances at EFM, then at woman; stands next to bed,
19.50			leaning over woman
	Nur:	'khay. Ruth come on	glances at EFM
	Wom:	he: he: he: hoo	
19.56		he: he: he: hu:h I can't	breathing hard, barely maintaining control
	Nur:	look at me he he he hoo	nurse is leaning over woman, mouthing the Lamaze breathing pattern
	Wom:	[attempts he he he hoo pattern]	woman increasingly distressed
	Nur:	he he just with your mouth just come on [	looking at woman
20.02	Wom:	I can't hu uh [	
	Nur:	look at me, try that's all you can do is try	
	Wom:	he he he hoo:	
20.10		HOO::::::::hh, he uh [	nurse glances at EFM
	Nur:	come on it's at the peak	leaning over woman
	Wom:	he he he he he hoo [	
20.15	Nur:	good	glances at EFM
	Wom:	he he hehoo [	
	Nur:	oka:y it's going down [	soothing voice
	Wom:	he he he-he [	husband is still standing next to woman, looking at her; she is looking at nurse
	Nur:	it's a smaller contraction	
	Wom:	HOO::::::::H:::::::: [	woman sounds like she is in great pain
	Nur:	almost gone [	insistent voice
	Wom:	OO:::::H:::::	
	Y:	(xxxx)	woman wipes her face with washcloth nurse straightens up, turns away from woman to someone off camera
20.23	Nur:	U:h-make sure Terry's got the house staff (coming/called) okay?	with smile in her voice and on her face
	Y:	(xxxx)	
	Wom:	[moaning, in pain]	
20.33	Nur:	she called them (with the information) they should be. here any minute [	to Y off camera
20.37			nurse turns back towards woman, glances at EFM, wipes nose with left hand
	Wom:	O:H::::: no::::: hhhu:::hh	sounds despairing husband looks on silently

		I::: ca:::n::::'t	
20.41	Nur:	almost finished a cleansing breath oka:y?	leans down to woman again, speaking in low, almost intimate voice
	Wom:	[heavy in-and exhaling]	
20.47	Nur:	let's just say you can: oka:y?	leaning over woman
20.53	Wom:	o::::::::::, no: no: no:::	moaning in pain
	Nur:	[	looks at EFM
	Nur:	one cleansing breath big deep sigh? [	as if talking to a small child
	Wom:	o::: :::h [heavy exhaling)	
	Hus:		adjusts woman's cover in a soothing way
	Nur:	good	
		now rest up save your energy for this next contraction okay? [	woman puts washcloth on her face
	Wom:	OH:: I ca::::n::'t	
	Nur:		scratches her upper lip, adjusts EFM output, looks at EFM
21.05	Wom:	uh-huh ay:ay:ay:ay:ay:ay:ay:ay: ay:ay:ay:ay:ay:ay:ay ay ay [exhales]	 rhythmic pain sounds nurse writes in chart on top of EFM, glancing back to check clock
	Hus:	you want some ice?	woman pats her face rhythmically with washcloth, indicates "no"
21.17	Wom:	I just wanna push	
21.19	Nur:	I know it won' be long it'll feel better for you to push but in the meantime I don't want you to okay'?	speaks to woman without looking at her while writing in chart leans towards woman and whisper emphatic
21.27	Wom:	NO:::H: I can't help it [exhales] [	
21.28	Nur:	Let's make sure that cervix is completely gone oka:y just try it that's all I ask(xxx)	singsong voice looks at EFM, then starts writing
	Wom:	0:::::o:: o:: H::: K:E::::N:	moaning in pain and distress, turns towards husband, lifts head
	Y:	Sue:	off camera
21.44	Nur:	yea::h	continues writing without looking towards speaker
	Y:	She said she paged him a second time (and she wasn't sure he's coming) so I'll just wait here(xxx)	
	Wom:	0::::o::::o::I:::I can't I can't::: He he he he he	briefly lifts her head begins a new round of rapid Lamaze breathing
22.00	Nur:	good	
	Wom:	he he he hoo he he he hoo he I::no:: no::	lifts head and upper half of her body in pain
22.10	Nur:	he he he hoo he he he hoo he he he hoo he he he hoo	bends over woman, insistently modelling Lamaze breathing
	Wom:	he he hoo he he he hoo he he he hoo he he he hoo	attempts to breathe in unison with nurse

		I:o:: no::no::no::	
22.17	Nur:	(xxx) away it's at the peak he he he hoo	glancing at EFM woman in great pain,
	Wom:	no::it's not: he he he he he O::::::::::O	barely able to keep up Lamaze sounds
	Nur:	come on he he he hoo he he he hoo (xxx) okay	sounding ever so slightly impatient
22.22	Wom:	he he he he hoo::::o he he he he hoo he he he hoo HE::HE::HE::HOO O::he he hoo	cannot maintain nurse's rhythm, her sounds fall in between those of the nurse
	Nur:	it's past the peak easing up going away she needs to be checked	sing-song voice turns back toward YMed who entered the room
22.38		this time	to YMed
	YMed:	ahm: (xxx)	
	Wom:	O:::: o::go::d O:::::o O::::::o	
	Nur:		talking to YMed while moving away from bed, off camera
22.44	YMed:	actually (xxx) and (Jim) is coming	both YMed and Nur are off camera talking, moving something
	Nur:	(xxx)	
	YMed:	first things first	
	Wom:	O::::::o (XXX) plea:::se	wiping her face heavy pain sounds
22.53	Hus:		moves off camera
	Wom:	O:::::o	
	Nur:		both approach bed. YMed puts a glove
23.00	YMed:		on her hand, Nur squeezes some jelly from a tube on YMed's finger
	Wom:	plea:::::se	
23.05	Nur:	we'll check you now, okay? see if your cervix is completely dilated	lifts sheet from woman's legs, steps out of the way
	Wom:	[moaning, heavy pain sound)	
23.13	YMed:	okay [	approaching lower part of woman's body
	Wom:	[moans]	
	Nur:		positions herself to mark EFM graph
23.19	YMed:	rest for me, okay? deep breath	inserts hand, looking up while performing the check
	Wom:	[heavy outbreaths]	
23.30	YMed:	head's down (xxx)	singsong
	Nur:	good.	marks the EFM output sheet
	Wom:	O::::o no:: no::::::::::::o	
	Nur:	plus one?	while marking EFM output
	YMed:	yes	
	Wom:	no::::	outbreaths, moaning
23.40	YMed:	can you open your legs a little bit more for me	to woman
	Wom:	aye I gotta::::aye:::hm::::	breathing heavily
23.50	Nur:	okay. he he he hoo	bends over woman breathing with her wipes her forehead with a towel
	Wom:	he he he hoo he he he hoo	

		he he he hoo	
23.54	YMed:	open up for me	continuing with examination
	Wom:	he::AYE::::AYE::AYE::::::	increasingly desperate pain sounds lifts her head
24.00	Nur:	come on he he he hoo come on	models breathing wipes woman's forehead
	Wom:	A::::o:::	
	YMed:	I'm not sure she is pretty close to (complete)	to nurse; pulls off glove
24.04	Wom:	AY:::::	shouting in pain
	Nur:		arranges the sheet back on woman's legs while talking to YMed who moved away
	YMed:	(xx) right now	in a light voice
24.11	Wom	he he::HURRY:::	raises voice even more, heavy breathing
	Nur:	almost gone she thinks you might be completely done okay?	takes woman's hand whispering
24.24	Wom:	O::::::::::o	
	Nur:	it's almost time to have this baby	[camera moves in for close-up and moves back]
	Wom:	GO::::d:::::: why don't they hurry::::	
	Nur:	(let's put your bed up)	sound of some electric adjustment
	Wom:	O:::::w:::::::: I want something for the pa:::in	slaps her own forehead moaning heavy outbreaths
24.50	Nur:	 you almost finished it's, it's probably too late for anything, okay? [	feeds woman some ice chips with a spoon puts the glass with the ice away
	Wom:	[moaning]	
24.58	Nur:	you just gonna have to wait okay? that's it you're almost finished	wipes woman's face with a towel writes in chart
25.05	Wom:	KE::N	outbreathing, crying
	Hus:		comes over and stands next to bed nurse is writing in chart
25.15	Wom:	A::::ye:::: he he he aye::: he he he:: he he he hoo he he he hoo he he he	 raises upper body heavy breathing
25.27	Nur:	go ahead Ruth good	puts pen in pocket, turns back to woman
	Wom:	I can', I got to push	
25.30	Nur:	okay, open your eyes he he he hoo he he he	bands over woman her hands behind her back
25.34	YMed:		goes toward EFM and observes output
	Nur:	just with your mouth not your chest	
	Wom:	[he he he hoo he he he hoo I CAN'T O::HO:::::	sounds of pain together with nurse very loud cry
25.45	YMed:	she starting to push yet?	to nurse
	Nur:	not yet, but it's right here (xxxx)okay?	points to EFM output turns to YMed as the YMed takes off her white coat and walks away, short inaudible exchange between them

		[	
	Wom:	O::HO:::::	crying, heavy breathing
25.51	Nur:	almost gone it's past the peak easing up	to woman, bending over her sing-song voice, trying to be soothing·
	Hus:		walks away from woman's bed
	Wom:	KE:N where are you going?	loud voice
25.57	Hus:	I'll be right here	
26.00	Nur:	good job you almost done it's almost all over	to woman, after briefly looking toward husband wipes woman's face with towel
	Wom:	oh go:d	
26.12	YMed:		approaches EFM and observes the output
	Nur:		moves off camera (to see about the page?)
	YMed:		takes over
26.18.	Wom:	I can't I have t'pu:::sh	YMed is standing by bed, hands on hips, then puts one hand on woman's knee
26.25	YMed:	NO::: listen take some deep breaths deep breaths right now (x gonna get) someone to check is gonna see if you can push okay? she's gonna (do it) right now [	 voice patterned, with a rehearsed quality one hand on the woman's knee, rubbing it
	Wom:	[breathing heavily]	
	YMed:	I don't know why somebody (xxxx) (giggles) he is supposed to follow me, you know when you're paged	turning away from woman, speaking to nurse in a chatty tone of voice
	Nur:	YEAH	woman lifts her head as if trying to see what they are doing
26.44 26.46	YMed:	while one was right behind me and-uh he left (chuckles)	 turns back into woman's direction and adjusts face from "laugh face"- to professional demeanor; looks at EFM Nurse back in, takes over again
	Wom:	[moans]	inaudible conversation between nurse and YMed; nurse walks to monitor, checks clock and starts writing.
26.56	Wom:	O:h god where are they he:: he :	desperate
	Nur:	I know we're almost there	nurse puts her pen in her pocket speaks in a pitying voice, while leaning over woman
	YMed:		moves off camera, in response to doctor's entry?
	Wom:	[high pitched pain sounds, sobbing, in- and exhales heavily]	
	YStud:	We got it	off camera
	Doc:	'kay	off camera
27.09	Doc:		doctor walks in, followed by male medical student who is carrying a white coat; doctor approaches the bed without looking at the woman or speaking to her; immediately goes to EFM; pulls up output and glances at it.
	Wom:	I can't	
	Nur:	come on he he he hoo he he he hoo	leaning over woman

		he he he hoo [	
	Wom:	he he he hoo he he he hoo he he he hoo he he he hoo	struggling desperately to maintain the pattern; great urgency in her voice
27.20	Doc:	hmh	inaudible conversation with YMed who holds out·a glove for him
	Wom:	AYH AYH he oo	nurse is wiping woman's face with the washcloth
27.26	Doc:	thanks. okay	to YMed doctor walks towards monitor, drops glove wrapper on EFM
	Nur:	good perfect, Ruth	leaning over woman, turns head to look at EFM
		past the peak going down, slowing down	singsong voice
	Doc:		pulls glove onto right hand, participants arrange themselves to frame him: he looks around, then goes over to turn spot lights on
	Nur:		looks back at doctor, straightens up away from woman, tracks doctor's actions
	Wom:	[moaning] O::h, I gotta pu:sh:	doctor approaches woman; looks at her for the first time since entering
27.49	Doc:	let me check you before you get another contraction okay? let's see if you can push come on over [	nurse walks to EFM, shuffles papers, starts to write but doesn't doc uncovers the sheet over woman's legs
	Wom:	ey: I can't:	
27.58	Doc:	come on	cajoling tone, like to a child
27.58	YMed:	he is checking to see if you can push okay? so try to relax some deep breaths here	in instructional voice, with a rehearsed quality leans over woman and rubs her shoulder
28.00	Doc:		starts examination
	Nur:	take a deep sigh now (one or two xx) [	low whispering voice leaning very low over woman, holding her hand
	Wom:	[heavy breathing and moaning]	
	Doc:	(Yeah I know)	to medical student, in a low voice
	YMed:	(xxxx)	
28.10	Doc	Yeah she can push	to nurse
	Nur:	can she? plus one?	looking up at doctor getting ready to write
	Doc:	yeah plus two	nurse writes in chart
	Wom:	Oh :NO::::	in pain
28.15	Nur:	you can push it'll fee good	to woman, with relief, like a good news announcement
	Wom:	uhoo::::::::::	woman moaning in pain nurse straightens up
28.16	Doc:	just get her just go ahead and get her into (the lithotomy position)	woman continues moaning nurse and medical student start to prepare woman for the delivery.
28.20	Nur:	okay, Ruth, go ahead and just bear down. Put all you're worth into your next contraction, okay?	

Appendix B

Transcript of Ops Room Activities

BP:	Baggage Planner
SUP:	Supervisor
OPS-A:	Operations A (in charge of jets)
OPS-B:	Operations B (in charge of commuter planes)
PSP:	Passenger Service Planner
(xxxx)	inaudible material
(zero left)	possible hearing
:::	lengthening of preceding sound
- - - -	(underline) stress
=	"latched to" preceding utterance (ending with =) without normal pause.

Note: much of the talk and other verbal productions are overlapping. Overlaps are not indicated. Most Tower and Ground Control radio communications are not transcribed. "Pilot" here means the person on plane who works the radio, most likely the First Engineer or copilot. The time is indicated in minutes and seconds just after 7 pm on a Wednesday evening. All proper names are pseudonyms.

		Talk	**Activity**
7:04.58	BP:	Sorry. Ten-ninety-one just moved to nineteen (xxxx) nine-oh-nine and two-two-five will hold for gate nineteen	on radio to Redge, crew chief at gate 19
	SUP:		walking around in room, glancing at work stations and activities
	OPS-B:		looking up at video monitors
	PSP:	Okay, you just about got everybody on? Okay. Alright. Thanx.	[to gate 15] puts phone down, still looking up at monitors
7:05.02		That's the last of the people there. He said catering was originally in the way back there, so	 turns to speak into room [re flight 475 at gate 15]
7:05.03	OPS-A:	Uh-yes. The airplane will go on to Seattle-uh. You guys are-uh continuing on ten-ninety-one, right?	on radio, talking to aircraft #656, flight 1091, coming into gate 19
7:05.04	SUP:		walks towards PSP's work station, works camera controls, looking up at video monitors
7:05.11	PSP:	you might wanna tell the ramp-uh they can go in and probably plan to pull those stairs up (while xxxx)	[re flight 475] steps over to BP, who does not react; [she is listening to radio on head phone]; goes back to his station, looks up at monitors again.
	SUP:		walking around the room, hands in pockets
7:05.13	OPS-A:	Okay. You'll be looking for aircraft six-seven-six which is here and it's-uh being pulled into gate fourteen right now, so the airplane will be here when you get here.	[to pilot of flight 1091] [false information] turns head, looks up to check info on video monitor
7:05.21	BP:	Okay, yeah, they'll they'll be told to hold out there at that gate	still talking on radio to crew chief at gate 15
7:05.25	SUP:		swivels on heels, walks back to OPS-A, taps him on shoulder (or points to schedule)
	OPS-A:	Roger?	

7:05.26	BP:	Sorry, Dave, what (was that)?	swivels on chair towards PSP, now acknowledging his earlier request
	PSP:	We didn't end up using the rear stairs	turning to BP
	BP:	Oh.	
	PSP:	I guess Marriott's was in the way earlier so-uh and that's the last of the people; we can go ahead and put those rear stairs up.	
7:05.29	OPS-A:	I'm sorry, disregard. Six-seven-seven. Fifteen.	[to pilot of flight 1091] [corrects mistake]
7:05.33	BP:	On fifteen?	[re 475]
	PSP:	Fifteen. yes (x).	
	OPS-A:	U::h	
7:05.34	SUP:	=Two-two-five, (Dave)?	looking at OPS-A
	PSP:		In rapid sequence, looks at monitor, manipulates camera controls, types into computer
	OPS-B:		picks up a piece of scrap paper and makes a note.
	OPS-A:	will be ten-ninety-one and he'll be touching down in about five minutes.	turns face up to supervisor
	SUP:	Is that two-two-five?	to OPS-A
	OPS-A	No.	
7:05.39	BP:		takes drink from pop can, looking up at monitors intermittently
	SUP:	If he calls in he's gonna have a wait till forty for a gate	[to OPS-A] [i.e. till 7:40 pm for gate 19] walks towards monitors
	OPS-A:	Okay.	[to supervisor] looks up at video monitors
7:05.43	SUP:	or longer	looking up at monitors
7:05.47	PSP:		turns head away from monitors, looks down to desk; possibly receiving radio call over ear phone
7:05.48	BP:	Kevin, (you guys gonna xxxx)	[re 225] turns towards OPS-A in chair, holds torque position
7:05.50	PSP:	Whenever we get-u::h	looking down at his desk
7:05.51	OPS-A:	Oh they turned the tug around, is that what they're doing? And hook back up again?	[re #676 move], glance to monitor, then to BP
	BP:	(uh-huh pull) and drive forward into the gate there	talking to OPS-A
	OPS-A:	U::h	
7:05.55	PSP:	Go ahead	raises head listening to radio, bends down to write on desk
7:05.59	BP:	You guys gonna tell the-uh cockpit on two-two-five (they're gonna hold, so they don't go zooming in here)	[re 225]
	OPS-A:	If he <u>calls</u> me	
7:06.03	SUP:		working camera controls
	BP:	Yeah	nods, turns back to her work station, looks at monitors
	PSP:	Thank you.	into radio, leaning down onto his desk, making a note
7:06.06	SUP:	He won't have anywhere to go anyway	looking up at monitors [re 225]
	OPS-A:	He can't zoom in anywhere cause twenny-one's full, so:: hhh:	[re 225]
7:06.13	OPS-B:		gets up and takes output from printer
	BP:	no, nineteen's (the one xx)	to OPS-A; turns back to her work station, looks down at her complex sheet
	SUP:	(xx there's gonna be somebody in there pretty soon.)	walks away from camera controls, hands in pockets
7:06.16	SUP:	So. the barn will be full when he gets here.	turns around to look at monitors again
	BP:		types on keyboard with single fingers of left hand

	OPS-B:		looks at output and rips it up
	SUP:		works cameras, looking at monitors
7:06.29		Eleven-forty-seven's gone.	[freeing gate 20 for 1161]
	PSP:	Excuse me, I'm sorry	[into radio, re 1161, complex 8] types furiously, makes a note, types again
	OPS-B:		types briefly, looks up at monitor
	BP:		writes on complex sheet, erases
	SUP:	(fairly inaudible conversation with ethnographer who is off camera)	
7:06.39	OPS-A:	Okay-uh, ten-ninety-one will be here at eighteen. So that forty oughta work pretty good for nine-oh-nine outbound.	[ETA at 7:18 and ETD at 7:40pm]
	PSP:	Yeah. 'kay.	into radio
	BP:	(Brad's) gonna be a little upset	
	SUP:		turns toward BP
7:06.57	PSP:	eleven sixty-one was out of LA on time but he's 14 minutes late getting here.	[to room, re complex 8] brief glance at OPS-A. BP marks her complex sheet, OPS-A updates FID screen and complex sheet.
	SUP:	(joking remark to BP: He normally works till eight. He can leave early. They both chuckle)	turns around, looks up at monitor, yawning
7:07.08	PLT:	San Juan ops ( ) fifty-one forty-one	[flight 5141, plane #359, complex 8] [mechanical problem]
7:07.11	OPS-B:		picks up radio handset
		This is San Juan go ahead please ( ) fifty-one forty-one?	
	PSP:	he'	working camera controls, looking at monitors
7:07.13	PLT:	Would you call (the barn at eight and send xxxx)	
	OPS-B:	I sure will. Thank you.	[re 5141/ plane #359] picks up phone, dials 7-digit number glancing at info sheet tacked up above him
7:07.16	OPS-A:	Let's see. Whadda we got. I don't know any of those people. Who's? Oh, that's Ed Mitchell. Nyuh? He's usually a pretty laid back guy, isn't he? (pause) Isn't he?	[OPS-A may have pulled up crew sheet for 1018 on computer] into room, looking at video monitors
	PSP:		opens yellow marker and marks complex sheet
7:07.18	SUP:		walks off camera
	BP:		types computer entry with both hands
7:07.30	BP:	(Isn't he) a chief pilot or something?	turns head to left, continues typing
	OPS-B	He used to be	
	OPS-A:	long time ago, yeah. I talked to him .a couple of times (during pilot training) he's pretty nice guy	turns into room
	PSP:		continues to look at monitor and check off planes on complex sheet. Closes marker. Picks up complex sheet and makes entry on computer
	OPS-B:		typing while holding phone to ear, waiting for answer
7:07.54	TWR:	Heavy ten-eighteen San Juan Tower clear to land runway three zero left	[first plane from complex 8 from Seattle landing 20 mins early]
7:08.00	OPS-A:	ten-eighteen's cleared to land for fiftee:::n.	
	PLT:	Ten-eighteen (pause) on the-uh visual three zero left	
	TWR:	Landing ten-eighteen San Juan Tower clear to land runway three zero left traffic two	

		miles right base turning final is a metro liner at one thousand. (He'll land) on three zero right.	
7:08.03	BP:		picks up radio control with right hand
7:08.10	OPS-B:		redials
	BP:	ten-eighteen is cleared to land for gate fifteen.	drops radio control in lap, types
7:08.17	OPS-B:	Hi, Charlie, this is Randy in ops? Uh- Mitchell just landed three-five-niner looking for a mechanic and called. The Hawks maintenance (and then went) down there, so if you happen to see one tell them that three-five-niner is going down there (when he comes in) alright? Thank you	on phone [re 5141/plane #359] hangs up, turns toward room, looking up at monitors
	BP:		looking at computer screen and making entries in complex sheet
7:08.29	PSP:	That sure worked out good to get that airplane moved, didn't it?	glances up at monitor, then turn to OPS-A [re #676]
7:08.32	OPS-A:	Huh?	
	PSP:	that plane got over there without getting in anybody's way?	again looking at monitor
	OPS-A:	Yeah.	
7:08.35	PSP:	'ts great.	
7:08.37	OPS-A:	We got lucky that one-eighty-four took a small mechanical (snicker)	[184 was at gate 16] [re #676]
	BP:		moves paper to left of her work area; types with both hands
7:08.46	PSP:	today one	turns to station, picks up paper, looks up at information sheets tacked up above his station
7:08.48	OPS-A:	Eleven-forty-seven, roger? Eleven-forty-seven take-off is eighty-seven- three, fuel thirteen-seven, zero a half, seventy-three five, status six and a half, flaps five, passengers sixty, security okay	on radio, talking to plane on runway preparing to leave [Reads "numbers" - weights and balances]
	PSP:		back to typing into computer
	BP:		stretches towards fuel slip slot, makes a remark?
7:09.10	OPS-B:	Four-seventy-five has pulled the stairs	spoken into room; he has been looking up at video monitors throughout
7:09.12	PSP:	'kay	
	BP:	four-seventy-five locked up (and away)	picks up radio control from lap [freeing gate 15 for incoming 1018]