Working paper submitted for 'Ethnographies of diagnostic work' 17-18 April, Lancaster University, UK.

Do You See What I See? - When an Expert Meets a Novice

Inka Koskela
Department of Sociology and
Social Psychology
University of Tampere

1 Introduction

Information and communication technology (ICT) has dramatically changed our daily lives both in work and in leisure time. Development of the technology has not only affected communication and knowledge interchange in societies, but it has also had influence on work conditions. Technology augmented work environments are such organizational settings where cooperation and multimodal interaction of the members form essence of the work performance. Technologically advanced forms of interaction and communication present a new challenge also to the social sciences raising a question of studying these new modes of interaction, work practices and communication patterns. In this paper I am going to study how professional competencies needed in the expertise based work is both learned and taught in technology mediated learning environment. Trainees and trainer's collaborative actions will be studied in the complex work environment of an air traffic control.

In my presentation I will focus to examine situational and socially organized nature of learning and training settings where a novice and an expert encounter, interact and collaborate. I will especially concentrate to study the multimodal nature of these pedagogical encounters and analyse how the material environment of technology-saturated learning environment features actions of trainees and trainers. The research has a particular interest to study the ways in which tools and technologies are used in action in the pedagogical settings and how they feature in trainees' and trainers' conduct and collaboration.

2 Air Traffic Control as a Work Environment

The air traffic controller's main tasks are organizing the flow of the air traffic in a given airspace and providing air traffic services for airlines, military air traffic and general aviation. The air traffic control as a work environment forms an

organizational network of people and their collaborative actions as well as technological equipment that ensures the safe operations for aircrafts in the airspace. In order to be able to organize the flow of air traffic efficiently, but safely, the air traffic controller must simultaneously control movements of several aircrafts, make observations of his work environment and handle information from several information resources. The controller must also co-operate with other participative workers, such as pilots and make rapid and efficient decisions. In such information saturated and safety critical environment worker's individual cognitive ability like information processing and decision making skills have been frequently seen as a critical part of the work performance. Thus, it is not surprising that majority of the previous research concerning air traffic controllers has conducted under the disciplines of cognitive sciences and psychology – or to be precise - under the fields of human factors, HCI and ergonomics.

However, over the past decade there has been growing interest to enlarge the view from individual perspective to social one (see e.g. Arminen, Auvinen & Palukka, forthcoming, and Palukka & Auvinen 2005) . The research interest has change to co-operational actions of the workers and their interactions in the workplaces where technological tools feature everyday organizational action. This research field known as *workplace studies* basically studies interactional and social organization of the technology in the workplace (Luff, Hindmarsh & Heath 2000, xii). The theoretical motivation of workplace studies is to examine collaborative actions in which participants coordinate a range of tasks and use various tools and material environment (see e.g. Heath & Luff 2000). Conventionally, empirical research has been conducted in complex technological environments which Lucy Suchman (1993) has characterized as *centres of coordination*. The air traffic control is one form of these multioperational and multitechnological work settings.

The air traffic control forms a complex, time and safety critical environment, in which professionals are expected to master conventions, procedures, rules and technical

tools. Though, Harper and Hughes (1993) point out that rules, procedures and regulations do not stand alone independently of the work activities but they direct members to recognize things and activities that are relevant in their work and it is precisely this interweaving of regulations and work activities the very characteristic of the ATC (Shapiro, Hughes, Randall & Harper 1994). Form a point of you of the ATC training it is interesting to follow how these norms are made visible and explicit by the trainers who are expected to master their work and expected to transfer their knowledge to newcomers.

While controlling the air traffic the controller has to manage events in the airspace in real time rather than to follow a kind of advance plan. There are always inevitable and contingent factors, which the air traffic controller must be able to deal with in order to avoid errors. The ATC's specialty is that while cooperating and sharing information controllers and their executives monitor each others' actions in order to point out and prevent potential errors. It is commonly accepted that everybody make mistakes, but it is also common responsibility that they are manifest before it's too late. (Shapiro et al. 1994.) In a way ATC work environment is strongly penetrated by the feature which may be classified as *technology of accountability* (Suchman 1993). Accountability of action –which is key concept in Garfinkel's ethnometodology – refers to that certain activity is observable-and-reportable and available to those who take part in the intercourse of situated practice (Garfinkel 1967, 1).

In order to perform properly in his future occupation an air traffic controller is expected to acquire adequate level of professional competence in his training period. The crucial question is: how training is organized in a way that these highly specified professional skills described above are transferred to the air traffic controller candidates.

3 Interaction and Multimodality in Pedagogical Settings

During the last decades new insights of participative and interactional processes of learning in a context of high technological environments has been provided by the research field of *computer supported collaborative learning* (CSCL). Meanwhile this field of study has concentrated on prescriptive standpoints in order to improve conditions of learning there has been lack of more descriptive perspectives which would take full account of the organization and the nature of the ongoing pedagogical talk and interaction. Comparatively little analysis has been devoted to the learning and teaching of professional practices in the context of technologically advanced learning and work environments where multimodality of (inter)actions is salient aspect. However, some preliminary research work has been introduced and it mainly concerns professions that rely on visualized work practices.

When studying archaeologists Charles Goodwin (1994) came up with the concept of professional vision that composes of practices such as coding, highlighting and constructing representational objects. In archaeology workers classify visual phenomena provided by material environment in a way that is relevant to the work they are performing. As participants collaborate to inscribe events and phenomenon they have seen, they display their understanding trough interaction, talk, seeing, writing and tool use. As consequent, seeing may be understood as a situated activity (Goodwin & Goodwin 1996) and professional vision and visibility as a social accomplishment (Goodwin 1994). In fact, the practice of seeing is an essential part of being practitioner of certain profession - archaeologist for example - and it is these professional practices of seeing that one is being held accountable to in his work. The whole idea of professional vision is to acquire the ability to see as presumably more-skilled others can see. The listener, who in learning context is usually a learner, is expected not only to see what is visible to the speaker (in learning settings more often

the teacher) but also see in the same way as a speaker. (Koschmann, LeBaron, Goodwin & Feltovich 2001.)

Medicine represents also a workplace where visualization is an important element of professional practice. In medical operations images are used, produced and exchanged within collaborative work activities. When surgeons operate the patient with the help of video images while demonstrating operations for training purposes they perform their action in such a way that it is recipient designed, visible and accountable for both audience and the expert. (Mondada 2003.) Thus, seeing *in action* and seeing *as action* becomes salient aspect in performing medical tasks for didactical purposes while video images and recordings actively produce the orderliness of the event it displays and documents (ibid., 60). Similarly, when studying video conferenced PBL training sessions Timothy Koschmann and Curtis LeBaron (2002) came to conclusion that learner articulation is an interactional achievement. Interactants actively use their hands and bodies and aspects of the material environment while displaying their understandings. Thus, learner articulation is multimodal and situated practice as gestures are always designed for use of particular audience and particular context of conversation.

It is clear that teaching and learning is above all an interactive process. Learners do not only interact with teacher and other learners and with the material being investigated and produced, but they also interact continuously with the physical and material environment that surrounds them. In the training settings both the trainee and the trainer design and manage their conduct and actions in such a way that they are able to monitor and observe each others actions. This monitoring work is done by various communicative modes that may be either language, gestures, gazes or use of material objects and technical artefacts. Thus, tools, rules, values, actors and their actions constitute a complex and highly interactive system in training settings. In order to capture the multimodal nature of pedagogical interactions I adopt an

ethnomethodological approach combining theoretical conceptions from computer supported co-operative work (CSCW) and workplace studies.

4 Methodological Framework

The aim of this paper is to analyse the nature and the dynamics of social interaction between the trainee and the trainer in a technically complex learning environment - 3-dimensional aerodrome control simulator. In the presentation I aspire to answer to following questions: How the trainee and the trainer organize and manage their interactions and social actions in the technology-based learning environment in a way that social intercourse composes an institutional teaching and learning setting? How the material environment is used by the participants in action and how it features in practical and social activities in the learning environment? How an object in material environment of the simulator or of the air traffic control is interactively made observable and accountable in the situated practices of training?

To give answers to the proposed research questions implies going into a detailed analysis of interactive practices that compose the air traffic controller's training and learning context. Drawing upon a corpus of video recordings of these training sessions, I will concentrate especially on the way learners as novices and trainers as experts organize their interactions and actions and collaboration during the training sessions. The theoretical and methodological basis of the research synthesizes principles from ethnomethodology (see e.g. Garfinkel 1967), conversation analysis (CA) (see e.g. Atkinson & Heritage 1984, Drew & Heritage 2006, Sacks 1992a & b; Schegloff 2007) and ethnography while fields of computer supported co-operative work (CSCW) and workplace studies, described above, provide theoretical concepts to conduct the analysis. Within this theoretical ground I will be able to do an extremely systematic and detailed analysis about how talk, action and the production of multimodality is intertwined in trainees and trainers actions.

5 Introduction to the Training Environment and to the Data

The Finnish air traffic controller training is organized and run by the Finnish Civil Aviation Administration – Finavia - according to the regulations set down for vocational training. The air traffic controller's basic course provides students a second degree vocational qualification. Each year from 10 up to 20 new air traffic controller candidates begin the three-part structured training. During the **ATC Fundamentals Training** trainees learn basics and principles of flight, aircraft recognition, navigation, etc. In the second part, **Aerodrome Control Tower Training,** trainees are brought to exercise their skills in tower simulator. In the last phase of **Live Approach Control -on the job training** trainees finally exercise their skills in real ATC workplaces.

The data analyzed in this paper has been gathered during the trainees' aerodrome control tower training period in the tower control simulator (TWR) situated at the air traffic contoller training center, Avia College. Altogether 13 samples of simulation training exercises and feedback meetings right after the exercise has been video recorded. Simulation training exercises have also been observed during one month and both trainees and trainers have been interviewed. There were sixteen participative research subjects altogether.

The analysis of this paper bases on the interaction analysis of the videorecorded training sessions. Each session lasts approximately 45 minutes. During this time trainee excercises basics of tower control like equipment use, flight data management, clearance delivery, use of the specific phraseology, controlling of the arriving and departing aircraft and other aerodrome control duties and responsibilities with the help of the more skilled trainer. As in this phase trainees are just in the beginning of their training they are rather sensitive to make errors and still need trainers backup in order to pass the exercise.

Description of the simulation environment here…

In this research special interest is focused on to those situated interactions in which some other communicative mode than talk is essential for the achievement of action. Therefore the CA analysis of video recordings combines the study of oral interaction and visually observable physical actions, while the use of technological artefacts and the material environment is integrated to the transcriptions. The spoken interaction is transcribed using the conventions of conversation analysis while visual actions are incorporated into the transcription of verbal actions.

6 Data excerpts and analysis

The CA analysis here presented focuses on typical modes of pedagogical interaction in air traffic controller training. I concentrate here to research such embodied pedagogical practices through which the environment and its artefacts are made visible and manageable by the both parties participating to training session (excerpt 1). I also look closely such gestural actions of the actors as *pointing* and *seeing* especially in situations where some problem(s) is likely to occur (excerpt 2 and 3). In the first excerpt I will focus on trainer's utterances and gestures that may be seen as environmentally coupled (see Goodwin 2007).

Making the environment and its artefacts visible and manageable
Excerpt 1.

```
Air traffic controller training_02_04_18092006
Cleared to Kuopio_IKOS

TR = trainer
TE = trainee
A2,
A3,
A4 = aircraft
✈  = radio contact with radar or aircraft
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1 ✈ **TE:** **Homer <one,> (1.2) cleared to (0.2) Kuopio. (0.4)**
((name of the city))
2 **Flight >one five zero.< (0.8) Time >(night) one.<**
3 **(1.2)**
4 ✈ **TE:** **a: (0.2) After departure (0.2)**
5 **TR:** **Flight,**
6 ✈ **TE:** **flight heading zero nine nine zero until flight**
7 **level six zero. Squawk (.) >three one three one.<**
8 **(2.4)** *((TE: moves his hand towards the stripboard))*
9 **TR:** Sit vasta ku se lukee sen niin kuittaat.=
Not until when he reads it then you sign for it.
10 ✈ **A4:** **=Head to [Kuopio tango eight one. Flight level] one**
((Name of the city))
11 *TE:* *[((draws a circle on the strip))*]
12 ✈ **A4:** **[five <zero.> (0.6) Af[ter (1.4) <departure flight**
13 *TE:* *[((moves the hand back))*
14 *TR:* *[((moves the hand onto the*
15 *strip))*
16 ✈ **A4:** **heading [zero niner [zero> (0.6) until [flight level**
17 *TE:* *[((moves his hand on the strip into the*
18 *position the TR has pointed))*
19 *TR:* *[((points to the simulator*
20 *sreen; TE looks at the pointed direction))*
21 *TE:* *[nods*
22 ✈ **A4:** **six zero. (0.4) Squack [(0.4) three one three one.**
23 *TE:* *[((draws a circle on the*
24 *strip))*
25 ✈ **A4:** **Homer one.**

26 **(0.6)**

27 ✈ **TE: Tower?**

28 **(2.2)** *((TE: lifts his left hand; TR: moves his right*

29 *hand towards the stripboard))*

30 **TR:** Ton mää laittaisin [tohon noin oikein.

That I would put right [there that way.

31 *TR:* *[((draws a line on the strip))*

32 *TE:* *[((leans towards the*

33 *stripboard))*

34 **(0.4)**

35 **TR:** Nä[in.

Th[is way.

36 **TE: [snff**

37 **(0.2)**

38 **TR: ( )=**

39 **TE:** [=Joo.

[=Yeah.

40 *TE:* *[((draws line on the strip))*

41 **(1.8)**

42 TR: Nyt sit (.) [katse ulos.

Now then (.) a [look outside.

43 **TE:** **[snff**

44 **(1.2)** *((TE: looks at the simulator screen))*

45 ✈ **A2: [Homer one. (.) <Approaching> (.) zulu [alfa.**

46 *TE:* *[((looks at the stripboard))* *[((looks at*

the simulator screen))

47 **(1.0)**

48 ✈ **TE: Homer one.**

49 **(1.0)** *((TE: looks at the stripboard))*

50 ✈ **TE:** [Oskar alfa mike? [(1.0) [tuuli >sata<nelkyt

[Oscar alfa mike? [(1.0) [wind >one< four zero

51 *TE: [((looks at the simulator screen))*

52 *TE: [((looks at the weather screen))*

53 *TE: [((looks at the simulator*

54 *screen))*

55 **TE**: astetta [>seitsemän solmua,< kiitotie

degrees [>seven knots,< runway

56 *TR: [((lifts his right hand))*

57 **TE**: [yks kaks. Selvä °läpilaskuun.°

[one two. Ready for °touch and go.°

58 *TR: [((draws line in the air with the right hand))*

59 ***(0.4)*** *((TE: writes down on the strip; TR: drops the*

60 *right hand))*

61 ✈ **A3**: Selvä läpilaskuun kiitotie yksi kaksi, oskar alfa mike.

62 **Cleared for touch and go, runway one two, oscar alfa mike.**

63 ✈ **TE**: °Torni?

64 °Tower? °

In the first seven lines trainee is producing departure clearance addressing to his speech to an aircraft called Holmer one. Contrasting the prosody of the utterance and the rather long pauses trainee (TE) makes in the middle of the complete phrase (lines 1, 2 and 4) he is apparently having some difficulties to articulate properly the clearance. And as it appears from the trainer's (TR) interrupting turn in the line 5, TR handles the situation as problematic and helps TE to complete the phrase with key word "Flight", which leads TE to give next necessary information for the plane - the flight direction. In CA's terms TR uses other initiated repair to aid TE to complete his task.

The second TR initiated repair appears already in the line 9. TE is about to write something down on the flightstrip but TR urges not to sign it until the TE has heard aircraft's read back. In other words TR verbal actions is related to TE's nonverbal, embodied action and can't be understood without paying the attention to the trainees bodily positions and embodied intentions - he is orienteting to write down something on the strip. TR is able to see TE's bodily orientation as he leans towards the board and corrects the TE's task timing. TE seems to follow TR's advice by waiting for the read back of the plane until he starts to mark the strip. More over he repositions his pen on the strip following the example given by TR (lines 14; 17 and 18).

In the line 28 both TE and TR are moving and positioning they bodies in different angles: TE towards the simulator screen and TR towards the stripboard, both though doing it partly simultaneously. TR's positioning towars the stripboard relates directly to his next turn in line 30, where he advices TE to do stripboard marks in a certain way, in fact, in a way that he self does. As a accentuation he starts to write down on the strip in the end of his utterance and receives TE's full attention as he leans towards the stripboard and follows what TR is doing. TR gets minimal reacting move from TE as he says "Yeah" in line 39. More over, TE writes again something on the strip and it seems like he is doing exactly like TR has adviced him a moment ago, by strengthening the line TR earlier drew.

Again in the line 42 TR is organizing TE's body posturing now towards the simulator screen. This he does by saying: "Now then a look outside." It is right there where next significant action is likely to happen. The plane, Oscar alfa mike, is decending and TE should give him a clearance for touch and go. TR is not only making visible the right timing for right action but making visible the simulator environment and its different information resources for TE. After TE is heard Holmer's confirmation of his position coordinates, he starts to produce the clearance, the one TE was moment a go referring to.

In this excerpt the role of TR is crucial from the point of you of the successful task managing and completing as in this phase of the training trainees still lack quite a amount of professional competence. It is TR who moves in the room, it is he who makes observations and makes different information sources visible and manageable for the TE. He is the one who organizes the traffic and organizes all the artifacts needed in a moment. It is also TR who makes most of the verbalized initiatives in this fragment but also the embodied initiatives, while task of the TE is to follow given instuctions by TR.

TR instructions are direct and commanding. The trainer makes corrections before problem has even occured as he would anticipate coming potential problems. TR refers and points to the surroundings and artifacts in order to show to TE what tool is relevat to use and in what way (e.g. line 5: RTF; line 9: RTF/radiophone; 14: strip, line 19: simulator screen; line 28: stripboard; line 30: strip; line 42: simulator screen an line 56: strip). Different tasks require different tool kits and moreover, within each task tools change as the activity progresses. Trainee's problem of tool selection in this information and tool-saturated environment is aided by his trainer as he shows and points task relevant matters occuring around them with different referential practices, be it verbal or gestural.

Going to more detailed analysis of practices of pointing and seeing in training contexts I present here two excerpts to illustrate how these embodied actions features trainees and trainers interactions. In the first excerpt the TR and TE are negotiating of the convenient landing order of the planes which are expected to land shortly.

Pointing and seeing

Excerpt 1:

Air traffic controller training_12_04_15092006
Very long right base _IKOS

TR = trainer
TE = trainee
A2,
A3,
A4 = aircraft
✈ = radio contact with radar or aircraft

1	✈	**A2:**	**We <are> at (0.6) <very long:> (0.2) right base (.)**
2			**run way °three zero. (.) Papa zero two.°**
3			**(1.2)** *((TE: nods))*
4	✈	**TE:**	**Papa zero two.**
5			**(1.2)**
6		**TR:**	[°>Selvitä< ↑laskuun se vaa.°
7			**[°>(Just) clear it for ↑landing**.°
8		*TE:*	*[((moves a strip on the board))*
9			**(0.6)**
10		**TE:**	[Eikö enks mää ota to- [(1.8)
11			**[Hey, can't I take that one-**
12		*TE:*	*[looks at the radar screen [..at the stripboard; … at*
13			*the simulator screen))*
14		**TR:**	>Minkä.<
15			**>Which one.<**
16			**(1.0)** *((TR: looks at the simulator screen at the same*
17			*direction))*
18		TE:	[°(Nii no) emmä kyl ehikkä[ä.°
19			**[°(Well) there's actually no ti[me ((to do it.°))**
20		*TE:*	*[((looks at the radar screen))*

21 ✈ **A4:** **[Alfa [Mike down wind**

22 TE: [((moves a strip

23 on the board))

24 ✈ **A4:** **runway [three zero. (.) °Touch and go.°**

25 *TR:* *[((turns around and points at the simulator*

26 *screen))*

27 **(0.6)**

28 **TR:** [<Soon tossa jo se kone tulossa.>

29 **[It's there already coming that plane.**

30 *TR:* *[points with his right hand towards the simulator*

31 *screen))*

32 **(0.6)**

33 ✈ **TE: [Oskar alfa mike (.) orbit right.**

34 **(1.2)** *((TE: turns to see in the direction pointed by*

35 *TR, TR: lays down the hand))*

36 ✈ **A4:** **Orbit right, Oskar alfa mike.**

The excerpt begins with the aircraft's (PZ2) information delivery about its position in the control zone of the TE in the lines 1 and 2. TE's response to the plane is plain and minimal as he repeats the call sign of the plane. With this phrase he acknowledges the given information, but does not take it as a clue to start the next relevant action whereas for the trainer the plane's notice is enough for launching the next action. He suggests for the TE that he should start to give a clearance for the plane. However and despite of that rather explicit advice TE makes his initiative to another direction (line 10). An aircraft, Oskar alfa mike (OAM), is also descending and quite soon ready for landing and TE suggests that he would handle this one first. At the same time he is looking at different information sources, radar screen, simulator screen and a strip, with the help of which he can visually control the aircraft's actual positions and movements. TR's stressed question "Which one" makes TE to check his

intentions and after the one second pause TE is able to produce repair for the action as he simultaneously monitors situation on the radar screen. Actually, there is no time for his original plan. To convince the TE of the appropriate landing order of the planes, TR turns around and points to the position of the coming plane (PZ2) on the simulator screen. During the time he is pointing TE has made up his mind and asks the other plane (OAM) to do waiting circulation ("Oskar alfa mike, orbit right.") With this he marks implicitly that (PZ2) has now the priority in landing.

The excerpt exposes fascinating way the key elements that construct the basis of the air traffic controller work. The air traffic controller's main duty is to manage and order the traffic in a safely and efficient way. This requires not only ordering tasks in a moment by moment basis but mostly it requires precision of timing. In order to time the tasks in an adequate way one has to see the environment and all information given by it. Moreover, one has to see it all in a special, work and task related way. "To see" is to localize all the moving elements in the airspace and to localize the directions the planes are heading. "To see" is to visualize the traffic situation of the next following minutes from the basis what one sees at that very moment.

The whole story isn't just what to see but what source to look at at what moment, since the tools give a bit different information and different view. It is strongly stressed form the part of the trainers that trainees should not only rely on the visual information given by radar screen but they should track the traffic situations from the outside view given by the simulator screen, as well. A competent controller always looks outside from the tower. With his pointing gesture TR not only remarks the current position of the coming plane (PZ2) but shows where in the environment the relevant information is available at that moment.

Excerpt 3:

Analysis under construction…

6 Conclusions

(under construction)

How do we see things as we do? How trainers enable trainees to see organizational things and work related matters in a way that there are understandable, meaningful, significant for the work standard? The general starting point in pedagogical encounters is that the actors do not have precisely the same body of knowledge: the other is more skilled than the other. The reciprocity of perspectives is only possible through actors' mutual interaction. Although individual may have a unique relationship to his instant material and social environment, the structure of that environment is shared with other people present. What and how we perceive the environment is then socially and culturally provided.

From the basis of the analysis I argue that the professional competence is actually knowledge of how to pick up, how to locate, how to see, how to see at glace and how to arrange relevant information. It is not how one sees the things around him/her as there are, but how one organizes the world of objects as meaningful. We always perceive i.e. see, hear or feel *something* i.e. we see, hear or feel things in their existing contexts against and in relation to the background of the situation and other social action (Anderson & Sharrock 1993). Seeing is intersubjectively produced action. Knowing how to look is like knowing how to speak, use language or other cultural practices embedded in any environment. (Anderson & Sharrock 1993.) An what is more knowing how to look, pick up and see relevant things in one's own work environment is the very professional competence.

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