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Achievement of Intersubjectivity in Airline Cockpit Interaction

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CONTENTS

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Achievement of Intersubjectivity in Airline Cockpit Interaction

Flight safety and efficiency requires that airline pilots have a shared understanding of what is going on both inside and outside the cockpit during the flight. The joint awareness of the action-in-progress is created and sustained through multiple interactions, such as talk, gestures and bodily orientations. This study concerns the interactive achievement and maintenance of mutual awareness between Commander and Co-pilot in the cockpit environment. The analysis focuses on those cases in which intersubjectivity, i.e., the socially shared understanding of ongoing talk and action temporarily breaks down, or threatens to do so, between the two pilots in flight. The instances describe situations in which the pilots have difficulty in terms of speaking, hearing or understanding the cockpit talk and in terms of maintaining the sequential order of flight tasks and activities. The study highlights the different types of repair practices the pilots use to identify and resolve problematic understandings in order to achieve intersubjectivity and optimize flight safety.

The research data was collected by videotaping Finnair pilot training sessions in the Airbus A320 flight simulator at the Finnair Flight Training Center, Vantaa, Finland. In the sessions, the pilots practiced a training technique called Line-Oriented Flight Training (LOFT), in which they must process a variety of scripted real-time scenarios including routine, abnormal and emergency situations. Experienced, licensed pilots are required to undergo this particular kind of training twice a year. The overall amount of data increased to over sixty (60) hours of recorded material, of which about twenty-six (26) hours was used in analysis. The primary research method was ethnomethodological conversation analysis, which considers talk and interaction as structurally organized social action. Although a secondary method only, ethnography was of great importance in providing the necessary background understanding for the detailed analysis of videotaped interactions. The ethnography included, among others, the researcher participating in a pilot training course on Multi-Crew Cooperation (MCC), observing the cockpit interaction in real operational settings and familiarizing herself with the work done in approach control and in the aerodrome control tower at Helsinki-Vantaa Airport.

The data analysis was based on comparisons between cockpit interaction and ordinary conversation (the non-institutional form of talk). The participants in ordinary conversation tend to avoid any potential for conflict and disagreement by mitigating and delaying other-repairs, i.e., the activities of correcting the other speaker. In everyday settings, other-repairs performed straightforwardly and without delay are largely detrimental to social solidarity and

possibly threatening to the face of the interlocutor. Direct, overt other-repairs can be accomplished without conflict or discord in cockpit interaction. In contrast to ordinary talk, the pilots' main orientation is not towards 'face work' in the activity of correcting one another. Through direct other-repairs, they rather orient to the rapid achievement of intersubjectivity in order to ensure the safety of the flight. The normative procedures of interaction in ordinary conversation are thus overridden by the institutional norms of flight safety.

The flight crew must carry out the tasks and actions in a strict sequence. The pilots may momentarily have different understandings of what actions are complete, in progress, and to be done next and by whom. In light of this study, the most common problem in maintaining the sequential order of action is so-called 'premature actions', in which the pilot orients prematurely to some particular flight action. The premature orientations resolved by the pilots with conversational repairs are more typical in abnormal and emergency situations than in normal conditions. The unpredictable and time-critical nature of emergency operations may contribute to the occurrence of premature actions in cockpit interaction. The task sequence also temporarily breaks down in so-called 'absent actions', in which the pilot fails to perform the action s/he is responsible for. The unperformed action is carried out after one flight crew member has reminded the other to perform it.

The pilots use not only talk, but also different kinds of visual activity as resources for processing their problematic understandings in cockpit interaction. The analysis focused specifically on the role of pointing gestures in the achievement of intersubjectivity. What is done or accomplished through gesticulation is at least partly dependent on the target of the gesture (human vs. material), the timing of the gesture relative to talk (gesture produced prior to vs. simultaneously with talk) and the organization of participation in the course of interaction (recipient vs. producer of gesture). The pilots use pointing gestures to make their orientation and engagement in processing of intersubjectivity visible. The visual pointing toward, for example, the cockpit instrument allows the pilot to direct the other flight crew member's attention to that object and therefore to establish mutual orientation in interaction. The spatial-temporal coordination of talk and gesture enables pilots to allocate flight tasks and specify the information sources employed in the production of talk.

The pilots not only identify episodes of problematic understandings, but also demonstrate their professional competence and know-how by their actions for repairing and reminding. The interventions accomplished with these practices can also be seen as evidence of a well-functioning interactive back-up system eliminating risks to flight safety. In focusing on the processes of cooperation and interaction, the research is closely related to the subject domains of pilot professional training called 'Crew Resource Management' (CRM). The study makes a practical contribution to CRM training methods by offering new insights for flight instructors and other training personnel to utilize in teaching trainees non-technical skills. The general guidelines provided by the 'LISA' model can be used as a starting point in helping to achieve intersubjectivity not only in cockpit interaction but also in other environments where safety is critical: Listen to what the other is saying. Intervene in action when necessary. State your intentions. Ask if you do not hear or understand.

GLOSSARY OF AERONAUTICAL TERMS AND ABBREVIATIONS

Abnormal situation: one in which it is no longer possible to continue the flight using normal procedures, but the safety of the aircraft or persons on board or on the ground is not in danger.

Acknowledgement: notification that a given communication has been correctly received and understood.

Air Traffic Clearance: approval by Air Traffic Control for an aircraft to taxi, take off, climb, enter controlled airspace, descend or land.

Altimeter: a cockpit display showing the aircraft's altitude.

Altitude: the height of an aircraft as shown on an altimeter adjusted to local barometric pressure.

AP: an abbreviation for 'autopilot'.

ATC: (Air Traffic Control): a system of directing all aircraft operating within designated airspace by radio. Divided into sectors such as Tower (aerodrome control for take-offs and landings), Departures, Control (en route aircraft), and Approach.

Attitude: the lateral and longitudinal relationship of the aircraft to the horizon.

CAVOK: The term (meaning ceiling and visibility OK and pronounced "kav-okay") may be used in place of visibility, weather and cloud, provided that visibility is 10 kilometers or more; there is no cloud below 5,000 feet above aerodrome level, or below the minimum sector altitude, whichever is higher, and no cumulo-nimbus clouds (i.e., thunderstorms); no precipitation reaching the ground, no thunderstorms, and no shallow fog or low drifting snow.

CDR (Commander): a formal rank held by a pilot. The Commander is the member of the flight crew who has the ultimate authority and responsibility for the conduct of the flight.

Checklist: a tool used as a human factors aid in aviation safety to ensure that items on a long list are not forgotten. It is needed because of the limitations of human memory.

'Clean' aircraft: an aircraft in normal cruising configuration, with high lift devices (flaps and slats) and landing gear retracted.

Climb (or climb phase): the period during which the aircraft climbs to a pre-determined cruising altitude after take-off. Depending on the aircraft, the altitudes involved, and other factors, this phase may last from a minute or two to half an hour or more. The opposite of a climb is a descent.

COP (Co-pilot): a formal rank held by a pilot. The Co-pilot is the member of the flight crew with accompanying Commander. The Co-pilot is usually the junior and less experienced member of the flight crew.

CRM (Crew or Cockpit Resource Management): part of pilot training which seeks to develop the ability of pilots to work together as a team and use all the resources available to them to effectively; for example, perform tasks, assess situations, make decisions, and identify and resolve problems.

Descent: the phase of flight in which an aircraft decreases altitude; the opposite of a climb. Descents are an essential component of the approach to landing.

DME (Distance Measuring Equipment): a radio navigation aid providing a constant readout of the aircraft's distance from a selected radio beacon.

ECAM (Electronic Centralized Aircraft Monitoring, Fin. lentokoneen elektroninen keskitetty valvontajärjestelmä): a system that monitors aircraft functions and relays them to the pilots. It also produces messages detailing failures and in certain cases lists procedures to undertake to correct the problem.

EFIS (Electronic Flight Instrument System, Fin. elektroninen lennonvalvontamittaristo): a flight deck instrument display system which shows all information regarding the aircraft's situation, position and progress. It primarily covers horizontal and vertical position and also indicates time and speed.

Emergency landing: an unplanned landing made by an aircraft in response to a crisis which either interferes with the operation of the aircraft or involves sudden medical emergencies necessitating diversion to the nearest airport.

Emergency situation: one in which the safety of the aircraft or of persons on board or on the ground is endangered for any reason.

E/WD: Engine/Warning Display

FCOM (Flight Crew Operating Manual): a technical publication written for a specific aircraft which is used to operate that aircraft and to explain its technical specifications. The manual includes a wide range of information, such as the procedures for abnormal and emergency operations (in Vol. III).

FCU: Flight Control Unit

Flaps (Fin. 'laipat')**:** adjustable surfaces on the trailing edge of an aircraft's wing. When lowered, flaps increase the lift of the wing, thereby reducing stalling speed, and increasing drag, steepening aircraft's glide angle.

Flight Director (FD): a computer-controlled flying instrument combining inputs of other flying and radio navigation instruments in a single large display located directly in front of each pilot.

Flight Level (FL, Fin. lentopinta): an expression of height in hundreds of feet, based on the standard barometric altimeter setting of 1013.2 millibars. For instance, 12,000 feet on the standard altimeter setting would be FL120. FL differs from altitude in that the latter is based on the actual barometric altimeter setting for a particular area or airport.

FMS: (Flight management system, Fin. lennonhallintajärjestelmä): an aircraft computer system that uses a large database to allow routes to be programmed and fed into the system by means of a data loader. The system is constantly updated with regard to position and accuracy by reference to conventional navigation aids.

Heading (Fin. ohjaussuunta): a direction described in compass degrees.

Human factors: the multidisciplinary field devoted to optimizing human performance and reducing human error, which incorporates the methods and principles of the behavioral and social sciences, engineering, and physiology. It is the applied science concerned with people working together in concert with machines.

IFR (Instrument Flight Rules, Fin. mittarilentosäännöt): stipulated procedures for navigating aircraft by reference to cockpit instruments and radio navigation aids alone to enable flight regardless of visibility. This is the normal operating procedure for airline flights.

ILS (Instrument Landing System, Fin. mittarilähestymismenetelmä): an electronic approach aid which enables a pilot to carry out an approach for landing when weather conditions preclude visual contact with the ground.

IMC (Instrument Meteorological Conditions, Fin. mittarisääolosuhteet): weather conditions in which visibility is less than specified for visual flying, and in which flight is legally possible only under IFR.

Knot (KT): one nautical mile per hour, equivalent to 1.853 km/h.

Landing: the phase of flight in which a flying aircraft returns to the ground.

Landing gear (also called undercarriage): the aircraft's wheels and associated assemblies. The landing gear is used during take-off and landing and to taxi on the ground. Most planes use what is called a tricycle landing gear arrangement. This system has two large main gear units located near the middle of the plane and a single smaller nose gear unit near the nose of the aircraft.

Localizer (Fin. suuntalähetin): the component of an instrument landing system (ILS) that provides lateral guidance with respect to the runway centreline.

LOFT (Line-Oriented Flight Training): refers to aircrew training that involves a full mission simulation of situations that are representative of line operations, with special emphasis on situations involving communications, management and leadership. In short, LOFT means realistic, "real-time", full mission training.

Nautical mile (nm): a measure of distance used for navigation in the air and at sea. An nm is equal to one minute of an arc of latitude on the earth's surface. A nm is 800 feet longer than a statute mile and equivalent to 1.853 km.

ND: Navigation Display

NDB (Non-Directional Beacon): a ground-based radio transmitter sending continuous signals in all directions for use by aircraft fitted with Automatic Direction Finder (radio compass).

PF (Pilot-flying): the pilot in control of the aircraft and generally responsible for making most routine decisions about the conduct of the flight.

PFD: Primary Flight Display

PNF (Pilot-not-flying): assists the PF and is responsible for most radio communications.

QNH: the code expression designating the altimeter setting in millibars – when set on the sub-scale of the altimeter, the instrument reads the aircraft's height above mean sea level.

QRH (Quick Reference Handbook): a handbook containing extracts from the Aeroplane Flight Manual (AFM) or Operations Manual (OM) which may need to be referred to quickly and/or frequently, usually including emergency and abnormal procedures.

Radial: a bearing to or from a VOR radio range navigation beacon.

SD: System Display

SID (Standard Instrument Departure, Fin. vakiolähtoreitti): a standard and published departure route from an airport, i.e., specifying runway, headings, navigation points and altitudes to be used during departure, and other critical information.

Slats: an aerodynamic device fitted to the leading edge of the wings to delay the onset of stalling.

Spoilers: surfaces on an aircraft's wings designed to 'spoil' the airflow over the wings and so reduce lift (e.g., during descent or after touchdown during the landing).

Standard callouts: used to convey vital information with a minimum number of words that have an exact meaning for all crew members. Proper adherence to standard callouts will stimulate more meaningful and standardized crew communications and provide for early detection of crew member incapacitation during critical phases of flight.

Standard operating procedures (SOPs): the guidelines as to who-does-what-and-when. These are designed to enhance safety, assist the flight crews to manage risks and ensure consistency in the cockpit.

STAR (Standard Arrival Route, Fin. vakiotuloreitti): a standard published arrival route to an airport, i.e., specifying runway, headings, navigation points and altitudes to be used during the approach, and other critical information.

Take-off: the phase of flight in which an aircraft goes through a transition from moving along the ground (taxiing) to flying in the air. Take-off is the opposite of landing.

Taxi (also called ground-taxi): the movement of the aircraft on the surface of the aerodrome under its own power, excluding take-off and landing.

TCAS (Traffic Collision Alert System): a type of airborne collision avoidance system (ACAS) based on a family of airborne equipment that functions independently of the ground-based ATC system to detect potentially conflicting aircraft that are equipped with secondary surveillance radar (SSR) transponders.

Transponder: a radio device fitted to aircraft which, when triggered off by certain radar wavelengths, emits a signal visible on ground radar screens. The signal usually includes additional information such as the altitude of the aircraft.

UTC: Co-ordinated Universal Time

V1: Decision speed during take-off. An aircraft is committed to fly when this speed is passed. (Fin. Lentoonlähdön päätösnopeus eli nopeus jota ennen lähtö voidaan keskeyttää turvallisesti kiitoradalle.)

Vr: Rotation speed. Speed at which an aircraft is "rotated" into lift-off attitude by raising the nosewheel off the runway.

V2: Take-off safety speed. Minimum control speed plus safety margin to allow for engine failure and other contingencies. (Fin. Lentoonlähdön pienin turvallinen nopeus mikäli moottori hajoaa lentoonlähdön jälkeen.)

Vector (also called: radar vectoring): A heading given by a controller to a pilot on the basis of radar-derived information to provide navigational guidance.

VFR (Visual Flight Rules, Fin. näkölentosäännöt): stipulated flight procedures for navigating aircraft visually, clear of cloud, in Visual Meteorological Conditions.

VMC (Visual Meteorological Conditions, Fin. näkösääolosuhteet): weather conditions providing a specified range of visibility, making it possible for pilots to use visual means to avoid terrain and other aircraft.

VOR (Very High Frequency Omni directional Radio Range): a radio range navigation beacon.

Introduction

Flight safety and efficiency requires that the airline pilots have a shared understanding of what is going on both inside and outside the cockpit during the flight. The joint awareness of the ongoing action and activity is created and sustained through a large variety of multiple inter-actions, such as talk, gestures and bodily orientations in the local surroundings. This study concerns the interactive achievement and maintenance of mutual understandings between Commander and Co-pilot in a cockpit environment. Along with the talk, the study highlights the role of gestures and other forms of embodiment in achieving the intersubjective sense of an unfolding course of action and interaction. The analysis focuses specifically on those cases in which the shared understanding temporarily breaks down, or threatens to do so, between the two pilots on the flight. The instances describe situations in which, firstly, the pilots have difficulty in terms of speaking, hearing or understanding the cockpit talk in and through which tasks and goals are accomplished on a flight deck. In these cases, for example, the airline pilot does not hear or understand the referent of the talk, or s/he misunderstands the purpose of the talk. Secondly, these instances include situations in which the pilots have problems maintain-ing the sequential order of flight tasks and activities; here, for example, the pilot orients prema-turely to a particular task or (re-) orients to accomplish an activity already done.

In conversation analytic terms, this study concerns the different types of repair practices the pilots use to locate and resolve problematic understandings in cockpit interaction (see Sche-gloff, Jefferson & Sacks 1977; Schegloff 1992a; Sorjonen 1997). The term 'repair' refers to the organized ways of dealing with the various kinds of trouble in the process of interaction (ten Have 1999, 116). On the flight deck, as will be shown, the airline pilots have troubles related to language use or the maintenance of the sequential courses of action and activities. These prob-lems can challenge intersubjectivity, i.e., the socially shared understanding of ongoing talk and action. The repair activity is a key resource in achieving intersubjectivity in situations where it is momentarily lost between the pilots. In the conversation analytical approach, the repair is treated as a sequentially structured phenomenon. The episodes of repair activity consist of a repair initiation marking possible disjunction with the prior talk and a repair outcome solving or abandoning the problem; the problematic talk which the repair addresses is referred to as

the 'trouble-source' or 'repairable'. The repair sequences used in a cockpit interaction fleetingly suspend the performance of the task the flight crew members are engaged in. The detection and resolution of the problem through the reparative operation is a necessary precondition for the continuation of the task; when the problem is resolved and intersubjective sense of talk and action achieved, the pilots can resume the suspended flight activity.

The crew members not only use verbal activities in achieving shared understandings on the flight. Within the repair sequences, the pilots employ and demonstrate their orientation to a large number of different visual and material phenomena, such as their bodies and the features of the surrounding physical environment. The simultaneous deployment of talk, the body and the material surroundings provides pilots with the resources for locating and dealing with problematic understandings in the course of cockpit interaction. The processing of intersubjectivity is thus analyzed as a multimodal activity in which the pilots juxtapose verbal, visual and material resources to make sense of and display their understandings of the ongoing action in the cockpit setting. Concentrating on the interconnections between talk, body and material surroundings in the production of meaningful action, the study strongly resonates with the theoretical notions of C. Goodwin (1994; 1996; 2000; 2003a), who points out that within a situated human interaction, talk, gestures and bodily orientations are deployed in ways designed to mutually elaborate each other. In a cockpit interaction, the achievement of intersubjectivity is not simply a verbal phenomenon but a multilayered activity, inseparable from the complex configuration of different kinds of meaning-making practices.

Using video-recordings from the simulator training sessions as the data, the study provides systematic and reliable knowledge of the social-temporal organization of cockpit interaction in general and the intersubjective problems emerging in the sequential courses of that interaction in particular. The main aim is to analyze and explore the various repair practices the airline pilots employ to collaboratively manage problematic understandings in the cockpit interaction. The study also addresses and examines the role of the visual conduct of pilots, especially pointing gestures and gaze movement, in dealing with possible losses of intersubjectivity on the flight deck. In centering on the processes of co-operation and interaction, the research is closely related to the subject domains of pilot occupational training called 'Crew Resource Management' (CRM). CRM training focuses on teaching pilots the concepts and skills related to such areas as communication, situational awareness, problem-solving, decision-making and teamwork, thus improving pilots' performance as the members of the team. The ultimate goal of training is to promote flight safety and the efficiency of flight operations by reducing the possibility of human error (Advisory Circular 2004a; CAP 720, 2002; Orlady & Orlady 1999, 268-294; Helmreich et al. 1999). The study is thus intended to make a practical contribution to CRM training practices and methods by offering new insights for flight instructors and other training personnel to use in teaching the 'non-technical' skills to the trainees.

In aviation research, the cockpit communication is generally investigated out of its context. The studies favor large-scale quantitative analysis in which particular types of utterance, or speech act, such as questions, requests, instructions, are encoded and counted to answer

the predetermined research questions (see, e.g., Kanki et al. 1991; Bowers et al. 1995; Sexton & Helmreich 2000; see also Krifka et al. 2004). In this study, however, the communication is analyzed in its context, embedded within the sequentially organized interaction between the pilots (see also Nevile 2004a). Examining the talk in its interactional context reveals that the pilots use not only verbal utterances, but also different kinds of embodied activity (pointing gestures, head movements, upper body orientations, etc.) as resources in organizing their collaborative courses of action. This study shows in detail how pilots orient to these verbal, visual and material modes of expression as relevant while processing the problems of intersubjectivity in cockpit interaction. Thus, as regards traditional research on aviation, the study extends the scope of analysis by taking the multiple communicative modalities the pilots use in producing, recognizing and coordinating their action on a flight into account. This research provides a much deeper understanding of how pilots display their orientation to, and awareness of, the unfolding courses of action and activities in the cockpit setting by addressing the multimodal nature of communication.

1.1   COCKPIT INTERACTION ON ACTUAL FLIGHTS

The Australian Maurice Nevile (2004a) introduced airline cockpit interaction as a subject of research. Drawing on the theoretical perspectives of ethnomethodological conversation analysis and institutional discourse analysis, he addresses routine cockpit talk and interaction in real operational settings. This talk is that which occurs when nothing seriously wrong happens, the talk though which normal flight tasks and activities are performed. By carefully investigating the video-recordings made on actual scheduled passenger flights in Australia, Nevile shows how pilots develop and make their situated and evolving understandings available to each other as they work together as a flight crew to fly the plane. The analysis highlights the processes of talk and interaction though which flight crew members maintain a joint awareness of what is going on around them, who knows what, who is doing what, and what they are to do next. Reasoning and understanding is made visible and interpretable through talk and other resources available in the cockpit interaction, such as gestural movements, handling material objects, bodily orientations in a local space, etc. (Ibid.)

Nevile's study consists of three empirical parts. The first part focuses on the interactive significance of pronominal choices of pilots in routine cockpit talk and interaction (Nevile 2004a, 31-79; see also 2001a). The analysis of the recorded interactions reveals how various pronouns are used and oriented to by the pilots as a socially significant resource to accomplish relevant cockpit identities in the ongoing course of interaction. The analysis demonstrates how selecting the wording of '*I - me - my*', '*you - your - yours*' or '*we - our - ours*', for example, is a characteristic feature of pilots' communicative practice in establishing and maintaining the intersubjective sense of who is doing what and what is going on as the flight proceeds to its destination. The analysis shows specifically how pilots invoke and make salient individual

identities of the 'Captain' and 'First Officer' or 'Pilot-flying' and 'Pilot-not-flying' as well as a shared identity of the 'crew member' or 'member of flight X' through the flexible use of different pronominal choices in the cockpit interaction.

In the second part of the study, Nevile demonstrates how pilots temporally coordinate talk and non-talk activities as they perform the routine tasks required to fly the plane (2004a, 81-144). The ordinary non-talk activities conducted in the airline cockpit consist of pressing the buttons, moving levers, turning dials, entering data onto the aircraft computer and looking at the displays. The analysis illuminates how the precise and timely coordination of talk and embodied action contributes to the pilots' shared understanding of the progress of the flight. Through the sequential coordination of talk and visual conduct, the pilots make themselves accountable for what they say and do, and exactly when, as members of a flight crew jointly responsible for the safe conduct of the flight. (See also Nevile 2002.) The third part broadens the focus to examine the ways in which pilots integrate their mutual talk within the cockpit with their talk with the air traffic controllers beyond the cockpit. The analysis concerns how the pilot's radio talk with the distant controller is fitted with the talk and non-talk activity within the cockpit between the pilots. The findings reveal how, through talk and non-talk activity, pilots establish the shared understandings of who has heard what, and who knows what, in terms of the significance of particular radio talk for their joint conduct of the flight (Nevile 2004a, 145-196; see also case example in Chapter 2: 2.2.1.4).

To summarize, Nevile (2004a; see also 2001a & b; 2002; 2004b; 2005a & b; 2006; 2007b & c) examines the pilots' daily talk and non-talk activities as they work together as a team to perform their routine flying tasks. Nevile's (ibid.) studies, based on the detailed analysis of the videotapes made on real operational flights, focus on the unproblematic, routine processes of talk and interaction and the ways in which flight tasks and activities are performed smoothly, without interruptions caused by the loss of intersubjectivity. In his article published in 2007a, Nevile concentrates on the specific problems the pilots encounter in maintaining the sequential order of action. In line with my research (see Chap. 5: 5.2.3), the article concerns the cases where a cockpit action is absent, i.e., an action is timely and relevant, but not yet initiated by the pilot responsible for doing so (see also Nevile 2008). In a few other studies, Nevile (2004a; Nevile & Walker 2005) touches upon the phenomenon of problematic understandings between pilots, revealing some cases in which they have trouble in the production of verbal and/or physical courses of conduct, and pointing out the repair work done to resolve the trouble. In the video-recorded materials used in my study, the pilots train to fly in both normal and emergency conditions in a simulated environment. The research thus provides an extensive and systematic analysis of intersubjective problems of pilots, not only in routine flight situations, but also during crises (e.g., fire in the cabin, technical failure, etc.).

1.2   DISTRIBUTED COGNITION IN AN AIRLINE COCKPIT

Distributed cognition is a theoretical approach developed by Hutchins and his colleagues in 1980s as a paradigm for re-conceptualising cognition (Hutchins 1995a). Theoretically and methodologically, the approach is based on cognitive sciences, cognitive anthropology and the social sciences. Rather than centering simply on an individual's internal cognitive processes, as traditional cognitive approaches do, distributed cognition focuses on the processes that occur in extended 'cognitive systems'. Within these larger systems, there are multiple people interacting with each other and a large body of technical tools and artifacts with which to perform their work activities. These individuals have overlapping and shared access to knowledge that enables them not merely to become aware of what others are doing, but also to coordinate the action collaboratively. Analyzing the properties and dynamics of a particular cognitive system, such as an airplane cockpit (see Hutchins 1995b; Hutchins & Klausen 1996; Hutchins & Palen 1997; see also Holder 1999) or air traffic control (see, e.g., Fields et al. 1998) involves carrying out an in-depth ethnographic study of the setting, paying close attention to the activities of the personnel, their communications with each other and their interactions with various media. These processes are conceptualized in terms of 'the propagation of representational state across media'. The propagation of a representational state refers to how information is transformed during the accomplishment of an activity. Since the media amount to both internal (e.g., an individual's memory) and external representations (e.g., computer displays, paper notes, etc.), the analysis is focused on the specific transformations of information between the media in revealing how the various representational states are propagated. (Hutchins 1995a; Rogers 2006.)

Hutchins and Klausen (1996) have analyzed the various cognitive properties of the simulated cockpit system, which is composed of the pilots and their informational environment. As a method of analysis, the researchers generated various representations of the events in the cockpit: (I) the audio and video-recordings and (II) transcriptions of the verbal and other behavior in the cockpit; and (III) the descriptions and (IV) the interpretations of the actions that took place. The aim is to interweave "the data, the actions, the interpretations, and the ethnographic groundings as they are needed in a narrative that seeks to present a theoretical account of the observed events" (Hutchins & Klausen 1996, 19). In the following, we will see the first half of the transcription in their study. The transcription is taken from the recording of a simulated flight from Sacramento to Los Angeles. The aircraft is climbing towards its cruise altitude of 33,000 feet. The aircraft type (Boeing 727-200) requires a crew of three people: the Captain (Capt), the First officer (F/O) and the Second Officer (S/O). The Captain is replacing the departure chart in his airway manual. The First Officer is flying the plane, monitoring the various flight instruments and handling the controls. The Second Officer begins a departure report by radio to the company offices on the ground.

Transcription 1(a)

Note: The number sequence on the left signifies the Coordinated Universal time (UTC); the descriptions within the { } – markers illustrate the pilots' non-verbal actions in the cockpit.

0216	S/O	xxx NASA nine hundred.
0224	S/O	Departure report.
	S/O	NASA nine hundred from Sacramento to Los Angeles International we have...fuel on board twenty seven point eight fuel boarded is not available out time is one six four five up time is one six five five.
0247	Capt	Oakland center NASA nine hundred request higher. {F/O reaches to vicinity of altitude alert setting knob when Air Traffic Control, ATC, begins transmission.}
0254	OAK24L	NASA nine hundred...roger contact Oakland center one thirty two point eight. {F/O pulls his hand back from the altitude alert knob when ATC says "contact Oakland center." 2.5 seconds after the end of ATC transmission, F/O looks at Capt} {Capt looks at F/O.}
0300	F/O	Thirty two eight.
	Capt	Thirty two eight?
	F/O	Yeah.
	Capt	OK
0303	S/O	That's correct, NASA nine hundred.
	Capt	One three two eight, NASA nine hundred. {Capt twists knob on radio console} {F/O looks in direction of Capt}

...continues...

(Hutchins & Klausen 1996, 15-16.)

The flight crew is now approaching the altitude which they were last cleared to, i.e., 23,000 feet. This means that without the air traffic controller's clearance to a higher altitude, the aircraft cannot legally climb above that height. However, the flight plan filed for the current flight requires a cruise altitude of 33,000 feet. In his opening turn, the Captain is thus calling the low-altitude controller and requesting clearance to a 'higher' altitude (see 0247). Instead of clearing the aircraft higher, the controller hands the plane off to a high-altitude controller by asking the crew to 'contact Oakland center one thirty two point eight' (see 0254). The number sequence in question is the radio frequency of a high-altitude controller: 132.8 MHz. According to the

procedures in aviation, the pilot should acknowledge all information from Air Traffic Control (ATC) immediately. Note how in this case, the Captain transmits delayed acknowledgement to the low-altitude controller (see Captain's turn after 0303). In the second half of the transcription, the one not shown here, the Captain contacts the high-altitude controller, who gives a clearance for the planned cruising altitude.

In analyzing various cognitive processes within the cockpit system, Hutchins and Klausen (1996) focus on how information about the radio frequency of '132.8 MHz' moves through the system as a sequence of representational states in different media, i.e., from speech channels (see transcription 1b: 0254) to the internal memory of the F/O, back to the speech channels (see 0300), to the internal memory of the Capt., back to the speech channels again (see Capt.'s verbal activity after 0303) to the physical setting of a device (see Capt.' s non-verbal activity after 0303). Next, however, I will show in more detail how the researchers examine 'intersubjectivity as a basis for communication' in a cognitive cockpit system. In order to do so, they concentrate on the particular verbal and non-verbal activities marked with arrows (←) on the right of the transcription 1(b).

Transcription 1(b)

0254	OAK24L	NASA nine hundred...roger contact Oakland center one thirty two point eight.
		{F/O pulls his hand back from the altitude alert knob when ATC says "contact Oakland center." 2.5 seconds after the end of ATC transmission, F/O looks at Capt}
		{Capt looks at F/O.} ←
0300	F/O	Thirty two eight. ←
	Capt	Thirty two eight? ←
	F/O	Yeah.
	Capt	OK
0303	S/O	That's correct, NASA nine hundred.
	Capt	One three two eight, NASA nine hundred.
		{Capt twists knob on radio console}

(Hutchins & Klausen 1996, 16.)

Hutchins and Klausen (1996, 22-25) start the interaction analysis from the Captain's looking activity at the First Officer; subsequently, the First Officer delivers "*thirty two eight*"; the Captain then asks "*thirty two eight?*" Firstly, what is going on in this interaction? The First Officer's utterance "*thirty two eight*" assigns a meaning to the Captain's staring, i.e., it classifies the Captain's looking as a question about the radio frequency to be used. The assignment of meaning to the prior look is available for negotiation. The Captain could, for example, dispute the classification and claim that he already knew the frequency. But this is not the case. Repeating

the radio frequency with the rising intonation, the Captain's utterance is in line with the First Officer's classification of the looking behavior as a request for specific information. Secondly, how did the Captain succeed in getting the frequency from the First Officer merely through his silent look, without using words? In this situation, the pilots share an extensive amount of prior knowledge and expectations of how things should go or, how they typically go in an airline cockpit (for instance, both pilots know, without verbalizing it, that the ATC call is supposed to be responded to by the Captain). This shared knowledge is used by the participants as a resource for constructing an intersubjective understanding of the particular situation (see Wertsch 1985; 1993; D'Andrade 1980). The intersubjectivity in turn permits efficient kinds of communication. The idea that the Captain was able to communicate his need for specific information merely looking at the First Officer was because the "glance occurred in a context of intersubjectively shared understandings about the nature of the current situation" (Hutchins & Klausen 1996, 24). In this case, importantly, the grounds for the construction of the shared understanding depend on a special distribution of knowledge within the pilot community.

From distributed cognition to the sequential order of action

According to the theory of distributed cognition (Hutchins 1995a), to summarize, the individuals in a cognitive system have shared access to the prior knowledge and expectations that enables them to become aware of each other's conduct and to coordinate their action. In the cockpit case, the pilots were able to construct an intersubjective understanding of their situation based on their access to shared knowledge about how things are supposed to go. Within this context of shared understandings, the Captain succeeded in getting the radio frequency information from the First Officer by visual rather than verbal means.

Finally, how would the CA approach deal with the present data? Would there be some major theoretical and analytical divergences between the theory of distributed cognition and conversation analysis? To begin with, the conversation analytic researchers seem to have a somewhat different notion of intersubjectivity than the proponents of distributed cognition. Instead of highlighting the meaning of 'implicit' resources (i.e., stored knowledge and experience), conversation analysis concentrates on the participants' use of, and orientation to, 'explicit' resources (i.e., verbal, visual and material practices) in achieving an intersubjective sense of action-in-progress (see Heritage 1984a, 254-260); consequently, in contrast to the distributed cognition approach in which intersubjectivity can be treated as a 'basis for communication' (Hutchins & Klausen 1996, 22-25), the conversation analytic perspective considers intersubjective understanding primarily as an 'outcome of communication', continuously produced and reproduced through the details of the participants' talk and visual conduct.

Secondly, the previous case does not necessarily or directly exemplify intersubjectivity as a particular precondition for effective cockpit communication. Instead, this case illustrates the phenomenon of problematic understandings in the sequential course of a cockpit interaction; the pilots locate and resolve the trouble through the temporal coordination of talk and embod-

ied action in the cockpit; the processing of the problem momentarily interrupts the current task performance, i.e., the pilot-controller communication, on the flight; the resumption of the suspended activity requires the achievement of intersubjectivity between Captain and First Officer. The more detailed sequential analysis could focus on the 2.5-second pause in cockpit talk, after the ATC message, and the ensuing activities (see arrows marked by me on the transcription 1c). Thirdly, the sequentially appropriate environment to start the interaction analysis is not the Captain's looking activity, as Hutchins and Klausen (1996) suggest, but rather the preceding activities or 'moves' in the course of cockpit interaction.

Transcription 1(c)

0254	OAK24L	NASA nine hundred...roger contact Oakland center one thirty two point eight.	
		{F/O pulls his hand back from the altitude alert knob when ATC says "contact Oakland center." 2.5 seconds after the end of ATC transmission, F/O looks at Capt}	←
		{Capt looks at F/O.}	←
0300	F/O	Thirty two eight.	←
	Capt	Thirty two eight?	
	F/O	Yeah.	
	Capt	OK	
0303	S/O	That's correct, NASA nine hundred.	
	Capt	One three two eight, NASA nine hundred.	←
		{Capt twists knob on radio console}	

(Hutchins & Klausen 1996, 16.)

At the beginning, the ATC instructs the flight crew to contact '*Oakland center*' whose the radio frequency is '*one thirty two point eight*' (see 0254). After the ATC instruction, there is a 2.5-second pause in the cockpit talk. What is happening here? At this particular sequential place, the Captain is failing to respond to the ATC message despite the fact that it is his responsibility to do so in the role of 'Pilot-not-flying'. After the 2.5 seconds of non-talk, the First Officer shifts his gaze towards the Captain; using this looking activity, the First Officer visually addresses the task of responding to the Captain. The Captain then responds to the First Officer's gaze by looking back. The First Officer's utterance, '*thirty two eight*' (see 0300), displays his understanding of the Captain's looking activity as the request for the frequency information. By repeating the radio frequency with a rising intonation ('*thirty two eight?*'), the Captain demonstrates his candidate understanding of the prior talk. Once the First Officer has

confirmed this understanding with '*yeah*' and the Captain has acknowledged the confirmation with '*OK*', the Captain starts acting in line with his official duties by responding to, or reading back, the ATC instruction ('*One three two eight, NASA nine hundred.*')

In lieu of emphasizing the individual pilots' tacit knowledge and beliefs in the particular situation, the conversation analysis directs its attention to the sequentially organized courses of talk and social interaction. In line with this, fourthly, the Captain's gaze and any other activity accomplished in the cockpit becomes understandable and interpretable in and through its relation to the previous turn(s) or move(s); at the same time, importantly, any 'current' action forms the context for some 'next' action in a sequence, therefore contributing to how the next action will be understood (Heritage 1984a, 242). Fifthly, rather than the researcher interpreting of what is going on in people's heads, the conversation analyst aims to figure out how participants themselves interpret and make sense of one another's conduct. These mutual understandings are displayed in the sequentially organized details of interaction and, because they are publicly produced they are also available for analysis (Heritage & Atkinson 1984, 11). At a more practical level, lastly, the reliability of conversation analytic research calls for complete and detailed transcriptions of audio and video recordings, among other things (see Peräkylä 1997b, 203-207). Within a conversation analytic framework, the transcription above should thus be refined and elaborated to include the exact descriptions of the temporal coordination of talk and action (such as the duration of pauses within and between the turns at talk, the initiation of gestural movements relative to talk, etc.).

1.3   OVERVIEW OF CHAPTERS 2-7

The aim of Chapter 2 is to set out and describe the methodological and theoretical foundation of the study. Ethnomethodology and conversation analysis (EM/CA) provide the main methodological tools for the empirical analysis of the cockpit interaction (see 2.1). EM and CA seek to explain how the orderliness of human activities – their regular, patterned or structured nature – is produced and made recognizable by the participants acting within local situations (see, e.g., Clayman & Maynard 1995). The theoretical roots of the current study lie in the anthropology of science and technology and the body of research known as 'workplace studies' (Suchman 1987; C. Goodwin 1995; Heath & Luff 2000; Luff, Hindmarsh & Heath 2000a). These traditions concern the ways in which tools and technologies feature in work and interaction in complex organizational environments. They focus on both face-to-face interactions, in which participants share the same physical space, and the production of activities which are coordinated between personnel within different domains (see 2.2). Chapter 3 has two basic objectives: to present and describe, firstly, the social and technical characteristics of the cockpit setting and, secondly, the research data used in this study (see 3.1-3.7). The empirical analysis of videotaped cockpit interactions has been conducted along two problem dimensions (see Arminen 2005b; Schegloff 2007). The first dimension, called cockpit 'talk-in-interaction', cov-

ers the sequence structure, the relationship between turns at talk. The second dimension, called cockpit 'talk-and-action-in-interaction', covers the sequential order, the relative positioning of moves, utterances or actions. The three analytical chapters (4-6) are constructed around the problems as follows: Chapter 4 analyzes the problems the pilots have in speaking, hearing and understanding the cockpit talk (see 1st dimension); Chapter 5 extends the scope of analysis by concentrating on the problems the pilots have in establishing the sequential order of action and activities during the flight (see 2nd dimension); Chapter 6 refines the analysis by considering the role and meaning of the gestures of the pilots in processing problematic understandings in cockpit interaction. The main research results and findings are summarized and discussed in Chapter 7. The aeronautical terms and abbreviations relevant to this study are listed in 'Glossary' after 'Abstract'.

Theory and methodology

Theoretically, this research is based on the anthropology of science and technology and workplace studies (Suchman 1987; C. Goodwin 1995; Heath & Luff 2000; Luff et al. 2000a). These traditions form a naturalistic approach committed to the detailed study of social and work practices in complex organizational settings. The analytic attention is directed towards the tacit body of reasoning and procedures through which the participants produce, make sense of and coordinate their activities with each other. Drawing on the combination of the methods of ethnomethodology (EM), conversation analysis (CA) and ethnography, the approach analyzes the production and coordination of tasks in real-time interaction through talk and visual conduct. This chapter consists of two main sections. The first Section (2.1) includes a description of the primary method used in this study: conversation analysis with its roots in ethnomethodology. The second Section (2.2) presents ethnomethodologically informed research in workplace studies. The case studies provide a body of empirical observations and findings on the situated and contingent use of technology in various work environments. Although a secondary method only, ethnography is of great importance in providing background understanding of the institutionally distinct setting of an airline cockpit. The ethnographic fieldwork typically involves the ethnographer participating in people's daily lives for an extended period of time, watching what is going on, listening to people and asking questions to clarify the issues that are the focus of the study (Hammersley & Atkinson 1983, 2). In this study, the knowledge gained through ethnographic strategies is a necessary precondition for the detailed analysis of videotaped cockpit interactions. The role of ethnography will be further discussed in Chapter 3; section 3.7 includes a thorough description of the ethnographic work and other related techniques that turned out to be useful in enhancing my understanding of the interactions between pilots on a flight.

Conversation analysis (CA) offers the most appropriate tools for a detailed scrutiny of the videotaped cockpit interactions. The development of this research tradition is closely associated with the ideas of American sociologist Harvey Sacks and his colleagues. Sacks's theoretical thinking was strongly influenced by two contemporary perspectives (see Hutchby & Wooffitt 1998, 24-37). One was Ervin Goffman's attempt to promote the acceptance of the 'interaction order' of face-to-face communication (1959; 1983). The other was Harold Garfinkel's

ethnomethodology, which had developed in the empirical studies on practical reasoning and common-sense knowledge in everyday life (Garfinkel 1967). As an introduction, I will briefly sketch the foundations of ethnomethodology and the origins of conversation analysis. After an overall account of the basic principles of conversation analytic methodology (2.1.1), I will introduce two related concepts which are of special significance for my research: adjacency pairs and intersubjectivity (2.1.2). In doing conversation analysis, particular comparative operations can be used; section 2.1.3 considers the role of comparisons between ordinary conversation and institutional settings. At the end of Section 2.1, I will recapitulate the affiliations between ethnomethodology and conversation analysis and the basic assumptions of the methodology used (see 2.1.4).

Section 2.2 on 'workplace studies' summarizes relevant earlier research done in a range of technological work environments, including the ground operations control room of an airport, the control room of the London Underground and an airline cockpit. In these complex settings, 'centres of coordination', the personnel collaborate through various technologies to coordinate co-located and distributed activities and deal with 'normal, natural troubles' in maintaining schedules. An introduction to Section 2.2 concerns the foundations and background of workplace studies. After introducing Suchman's (1993) idea of the 'centres for the coordination of human activity' (2.2.1), I will turn to more detailed discussion of the empirical studies conducted in the field (see 2.2.1.1-2.2.1.4). The case studies illuminate the social and interactional organization of technology in complex organizational settings. The analyses reveal the ways in which work activities are accomplished and routine problems managed in settings saturated with technology. The issues and phenomena to be discussed include the sequential organization of human-computer interaction, the interpretative and inferential work by the personnel using the technical equipment and the various forms of co-participation in collaborative work. Section 2.2 ends with a 'Summary' of key insights and the contributions of ethnomethodologically oriented workplace studies (2.2.2).[1]

2.1   ETHNOMETHODOLOGICAL CONVERSATION ANALYSIS

Ethnomethodology, both as a term and as a research orientation, was founded by the American sociologist Harold Garfinkel in 1950s. His seminal book *Studies in Ethnomethodology*, which was published in 1967, brought this distinctive perspective into the public domain. Garfinkel did empirical research on how ordinary people use tacit knowledge and reasoning procedures to produce and recognize intelligible courses of action. In this view, the social order is seen as an emergent achievement resulting from the joint efforts of members of society acting within

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1   Along with ethnomethodology, workplace studies can be approached from a variety of other perspectives, such as course-of-action analysis, activity theory and distributed cognition (see Heath, Knoblauch & Luff 2000, 305-308; Heath & Luff 2000, 15-19).

local situations (Maynard & Clayman 2003, 174). The stress on the knowledge-ability of actors shows how they analyze their circumstances and maintain intersubjective understanding of them (Heritage 1987, 226).

Ethnomethodological studies focus on the ways in which societal members produce, recognize, and render their actions accountable in context. The studies emphasize the practices that ensure the accountability of actions, i.e., the detailed, collaborative ways in which members manage their conduct and circumstances to achieve order in everyday activities. (Zimmerman & Boden 1991, 7.) The subject of ethnomethodological studies is the 'ethno-methods' – the lay practices, knowledge and reasoning procedures – through which members of society make sense of and simultaneously accomplish their practical activities. From an ethnomethodological perspective, then, the social reality is not a preexisting entity but is constantly built up by the actors. (Coulon 1995, 2, 15-16.)

According to Garfinkel (1967), the practical actions demonstrate the norms the ordinary people use in organizing the situation of action. Garfinkel's idea of the norms in social action differs drastically from that propounded by Parsons (1937). Parsons theorizes that the rules and maxims of conduct are internalized 'need positions'. The role of a norm is essentially guiding or determining conduct in pre-defined scenes of action. From Garfinkel's standpoint, the normative conventions are considered as resources by which participants in interaction render their circumstances both intelligible and morally accountable. The norms of conduct are constitutive of the activities and circumstances to which they are reflexively applied by actors. (Heritage 1984a, 103-134; 1987, 240-248.)

The lay 'methodology' (i.e., the ethno-methods of people) is uncovered in and through members' use of language and action. For Garfinkel, understanding language amounts to understanding utterances or actions carried out in a particular context. Any utterance or action gains its meaning in the context of its production, i.e., by reference to the time and place of talk, etc. The practical, everyday language and action is thus indexical for a given setting. (Heritage 1984a, 135-157; Coulon 1995, 17-20.) The fact that language is analyzable only in relation to its context becomes obvious in indexical or deictic expressions (see Levinson 1983, 54-96): the sense of the referent of 'this', 'that', 'here' and 'there', for example, is contextually determined without exception.

Ethnomethodological studies concern the body of common-sense knowledge and reasoning procedures through which ordinary members of society make sense of and act upon their local circumstances (Heritage 1984a, 4).[2] The common-sense knowledge in question is specifically that of members. 'Member' as a term does not allude to any social category but to mastery of natural language, where language encompasses both grammar and its use (Garfinkel 1972, 304-305). Fundamentally, natural language with its indexical properties provides a window through which to see "that the orderliness, rationality, accountability of everyday life is . . . a 'contingent, ongoing accomplishment,' a kind of 'work,' or 'doing.'" (Garfinkel 1972, 304).

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2   On the problems of studying commonsense practices, see ten Have 2004, 154-161.

Inspired by ethnomethodology, conversation analysis developed from the collaboration between Harvey Sacks and his colleagues Emanuel Schegloff and Gail Jefferson (see Sacks et al. 1974; Schegloff & Sacks 1973). Initially, CA originated in the insights of Sacks, who lectured in the sociology departments of the University of California at Los Angeles and Irvine in 1964-1972. The tape-recorded lectures were edited by Gail Jefferson and published as a book (see Sacks 1992a & b).[3] Like Garfinkel, Sacks was intrigued by the levels of social order that could be uncovered in the details of language use. Sacks's notion of 'order at all points' holds that social interaction is a structurally organized phenomenon; not even the smallest details should *a priori* be seen as trivial or uninteresting (Hutchby & Wooffitt 1998, 21-22; Arminen 2005a, 12).

To examine the orderly features of social action, Sacks began to use recorded data on naturally occurring talk. The tape-recordings enabled him to replay, transcribe and study the research materials in detail; importantly, the recordings could be observed and analyzed by others as well (see Sacks 1984, 26). By means of recorded data, Sacks was able to observe the members' sense-making – the establishment and maintenance of shared understanding – as it occurred in a situation of action (Hutchby & Wooffitt 1998, 33). Sacks's concerns with orderly structures of everyday human conduct with the help of real-world data are the main characteristics of his work and of conversation analytic method. The methodological principles of conversation analysis are discussed further next.

2.1.1 The methodological basis of conversation analysis

Conversation analysis (CA) is the study of talk. To put it more precisely, it is the systematic analysis of 'talk-in-interaction' (Schegloff 1987a) – the term encompassing talk and other interactional activity such as physical activities, gestures and the paralinguistic features of talk. The aim of CA is to uncover the tacit, organized reasoning procedures which inform the production and interpretation of naturally occurring talk. CA seeks to explicate these procedures on which participants rely in producing utterances and making sense of one another's talk. (Hutchby & Wooffitt 1998, 1.) The focus is on how particular social actions are organized and locally produced through talk. The issue of what a given utterance is doing in the service of some identifiable action – such as requesting, joking, complaining or closing the conversation – is relevant. (Schegloff & Sacks 1973; Schegloff 1987b.)

CA is based on three primary assumptions (see Heritage 1984a, 241-243). Starting from the most fundamental one, social action and interaction is structurally organized. All aspects of social interaction can be found to demonstrate stable organizational patterns of action to which participants orient. Like other social institutions or conventions, these organizations are independent of psychological, sociological or any other characteristics of the participants.

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3   This publication is posthumous (Sacks died in a car accident in 1975).

Knowledge of these organizations is part of the competencies the participants use in organizing their conduct and interpreting the conduct of others. The participants' orientation to structural organizations is relevant for the ways they design utterances in the course of interaction (Schegloff 1991).

The second assumption holds that the utterances are simultaneously context-shaped and context-renewing. Here, the meaning of context is twofold, referring both to the local configuration of prior activity in which an utterance occurs and to the larger sequence of activity within which that configuration occurs. (Heritage 1984a, 242; 1989, 22.) How any action's contribution to the ongoing sequence of actions is understood depends on the context in which it occurs. In this sense, utterances are shaped by the context. While every current action will itself form the context for some succeeding action, it will contribute to the contextual framework within which this action will be understood. Any current action can thus also be seen to renew the context of a succeeding action. (Heritage 1984a, 242.)

The third assumption maintains that no order of detail in interaction can be dismissed as trivial or uninteresting before it is subjected to analysis – a significant argument for how conversation analytic research is done (Heritage 1984a, 242-243). An empirical approach to the study of social interaction is favoured instead of prior theory construction. The idealization of data is seen as hindering the development of appropriate analysis, and is therefore shunned. The analysis is data-driven, i.e., developed from phenomena which are evidenced in the details of interaction data. The social interaction in all its details is best approached through the analysis of recorded, naturally occurring data (Heritage 1989, 22; Hutchby & Wooffitt 1998, 13).

Conversation analytical studies describe 'regular forms of organization' in materials produced by different speakers. The participants produce and orient to these regularities as normative grounds for action. In other words, the participants hold themselves morally accountable for departures from such regularities. At this point, the analysis of deviant cases – in which some proposed regular procedure is not realised – becomes relevant (Heritage 1984a, 243-244.) The deviant cases strengthen the analysis, as the researcher may either modify the original account so that deviant features can be included in it, or, preserve the original analysis and produce a separate analysis of deviant cases (Arminen 2005a, 70-71; Clayman & Maynard 1995, 8-9).[4]

2.1.2 Adjacency pairs and intersubjectivity in conversation

CA describes the procedures and expectations through which participants produce and make sense of ordinary conversational conduct. Conversation analytic studies examine the organizational features of talk as they are displayed and understood in the actual events of interaction.

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4   For the analysis of deviant cases, see Schegloff (1972) on telephone interaction; Heritage & Greatbatch (1991) and Heritage (1998) on news interviews; Arminen (1998) on AA (Alcoholics Anonymous) meetings.

The units of analysis in CA are larger than the individual utterances alone. The analysis concerns the ways in which utterances accomplish particular actions in terms of their placement and participation within sequences of actions. Consequently, the scope of these studies covers action sequences and their component unit turns that are conceived as turns-within-sequences. (Heritage 1984a, 245.)

To begin with the description of sequentially organized actions, the production of some current turn proposes a local definition of the situation to which subsequent talk will be oriented (Heritage & Atkinson 1984, 5). More specifically, the phenomenon of the 'sequential implicativeness' of a turn's talk (Schegloff & Sacks 1973, 296) takes place when some current turn projects a relevant next action, or range of actions, to be performed by another speaker in the next turn. This projection of the relevant next action is conventionally accomplished through the identifiable pair of actions known as an 'adjacency pair' (Schegloff 1972; Schegloff & Sacks 1973, 295; see also Heritage 1984a, 245-253).

Schegloff and Sacks (1973, 295-296) characterize the adjacency pair as (1) a sequence of two utterances which are (2) adjacent, (3) produced by different speakers, (4) ordered as a first pair part and second pair part, and (5) typed, so that a first part requires a particular second part(s). Instances of pair types include greetings and return greetings, questions and answers, invitations and acceptances/declinations and so on. The adjacency pair structure is normative in character. To exemplify that point, questioners orient to the fact that their questions are framed within specific normative expectations. These expectations have sequential implications for the next speakers to perform a particular kind of action – namely, to answer the question. (Heritage 1984a, 249.)

Providing the next speaker fails to respond, his/her behaviour becomes accountable. The first speaker may infer that the recipient has some trouble in responding. By repeating the question, the first speaker displays that the answer to the original question was appropriate and it is 'officially absent' (Schegloff 1972, 364).[5] The regular occurrence of certain paired actions is explained by the property of 'conditional relevance' (Schegloff 1972), which stipulates that the production of the first pair part makes a corresponding second pair part both relevant and expectable (see also Schegloff & Sacks 1973). This constraint allows the speakers (and the analysts) to recognize whether some conversational events, such as answers to questions, are noticeably absent (Heritage 1984a, 249).[6]

Whilst the apparatus of adjacency pair is important in many respects (see Heritage 1989), only a few points are discussed here. As mentioned, the paired action sequences offer a systematic basis on which the speakers, and the analysts, can determine whether relevant next actions are noticeably and specifically absent. The organization of adjacency pair is also significant in terms of how intersubjectivity – the mutual understanding of ongoing (inter)action – is accomplished and displayed in talk. As Schegloff and Sacks (1973) describe:

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5   On the location and management of official absences in cockpit talk, see Chapter 5: section 5.2.3.
6   On the procedures through which the speakers deal with 'no responses' to their assertions, see Pomerantz (1984).

by an adjacently positioned second, a speaker can show that he understood what a prior aimed at, and that he is willing to go along with that. Also, by virtue of the occurrence of an adjacently produced second, the doer of a first can see that what he intended was indeed understood, and that it was or was not accepted. Also, of course, a second can assert his failure to understand, or disagreement, and inspection of a second by a first can allow the first speaker to see that while the second thought he understood, indeed he misunderstood. (Schegloff & Sacks 1973, 297-298.)

The production of a first pair part, such as an 'invitation', makes relevant a particular action to be done next, or a limited set of such actions. By 'acceptance', among other alternatives, the second speaker not only complies with the constraints of the adjacency pair structure but also displays an understanding of what the prior utterance was doing (see Sacks et al. 1974, 728-729).[7] The producer of the initial turn may comment on or correct the second speaker's understanding in the third turn of the sequence. Essentially, the adjacent positioning enables co-participants to display their understandings of the ongoing talk and to recognize possible misunderstandings in conversation (see Schegloff & Sacks 1973, 297-298).

The structural organization of conversation is managed on a turn-about basis. These resources provided by the mechanisms of talk-in-interaction enable the co-participants to publicly display and continuously update their intersubjective understandings (Heritage & Atkinson 1984, 11). In this regard, mutual understanding is a methodical achievement (Garfinkel 1967, 38-42; 1972, 315-321; Psathas 1977, 89-96; Heritage 1984a, 254-260). Since public understandings are a kind of by-product of sequentially organized action, the issue of 'understanding' itself is only rarely discussed by the participants. In other words, turn-by-turn organization of action enables participants to refrain from explicitly or literally confirming their understandings to one another. (Heritage 1984a, 259.)

The activity feature of adjacency pair structure is central in terms of action interpretation. The action used by the first speaker forms a basis for interpretation of what the second speaker will say. In the succeeding action, the second speaker displays an interpretation of prior action. This interpretation is publicly available to the first speakers to determine whether they were understood. (Heritage 1984a, 254-256.) A mutual understanding entailing the courses of interpretation is thus operationally structured within ongoing interaction (Garfinkel 1967, 31; 1972, 321). Because of their 'public' nature, these understandings are also available for analytical scrutiny by social scientists (see, e.g., Sacks et al. 1974, 728-729; Heritage & Atkinson 1984, 11; Hutchby & Wooffitt 1998, 15-17.)

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7   The grasp of what the utterance is doing may differ between overhearers or analysts of talk and co-participants in the actual course of conversation: the sense of what is going on in talk may seem ambiguous for the former but not necessarily for the latter. (See Schegloff 1984b.)

2.1.3 Ordinary as against institutional interaction

Conversation analysis started from the study of the mundane, everyday conversation that is the predominant medium of interaction in the social world: we use it to raise our children, maintain family relationships, friendships, love affairs, and so on. It is suggested, then, that the basic forms of mundane conversation constitute a kind of bedrock against which more formal or institutional types of interaction are distinguished. A comparative analysis between institutional interaction and normative procedures of interaction in ordinary talk provides one important way of doing conversation analytic research. (See Sacks et al. 1974, 729-731; Heritage 1984a, 238-240; Drew & Heritage 1992a; Hutchby & Wooffitt 1998, 146-149; Arminen 2005a, 43-47.)

The term 'institutional interaction' refers to the talk through which participants conduct their particular institutional tasks and goals (Peräkylä 1997a, 177; Drew & Sorjonen 1997, 92).[8] Interaction is institutional to the extent that participants orient to their institutional or professional identities to perform particular work activities, an orientation evidenced in the details of language through which the participants manage their institutional tasks (Drew & Heritage 1992b, 3-4; Drew & Sorjonen 1997, 97). Importantly, therefore, the institutional context is not an external constraint causing certain forms of interaction to occur, but rather the ongoing accomplishment of the participants in interaction (Hutchby & Wooffitt 1998, 171; Arminen 2005a, 19).

The first systematic analysis of institutional interaction was done by Atkinson and Drew (1979) who compared interactions in the courtroom and everyday settings. Some of their later studies also concern interaction in the legal environments (Drew 1985; 1992; Atkinson 1992; see also Pomerantz & Atkinson 2003; Pomerantz 1987). Other research areas on institutional interaction include, for example, classroom or instructional settings (see, e.g., Mehan 1979; 1985; McHoul 1990; Psathas 1992), news interviews (see, e.g., Heritage 1985; Greatbatch 1988; Clayman 1988; Heritage & Greatbatch 1991), counseling and social welfare (see, e.g., Linell & Fredin 1995; Silverman 1997; Sarangi 2000), medical settings (see, e.g., Sharrock & Anderson 1987; ten Have 1991; Maynard 1992; Heath 1992a; Ruusuvuori 2000) and architectural practices (Heath & Luff 2000, 155-178; Mondada 2006).

These studies show how participants, through the design of turns and sequences of turns, orient to particular institutional identities, thereby managing their practical tasks in a given institutional setting (Drew & Sorjonen 1997). The participants may be either professional members of the institutions or their 'clients' (students, patients, etc.). The studies on institutional interaction concern the ways in which institutions and organizations, such as hospitals or schools, are 'talked into being' (Heritage 1984a, 290; see also Arminen 2005a). The aim is to describe the patterns of interaction in institutional settings and to indicate, if possible, how

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8   Drew and Sorjonen (1997) use the term 'institutional dialogue'.

they differ from the characteristics of ordinary talk (Heritage 1989, 33; Drew & Sorjonen 1997, 106).

The institutional features of interaction are often manifested in differences from ordinary interaction. These differences tend to involve 1) specific reductions of the range of options for action that are available in mundane interaction and 2) systematic specializations of the interactional functions of the remaining activities (Heritage 1984a, 239-240; Drew & Heritage 1992b, 26-27). The unique 'fingerprint' of any form of institutional interaction rests on a set of conversational practices that are differentiated from ordinary talk and from other institutional interactions. The institutionalized reductions and specializations of conversational options are conventional and exposed to processes of social change. (Heritage & Greatbatch 1991, 95-96; Drew & Heritage 1992b, 26.)

In contrast to ordinary conversations, many kinds of institutional encounter exhibit a standard shape or order of phases. Institutional activities are conducted in a repetitive and fixed sequence, which lends a distinctive structure to such encounters. (Drew & Sorjonen 1997, 109-110; see also Zimmerman & Boden 1991, 13.) However, the boundaries between institutional and ordinary talk are not rigid. For example, the activity of cross-examination is not restricted simply to legal settings, but may also occur in private homes. Similarly, people in workplaces may talk about things unrelated to their work. A single interactional exchange can thus involve both institutional and conversational features of talk. (Heritage 1984a, 240; Drew & Sorjonen 1997, 92-94.)

The basic comparison between institutional and ordinary talk can begin from the analysis of turn-taking. Sacks, Schegloff and Jefferson (1974) in fact introduced the idea of doing comparative research on different turn-taking systems in their early paper on turn-taking, a system which allocates turns between participants. A turn consists of one or more turn-constructional units (TCU). The unit types involve single words (such as *hello*, *yes*), phrases, clauses and sentences. When the current speaker completes any such unit, s/he reaches a possible transition relevance place (TRP); i.e., a point at which a potential next speaker may start a turn. In ordinary conversations, turn-taking is managed locally, without any predetermined arrangements. In more formal settings, by contrast, allocation of turns is based on a fixed order of who takes the floor and when. (See Sacks et al. 1974.)

Heritage and Greatbatch (1991) compared the turn-taking procedures between news interview interaction and ordinary conversation. In the news interviews, unlike conversation, the types of turns are pre-specified to permit the interviewer (IR) to ask questions and the interviewee (IE) to answer them. Through the question-answer sequences, the parties not only constitute themselves as IR and IE, but also collaboratively maintain the 'interview' character of the interaction. Moreover, both IR and IE may use a number of turn constructional units in producing their talk. The entitlement for long turns in news interviews departs from ordinary conversation where turn-taking system tends to minimize turn size (Heritage & Greatbatch 1991, 97-102; see also Sacks et al. 1974).

In everyday conversation, however, the speakers may use multiple turn constructional units, among other things, in telling stories. The listeners actively participate in storytelling with particular response tokens such as 'continuers' (*uh huh*, *yeah*, etc., see Schegloff 1982) or objects treating the prior talk as informative or news (*oh*, *really*, etc., see Heritage 1984b). In news interviews, the IE may produce long responses to the IR questions. In this case, however, the IR refrains from producing response tokens in the course of IE talk. The systematic absence of tokens is a means by which news audience is maintained as the primary addressee of IE talk.[9] By sticking to 'questioning' activities only, the IR adheres to the provisions of turn-taking in the news interview context. (Heritage & Greatbatch 1991, 107-113.)

The social world of news interviews, as well as of any other institutional form of interaction, is invoked and made actionable in and through talk. The institutional realities are not only 'talked into being' but they also exist in and as documents, buildings, official arrangements, and so on, as Heritage (2004, 222-223) points out. The conversation analytic studies on institutional interaction can include comparisons between ordinary talk and institutional conversational practices. The comparative approach uncovers the ways in which non-specialized interactional procedures function in specialized institutional settings. It also helps the analyst to determine the characteristic features of the particular form of institutional interaction. (Drew & Heritage 1992b, 38-39.)

2.1.4 Summary

The conversation analytic perspective developed from ethnomethodology in the 1960s and 1970s. Despite some differences, the commonalities between the two approaches are obvious (see Clayman & Maynard 1995). They both treat everyday human conduct as a meaningful activity, and as produced to be such by participants in interaction (Pomerantz & Fehr 1997, 69). These approaches reject 'top-down' theories that attempt to explain social order in terms of cultural or social phenomena which stand outside of everyday settings. Instead, they adhere to the 'bottom-up' approach in which the social order is a local achievement resulting from the observable orientations the participants display to each another. (Clayman & Maynard 1995, 2-4.)

The procedures members use to produce and recognize intelligible courses of action are crucial to the achievement of social order. The levels of social order are revealed in the natural language used by members within local situations. For both EM and CA, the interest in the

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9   Maynard and Clayman (2003, 196, footnote 4) suggest that an item is "systematically absent" when the analyst "can (1) formally characterize the sequential environment at hand, (2) show that the item in question regularly occurs at that sequential juncture in other situations, and (3) show that in the present class of situations the item is regularly withheld". Therefore, as Maynard and Clayman (ibid., see also Clayman & Maynard 1995, 29-30, footnote 8) claim, the systematic absences somewhat differ from "official" absences of talk (Schegloff 1972, 364): An item is "officially absent" when its nonoccurrence is noticed and explicitly oriented to by the co-participants (see also section 2.1.2 above).

properties of natural language use emerged through the phenomenon of indexical expressions (Maynard & Clayman 2003, 182). The term 'indexicality' implies, briefly, that the meaning and intelligibility of an utterance depends on the context in which it occurs. The indexical features of language are not seen as an obstacle but rather as a resource for the achievement of shared understandings in everyday settings (Heritage 1987, 250).

Peräkylä summarizes the basic assumptions of conversation analytic research in the following points: "(1) *talk is action*, (2) *action is structurally organized*, and (3) *talk creates and maintains intersubjective reality*." (2004, 166-167; emphasis original.) In CA, utterances are treated as objects which speakers use to accomplish particular actions in the course of their interactions (Hutchby & Wooffitt 1998, 19). The individual acts are parts of larger, structurally organized sequences. The most basic sequence, called the 'adjacency pair' (Schegloff & Sacks 1973), consists of two actions in which the first action ('first pair part'), produced by one speaker, requires a particular type of second action ('second pair part') to be produced by another speaker.

Through the sequential organization of action, the participants create and sustain a context of publicly displayed and continuously updated intersubjective understandings (Heritage 1984a, 259; Heritage & Atkinson 1984, 11). At least three levels of intersubjectivity can be distinguished, of which the most fundamental concerns the understanding of the prior turn displayed by the current speaker (see Peräkylä 2004, 168). For example, in producing a turn that is hearable as an answer, the speaker shows that s/he has understood a prior turn as a question. If the first speaker considers the understanding of his/her talk displayed in the second speaker's utterance as false or problematic, s/he may repair this (mis-)understanding in the 'third position' (Schegloff 1992a).

Another level of intersubjectivity concerns the state of the talk. In initiating a new topic, for example, the speakers display their understanding that 'then and there' is an appropriate place to raise something new. (Heritage & Atkinson 1984, 10.) The final level of intersubjective understanding deals with the context of talk which is especially significant in institutional interaction, i.e., interaction through which participants accomplish their institutional tasks and goals. The participants' understanding of the institutional context of talk can be observed in the details of their actions, i.e., in the ways of asking and answering questions, of giving and receiving information, and so on. (Peräkylä 2004, 168; see also Schegloff 1991; 1992b; Drew & Heritage 1992a.)

From the outset, conversation analysts have been concerned with both verbal and paralinguistic features of talk, such as sound qualities, pauses, interruptions, restarts, and overlaps (Pomerantz & Fehr 1997, 65). In the 1980s, a bunch of researchers widened the scope of CA by examining the ways in which talk and bodily conduct are coordinated with each other in social interaction (see, e.g., C. Goodwin 1980; 1981; M. Goodwin 1980; Schegloff 1984a). From the 1990s on, EM and CA have been applied in analyzing the sequential organization of talk and visual conduct in complex technological environments. This body of research, which will be discussed next, is commonly known as 'workplace studies' (see, e.g., Heath & Luff 2000; Heath et al. 2000; Luff et al. 2000a).

2.2   WORKPLACE STUDIES

Workplace studies are about work, interaction and technology in complex organizational settings. These studies concern the ways in which tools and technologies – ranging from paper to multimedia systems – feature in the practical accomplishment of work activities. (Heath & Luff 2000; Heath et al. 2000; Luff et al. 2000a.) The purpose is to explicate the tacit and 'seen but unnoticed' resources in and through which organizational activities are carried out. The analysis focuses on the *in situ* reasoning and knowledge upon which participants rely in accomplishing their routine tasks (Heath & Luff 2000, 19). As a theoretical necessity, the use of technology must be studied where the action is – in everyday settings and at work sites (Arminen 2001, 186).

Characteristically, workplace studies examine the ways in which a range of verbal, visual and material resources are used by the participants in the practical accomplishment of organizational activities. These studies are based on the situated, contingent and socially organized character of workplace activities. It is assumed, then, that the competent accomplishment of individual actions and activities is necessarily sensitive to and thoroughly embedded in the real-time contributions of others. 'Situated' amounts specifically to the emergent, moment-by-moment production and coordination of workplace activities, and the ways in which tools and technologies feature in the accomplishment of those activities. (Heath & Luff 2000, 20-21.)

Workplace studies may analyze both face-to-face interaction, in which participants share the same physical space, and the coordination of activities between personnel located within different domains. The studies include many organizational settings, such as air traffic control (Harper & Randall 1992; Harper & Hughes 1993), an oceanographic research vessel (Goodwin 1995), an emergency dispatch centre (Whalen 1995), a newsroom (Heath & Luff 2000, 61-87; see also Heath et al. 2002, 321-324) and an anesthetic room (Hindmarsh & Pilnick 2002). The combination of ethnography, ethnomethodology and conversation analysis forms the methodological basis of workplace studies. Ethnography is used for overall description of the workplace, whereas the finer details of work activities are revealed through EM and CA. (Arminen 2001, 187.)

Heath and Luff (2000, 8) offer some developments which have directed analytic attention towards the situated conduct of technologically mediated activities. For example, the more traditional models of human-computer interaction have been subject to wide-ranging criticism for focusing on the individual user and utilizing experimental paradigms. These models, which dominate cognitive science, Artificial Intelligence (AI) and Human-Computer Interaction (HCI), are seen as overlooking the collaborative nature of technology use in everyday settings. The experimental setups and methods neglect the situated, contingent ways in which activities are accomplished. They may further constrain the ways of informing the design and deployment of technology for real-world settings. (Luff, Hindmarsh & Heath 2000b, 10.)[10]

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10   The growing dissatisfaction with conventional research within HCI, coupled with technological change, has contributed to the emergence of the 'Computer Supported Co-operative Work' (CSCW) discipline which aims to develop

It is Lucy Suchman and her 1987 monograph *Plans and Situated Actions*, which has facilitated the emergence of workplace studies in the United States and Europe. Her original critique of conventional models in cognitive science and HCI was based on ethnomethodology and conversation analysis. Suchman dissents from the idea that action is determined by pre-specified plans and goals and argues instead that the planned, goal-oriented actions are situated actions, i.e., actions taken in the context of particular social and physical circumstances. In this view, technologies are seen to be inseparable from the situated practices of their use and, accordingly, the technology use must be studied as part of social action in which it occurs. (Suchman 1987; Suchman, Blomberg, Orr & Trigg 1999; see also Arminen 2001.)

In her study on human-machine communication, Suchman (1987) analyzes comprehension problems in users' interactions with a photocopier. These variant understandings are located in the deep asymmetry between person and machine. As findings from EM and CA show, face-to-face interaction will succeed not because of the absence of understanding problems, but because of the resources available for their collaborative identification and repair (see Schegloff et al. 1977; Schegloff 1992a; Sorjonen 1997). These communicative resources are only available to the machines in a limited way, which constrains their ability to engage in joint sense-making as humans do. Research insights into face-to-face interaction are to be applied to the study of human-machine interaction in designing interactive and intelligent machines. (Suchman 1987.)

2.2.1 Centres for the coordination of human activity

As an anthropologist, Suchman has spent time at several organizations. She has, for example, studied the work taking place in the ground operations room at a metropolitan airport in the United States (Suchman 1993; 1996). The setting exemplifies what Suchman calls a 'centre of coordination:'

1) The centre of coordination manages with distributed activities in which one set of participants is responsible for providing services to another. This operation requires that each set will engage and cooperate within themselves and with other sets.

2) The management of activities is influenced by and sensitive to troublesome contingencies. The setting is charged with handling these contingencies; when contingencies arise during the course of action, the participants must be able to do their work in spite of them.

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technologies to support co-operative work. CSCW includes a diverse range of approaches such as distributed cognition, activity theory, symbolic interactionism, actor-network theory, ethnomethodology and conversation analysis. (See Heath & Luff 2000.)

3) Each setting is liable for knitting people and activities together over space and time according either to a time-table or the immediate demands of a time-critical situation. (Suchman 1993, 114-115.)

The centre of coordination is designed to manage with two contradictory forces: on the one hand, the centre has to be a fixed site to which persons distributed in space and time can orientate. To coordinate the distributed activities, the persons within the site need to, on the other hand, have access to the situations of people that are distant in space and time. In the centres of coordination, technology is charged with resolving this contradiction through the establishment of relevant spatial and temporal relations. (Suchman 1993, 115.)

2.2.1.1 Tool-mediated work in a hi-tech environment

The ground operations room is a hi-tech environment equipped with various material artefacts, such as computers, radios, telephones, video monitors, paper and electronic documents. The room is used as a communications centre for the coordination of ground activities at the airport – the activities that involve servicing arriving and departing airplanes. The work in the operations room is characterized by a strict division of labour; i.e., each worker has particular communication responsibilities with other relevant locations. Despite the formal allocation of tasks, individual workers participate in the work of others by overhearing conversations, making corrections or assisting others to cope with the routine problems at work. (Suchman 1993; 1996.)

The ground operations room is not only a workplace in its own right but also part of a larger network of locales: gates, ramps, other airlines' territories at the airport, other airports and the locations of the national organization. In the operations room, the workers control the airplanes moving on the ground and coordinate the activities of their operation. The work may be described as the production of a coherent relation between a normal order of events represented by various technologies and an order of events observable by the personnel at the local site. A salient device for this work is the schedule: the technology that allows the plotting of airplanes into a two-dimensional co-ordinate of space and time. (Suchman 1993; 1996.)

The main task of the operations personnel is to achieve a normal order of on-time arrivals and departures. The maintenance of normal order includes, among other things, the task of entering the departure times into the nationwide computerized scheduling system. In a case to be discussed (see Suchman 1993, 116-117), the person concerned was inserting the time out[11] for particular aircraft into the system. The time entry was received by the system with the message 'OK.' In lieu of accepting this person's next entry for estimated take-off time,[12] the

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11 'Time out' refers here to the time at which an aircraft leaves the gate.
12 'Estimated take-off' time is the time at which the aircraft can be expected to leave the ground.

machine sent an error message 'time out of range'. Subsequently, the person repaired his routine error made at the keyboard by inserting a new, corrected time into the system. The structural organization of the course of human-computer interaction is illustrated in Figure 2.1.

01.   USER: ((enters time out))

02.   DISPLAY: | OK |

03.   USER: ((enters estimated time off))

04.   DISPLAY: | TIME OUT OF RANGE |

05.   USER: ((enters corrected estimated time off))
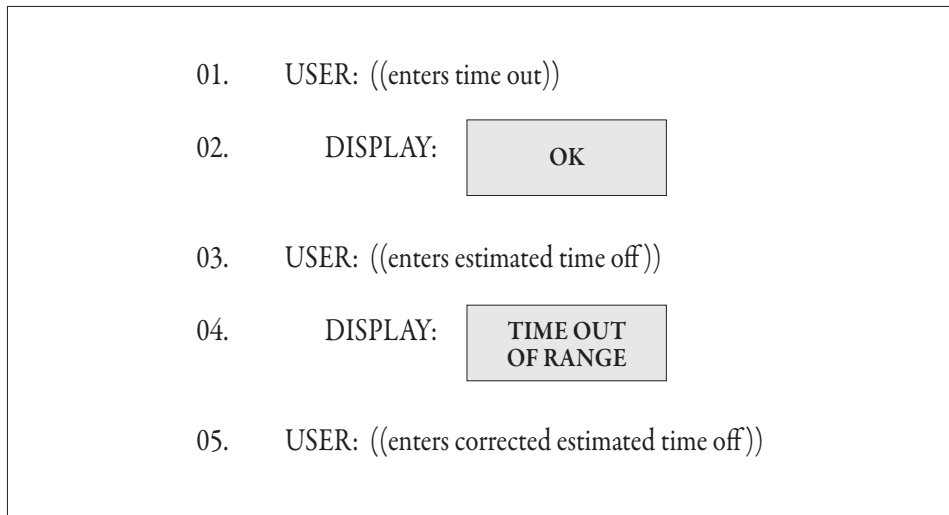
Figure 2.1
Sequential organization of Human-Computer Interaction

This episode brings out some interesting aspects of the nature of human-computer interaction. As shown at lines 2 and 4, the task of differentiating between false and correct time entries had been delegated not to a person, but to a system (Suchman 1993). In this way, the computerized schedule, a particular technology, becomes a dynamic participant in the work of the operations room. The episode also demonstrates the sequential, step-by-step basis of human-computer interaction: the user performs an activity → a system state changes and a display shifts → the user performs next activity, and so on (for further details see Suchman 1987; Arminen 2005a, 202-208).

The case continued (see Suchman 1993, 117-119), as the operations worker started to visually inspect the status of the flight through the video monitor and his window. By comparing the scheduled departure times with what he saw going on at the ramp, the operator concluded that the passenger boarding was a couple of minutes late. He reasoned that the delay in boarding was so short that the flight could be recorded as on time, but the situation was still treated as problematic enough to require continuous monitoring for the signs of further delay. The operations worker addressed his professional competence and skill in practice by maintaining an acceptable relation between a scheduled order and an order observable at the local site.

The next case concerns the 'routine' trouble occurring at the gate of the airport (see Suchman 1996). When the inbound airplane pulls into a gate, the gate workers normally wheel a set of stairs out onto the ramp to be aligned with the door so that the passengers can disembark. In this case, however, the stairs could not be raised up high enough to reach the level of the airplane. Consequently, the passengers were left waiting in a plane and the operations personnel started to deal with the problem among themselves and with those outside the room: gate workers, ramp crew, ground maintenance staff and the pilot witnessing the trouble.

The conversation shown below takes place at the stage of trouble dissolution. Prior to this, the problem had been recognized, formulated and brought to the attention of the relevant others. The conversation occurs between two co-workers at the operations room, the Passenger Service Planner (PP) and the Supervisor of Ramp Services (Sup).[13] Before this episode, the ground maintenance had reported to the Sup that the correction of the stairs was in progress and would be completed in couple of minutes. Despite the ongoing repair work, the Sup asks the PP to re-contact[14] an airline 'Pacific' in order to borrow a set of stairs from there (lines 159-162).

159.	Sup:	U::m (.) let's call them back	*to PP*
160.		we've used them before (.)	
161.		who–who'd you talk to at	
162.		Pacific?	

((8 lines of PP's talk omitted))

171.	PP:	I'll be glad to call them	
172.		back (.) um	
173.		(.8)	
174.	PP:	They were truck stairs	
175.		is that what we used?	
176.		(1.0)	
177.	Sup:	Looks like they might have	*gaze towards monitor*
178.		got it started.	
179.		(1.0)	
180.	Sup:	They got it.	
181.		(5.0)	

(Suchman 1996, 55.)

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13   The operations room is also inhabited with three other co-workers that are named as the Operator A (Ops A), the Baggage Planner (BP) and the Operations B (Ops B).

14   The PP had already once contacted the Pacific to get their assistance; the Pacific refrained from helping by arguing that they did not have an appropriate set of stairs to borrow.

After accepting the prior request, the PP asks the Sup's confirmation about the type of stairs borrowed from Pacific before (lines 171-175). Instead of responding, the Sup notes that the trouble at the gate has been resolved, the ground maintenance seemingly having succeeded in repairing the stairs (lines 177-180). While the Sup is making his observation about the possible trouble resolution, he is gazing at the video monitor (see line 177). The operations personnel employ particular material resources in making sense of what is going on at two physically distinct but operationally connected sites: the operations room and the gate. The video monitor is used here as a source of knowledge in the organization of work and consequently becomes a dynamic participant in an ongoing course of interaction (see also Arminen, Auvinen & Palukka 2009).

2.2.1.2 Production of multiple local perspectives

Charles Goodwin and Marjorie Goodwin have examined the situated organization of action in a range of workplaces. Together with Suchman (1993; 1996), they have analyzed the work practices at the same middle-sized American airport (see M. Goodwin 1995; 1996; C. Goodwin 1996; Goodwin & Goodwin 1996). Some of their studies focus on the role of perception in the work of ground operations (Goodwin & Goodwin 1996; see also C. Goodwin 1996). Looking at airplanes is a crucial activity in the work of operations personnel. This activity is conducted using disparate technologies. The habitual knowledge of the setting includes an awareness of which technology to use to see the airplane in a task-relevant way (Goodwin & Goodwin 1996, 72).[15]

Out of the bunch of technologies, the present analysis concerns the role of video monitors in perception. At the airport, each plane is assigned to a specific gate. The operations personnel can see the whole set of gates by glancing through the monitors at the front of their room. A numerical label (e.g., '12') placed on each monitor determines the airplane's location at a specific gate. The activity of seeing is considered as a social and situated process, in which the operations workers pursue a shared consensus about the airplane's status on screen. As will be shown, the seeing activity can also engender multiple, incompatible interpretations about the scene visible on the screen. (See Goodwin & Goodwin 1996.)

The operations room is now occupied by four experienced workers and one newcomer, Stan, who is still being given instructions on the job. Having gained some work experience in the operations room, Stan has been assigned a position to work on his own. One of the operators, Brad, gets a radio call from the ramp worker outside the room. The conversation concerns a problem with the jet bridge canopy at a particular gate. The jet bridge is an extendible tunnel for loading passengers into the aircraft; the canopy is the transparent enclosure over the aircraft

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15   C. Goodwin has examined the activity of seeing also in the following work settings: an archeological field excavation and courtroom (1994) and an oceanographic research vessel (1995).
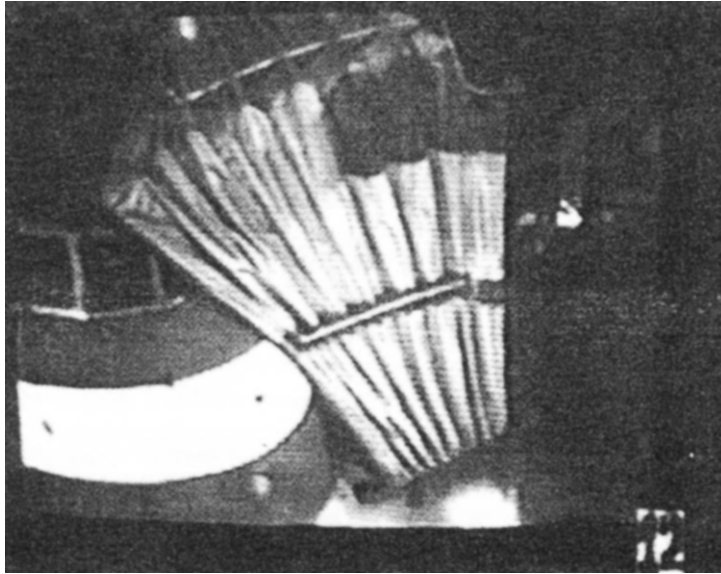
Figure 2.2
The view through the gate monitor
[Goodwin & Goodwin 1996, 82]

cockpit. The problem is that the canopy is in an unusual position as it covers too much of the cockpit. (Goodwin & Goodwin 1996, 79-82, see Figure 2.2.)

Seeing the abnormal position of the canopy through the gate monitor, the operators start to laugh. Through looking activity, the operators accomplish a collaborative, multiparty and transparent interpretation of the 'seeable trouble' at the gate. From their point of view, the problem lies within the jet bridge canopy. The operations personnel is then provided with another version of the trouble at the gate: the ramp crew reports that there is no problem with the jet bridge at all but with the ground power unit as the airplane is not being supplied with power. This information, however, does not change the shared interpretation of the operations workers about the trouble visible in the scene. (Goodwin & Goodwin 1996, 80-83.)

In the following we will see how the operation personnel's shared consensus about the see-able trouble is challenged by Stan, the newcomer. It turns out that Stan does not see the trouble on the screen the way the others do. At the outset, Jay, the supervisor, contacts facilities mainte-nance to ask for a repair crew to handle the problem with the jet bridge. The radio conversation between operations room and maintenance facilities is marked by ■ on the transcription. At lines 4-5, 12 and 15 (arrows added by me to the left), Stan repetitively challenges others in the room about the seeable trouble on the screen.

■	01.	Jay:	Operations to Facilities Maintenance.
	02.	Brad:	O[kay thanks.
	03.	Julie:	[That's good en ugly.
→	04.	Stan:	What is the problem <u>with</u> it?
→	05.		What are they saying is the problem?
■	06.	Radio:	Yeah. They-
■	07.		They won't be here until ten o'clock.
■	08.		(1.4)
■	09.	Jay:	We've got a problem with a <u>jet</u> bridge on alpha twelve
■	10.		right now.
■	11.		Anybody a:ble to handle that?
→	12.	Stan:	What is the problem <u>with</u> it.
	13.	Jay:	Look at the: uh canopy. ←
■	14.	Radio:	What's the problem with it?
→	15.	Stan:	[Yeah but-
■	16.	Jay:	[The canopy has uh: fallen away,
■	17.		<u>from</u> the jet bridge on [to the: (.) cockpit of the aircraft.
	18.	Stan:	[They can still back it up.

(Goodwin & Goodwin 1996, 84.)

Stan repeatedly asks from the others present in the room about the nature of the problem (see lines 4-5, 12, 15). Despite the challenge, the other co-workers continue to treat the trouble as completely obvious (see lines 3, 16-17). Stan's continual enquiries about the problem are finally answered by Jay at line 13, whose response implies that the trouble is with the canopy. By prefacing his talk with 'yeah but' (line 15), Stan offers a challenge to what he has just been told. Despite what can be seen on the screen, Stan proposes 'they can still back it up' at line 18. Stan's talk not only challenges his colleagues' interpretation of the seeable trouble on the screen but also displays competence with jet bridge operations. Afterwards, Jay acknowledges Stan's expertise by asking him to go down to the gate and deal with the problem.[16]

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16 The operations workers actually misrecognized the problem: as it was later revealed, the problem was not with the jet bridge but with the ground power unit. As Arminen points out, the limited technical access to

Each worker brings a particular work history and personal skills to the operations room. As shown, Stan's competence with the jet bridges cuts across the formal hierarchy of the work community. Although a novice, Stan might successfully challenge his supervisor's analysis of the events visible on the monitor. Instead of ignoring Stan, the supervisor both listened to him and drew upon the skills he displayed. By articulating their interpretations of the scene visible on the screen, operations workers organize their work-relevant seeing through public discourse. The operations room can be seen as a multi-vocal environment – a site in which contradictory viewpoints can be expressed aloud. (Goodwin & Goodwin 1996, 85.)

2.2.1.3 Coordination of located and distributed activities

Christian Heath and Paul Luff from King's College, London, have examined the situated accomplishment of activities within various work settings and institutions. They start from the premise that the organizational culture is fundamentally social and interactive, i.e., the work is accomplished in and through interaction with others. The personnel rely on tacit practices and reasoning in producing, making sense of and coordinating their activities with each other. The seemingly individual work tasks are accomplished with respect to actions by colleagues; being a competent worker requires that the staff member is capable of participating in multiple simultaneous activities. (Heath & Luff 2000.)

One of the case studies by Heath and Luff (1992; 1996; 2000, 88-124) concerns the interactive and contingent accomplishment of activities in a line control room on the London Underground. The control room houses four to six staff, whose task is to oversee traffic movement and deal with problems and crises. The line controller coordinates the daily traffic on the railway. The Divisional Information Assistant (DIA) is responsible for providing information to passengers and communicating with station managers. Two or three signal assistants control the operation of the signaling systems in one of the busiest sections of the line. The control room may also contain a trainee DIA or Controller who are not professionals yet. The general layout of the control room is shown in Figure 2.3.

A tiled, real-time, fixed-line diagram runs almost the entire length of the room. By indicating the location of the trains on a particular track, the diagram allows the personnel to assess the state of the service and to notice any gaps between the trains. The line controller and DIA are seated side by side at the semicircular console, which includes various tools and technologies, such as a radio phone system for speaking with drivers, the public address (PA) system for informing the passengers, close-circuit television (CCTV) monitors for providing access to a specific train, touch-screen telephones, and so on.

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distant objects may also lead to failures in the achievement of shared understanding and open up a possibility for human error (2005a, 225).
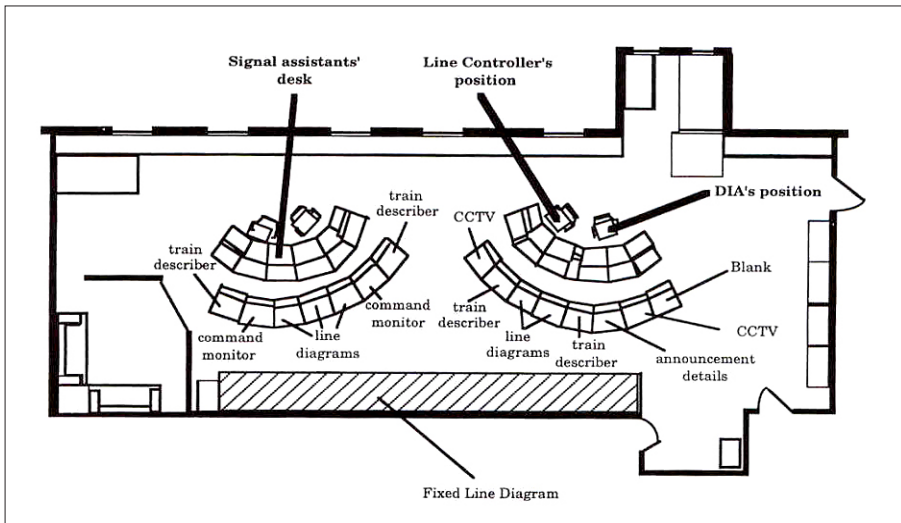
Figure 2.3
The Bakerloo Line Control Room
[Heath & Luff 2000, 91]

A strict division of labor within the control room becomes evident in problem situations. The personnel orient to the distinct activities in dealing with traffic delays caused by line closures, construction activities, etc. The operators are obliged to use diverse forms of information and communicate with different groups of people (station supervisors, drivers, crew managers, passengers, etc.). At the same time, the personnel need to have a shared understanding of the ongoing events and coordinate their activities with each other and those outside the room. The sequential organization of workplace activities is used as a resource in producing and understanding the activities occurring both within and outside the control room. (Heath & Luff 1992; 1996; 2000, 88-124.)

In the following it will be shown how local and distributed activities are sequentially coordinated within the line control room. Because part of the Bakerloo line is temporarily closed, the line controller requests one of the drivers, or Operators (Op), through the radio to 'reverse' the train (lines 6-8). The DIA overhears the controller's request and undertakes specific actions with respect to it: he first informs a given station manager by phone about the situation (lines 23-25) and then produces an announcement to the passengers through the PA system (lines 28-31).

01.	C:	<u>Contr</u>oller↑ to <u>Sou</u>th Bound <u>Two</u> <u>Three</u> <u>Three</u>,
02.		<do you receive?
03.		(8.2)
04.	Op:	Two Three Three receiving pass your message (...) (0.3)
05.		over↑
06. →	C:	Yeah Two Three Three:, (.)
07. →		I'd like you to <u>re:verse:</u> at Piccadilly:, (.)
08. →		an: you'll also be <u>re:for</u>med there:>
09.		I'll come back to <u>you::</u> when you get to Piccadilly:.over.

((13 lines of talk between controller and driver omitted))

23. →	DIA:	Yeah (.) Bakerloo Line Informa<u>tion</u> Two <u>Three</u>
24. →		Three is going to reverse with you:, (0.2)
25. →		South to North:,
26.		(2.0)
27.	DIA:	Two <u>Three</u> <u>Three</u>. He's at Baker: Street now::.

((roughly 3 minutes later))

28. →	DIA:	Good morning Ladies and Gentlemen↑ (.) Bakerloo
29. →		Line Informa<u>tion</u>↑ (1.0) This train is for:: (0.4)
30. →		Piccadilly Circus:↑ only. (1.2) This tr<u>ain</u> (.) for: (.)
31. →		Piccadilly Cir<u>cus</u>↑ only.

*((Successive announcements made at each station as the
train in question arrives.))*

(Heath & Luff 2000, 99-100.)

At lines 6-8, the controller asks the driver to reverse the train. On overhearing the controller's request, the DIA produces a series of sequentially appropriate activities. First, he warns the station manager at Piccadilly Circus about the upcoming events (lines 23-25). Second, he informs the passengers that the presumed destination of the train has been changed (lines 28-31); the same public announcement is then made at each station prior to Piccadilly. In and through an ongoing interaction, the DIA displays his orientation to the sequential relationship between co-located and distributed activities. The management of a 'routine' problem requires that while undertaking one activity, the DIA monitors the seemingly independent actions of others. (Heath & Luff 2000, 100-102; see also Heath & Luff 1992; 1996.)

The sensitivity to each other's conduct allows the control room personnel to coordinate their activities and gain relevant information about the details of the current operation of the

service. The personnel keep a certain social distance while participating in one another's activities. When the DIA starts to 'chase up' the activity of the line controller (the call to the driver) and prepare to accomplish his own sequentially relevant activity (the passenger announcement), he avoids direct attention to the line controller's conduct. In practical terms, the DIA does not look at or speak to his colleague. Instead, he maintains a proper balance of involvement in the collaborative work of the control room by overhearing the radio call and monitoring the line controller's actions on the periphery of the visual field. (Heath & Luff 2000, 98-99.)

2.2.1.4 Sequential organization of cockpit activities

Last but not least, Maurice Nevile (2004a) has studied pilots' cockpit interaction during scheduled domestic flights in Australia. One part of the research concerns the ways in which pilots integrate their radio talk to the air traffic controllers with their ongoing talk and non-talk activities in a cockpit (ibid., 145-196). The pilots communicate with the controllers to ensure that the movements of their flight are coordinated with the movements of other flights. The crew member who has the formal role of Pilot-not-flying (PNF) is normally responsible for talking with air traffic controllers; either the First Officer (FO) or the Captain (C) can be the PNF. It is important to note that the pilot in control of the aircraft, i.e., the Pilot-flying (PF), is able to hear the radio talk through the headset or cockpit speaker.

In the previous case, the DIA overheard the particular radio talk and undertook a series of relevant actions in respect of it. The next case demonstrates how the C/PF produces appropriate talk and non-talk activity within the cockpit on overhearing the radio talk between the FO/PNF and the controller; we will also see how the FO/PNF accepts the C/PF's conduct as appropriate by producing corresponding talk and non-talk activity. At this point, as the aircraft is taxiing after landing, the flight crew needs the ground controller's clearance to cross a particular runway. The radio talk between pilot and controller is shown in italics (see lines 2-6).

01		(20.7)
02	FO/PNF:	*City ground, (0.2) >bravo juliet tango< bay two five,*
03		(1.0)
04	Ground:	*bravo juliet tango ground, cross: runway: ah (.) <two four> (.)*
05		*for bay twentyfive.*
06	FO/PNF:	*cross two four for bay twentyfive. (.) >bravo juliet tango<.*
07		(0.3)
08	C/PF:	clear left,
09		(0.4)
10	FO/PNF:	okay clear right.
11		(0.3)

(Nevile 2004a, 168.)

At line 2, the FO/PNF calls and informs the ground controller that their plane is taxiing to parking 'bay two five'. The controller's response includes the necessary clearance to cross a runway 'two four' (lines 4-5).[17] Subsequently, the FO/PNF confirms that the prior clearance is fully understood and the crew will comply with it (line 6). Performing the task of runway crossing requires particular talk and non-talk activities from both pilots. The C/PF initiates the task by looking through the left side cockpit window (visual conduct not shown) and saying 'clear left' (line 8); the C/PF's talk shows that the runway is clear on his side of the plane. The FO/PNF performs his part of the task by looking out the right side cockpit window (visual conduct not shown) and uttering 'okay clear right' (line 10). The pilots establish a mutual understanding that crossing the runway is an appropriate thing to do through verbal and visual conduct. (Nevile 2004a, 168-169.)

The pilots integrate the radio talk to/from the controller with their cockpit activities to perform particular flight tasks. Once the FO/PNF's had talked with the controller, the C/PF initiated the task of crossing the runway, first looking through the cockpit window and then confirming that the runway was 'clear' of traffic. The FO/PNF then did the same. Now, as the crew has received the clearance and performed the relevant cockpit activities, the airplane may continue taxiing across the runway. (Nevile 2004a, 168-169.) As was evidenced in his conduct, the C/PF had monitored the action by overhearing the radio talk between FO/PNF and controller. The pilots displayed their orientation to the sequential relationship between co-located and distributed activities both verbally and visually.

2.2.2 Summary

Workplace studies concern the situated conduct of work activities. The aim is to describe the practices and procedures – the *in situ* reasoning and knowledge – through which participants produce and coordinate their mundane actions in organizational environments. These studies address the ways in which tools and technologies, objects and artefacts, feature in the collaborative accomplishment of routine tasks. (See Heath & Luff 2000; Heath et al. 2000; Luff et al. 2000a.) The analysis of work practices is largely based on ethnography and video recordings. The ethnographic materials provide background understanding for a more detailed scrutiny of videotaped (inter-) actions at work. (Arminen 2005a, 230.)

The particular workplace studies described above were conducted in an airport ground operation control room (2.2.1.1-2.2.1.2), a subway control room (2.2.1.3) and an airline cockpit (2.2.1.4). The personnel in these 'centres of coordination' (Suchman 1993) are responsible for coordinating a complex set of co-located and distributed activities. The coordination of simultaneous and sequential activities requires the utilization of various technologies, such as

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17   The plane cannot be taxied across the runway without the controller's permission to do so.

information systems (e.g., a schedule), digital displays (e.g., a monitor screen) and communication devices (e.g., a phone or a radio). The centres of coordination are 'multimedia' environments that show the ways in which personnel use technological resources to oversee distributed activities and respond to routine problems. (Heath et al. 2000, 311.)

The work in control rooms and airline cockpit is characterized as being information rich and technologically saturated. The working activities specifically include responsibility for many people, high intensity and the potential for fatal errors. The personnel within coordination centres need to deal with vast amounts of information. The management of information flows consists of recognizing visual representations of objects or overhearing verbal exchanges, and interpreting their significance for the tasks in hand. The work tasks also involve compiling and sharing data from different media, and maintaining collaboration with co-located and distributed personnel to achieve intersubjective understanding of the ongoing action. (Arminen 2005a, 218-219.)

Ethnomethodologically informed workplace studies concern socially organized practices and reasoning in and through which participants produce, recognize and coordinate their technologically mediated activities at work. They examine the *in situ* accomplishment of workplace activities and the ways in which participants constitute a sense or intelligibility of technologies in the course of their social interaction. (Heath & Luff 2000, 19; Heath et al. 2000, 307-308.) The vocal and visual conduct of the participants is interactionally and sequentially organized; the studies on 'situated action' specifically demonstrate how participants themselves orient to the sequential organization of activities in the workplace. (See Heath & Luff 2000, 26-27.)

The analysis of the step-by-step organization of social action shows the ways in which participants produce their conduct and make sense of the conduct of others. As Arminen suggests, "these [workplace] studies reverse engineer the building blocks of the intersubjective understanding of social action in which parties' coordination of their activities itself displays the sense of action" (2005a, 230). More specifically, each activity is positioned with regard to the preceding activities, thereby demonstrating the participant's interpretation of the phase and intelligibility of action. Since Arminen concludes that there is 'order at all points' in work activities as well (2005a, 230), no detail of (inter-)action at work site should be dismissed as trivial or uninteresting before subjecting it to analysis.

These naturalistic studies of workplaces highlight the situated and contingent character of collaboration and use of technology. These studies specifically analyze technologies in action. The findings from workplace studies reveal how participants themselves use and make sense of technologies in and through (inter-)action. As a practical contribution, workplace studies can provide directions for the design of technologies that support the accomplishment of collaborative work. Along with design implications, these studies have outlined significant conceptual and methodological innovations essential for social sciences in understanding technology use and cooperation in the workplace. (See Heath & Luff 2000; Heath et al. 2000; Luff et al. 2000a.)

Workplace studies enable us to re-specify the concepts which have previously underpinned our understanding of working life. The use of technology by the individual is essentially sensitive to and coordinated in real-time with others. The 'user', therefore, is not restricted to the individual, but extends to cover all those for whom technology use is relevant. Moreover, the performance of 'tasks' is based not only on a body of practice and procedures, but also on the personnel's ability to share an understanding of the events and coordinate their activities with each other. Despite a formal 'division of labour', the competent performance of the work is inseparable from the unfolding interaction and the forms of collaboration it requires. (See Heath & Luff 2000; Heath et al. 2000; Luff et al. 2000a.)

Data and methods

The mutual interaction between the Commander and Co-pilot takes place in the high-tech, information-rich environment of an airline cockpit in which the social and technical aspects of action are closely interconnected. The multiple flight tasks and activities are collaboratively accomplished by the pilots through the sequential coordination of verbal, visual and material resources. Together with the actual cockpit, these same resources are used, or available for use, in the accomplishment of the tasks in the so-called (Level D) 'full flight simulators' (FFS). The Airbus A320 flight simulator, from which the present research data has been collected, provides this highest level of simulation fidelity.[1] It duplicates, or simulates, all aspects of the aircraft and its environment in an extremely realistic manner. The A320 high-fidelity simulator includes the wide-angle visual system that displays the world outside the cockpit in daylight, twilight and night conditions. The simulator also has a motion platform capable of providing the three linear movements[2] and the three rotations[3] that a freely moving body can experience. The flight simulators are used extensively to train flight crew members in normal and emergency operating procedures. With regard to this study, the research data consists of the videotapes of the 'Line-Oriented Flight Training' (LOFT) sessions in which the flight crews handle scripted scenarios including various routine and emergency situations. Using simulators, the pilots are able to learn and practice their flight skills in an appropriate and safe context. In addition to ensuring the safety of the pilots, the simulator training generally saves time, money and the environment.

This chapter is a prologue to the empirical part that aims, firstly, to provide the reader the basic information and description of the airline cockpit. The specific issues highlighting the social and technical features of the cockpit environment include the sequential organization of flight tasks and activities (see 3.1), the multifaceted cockpit technology (see 3.2), the cockpit

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1   Fidelity concerns the degree to which a flight simulator matches the characteristics of the actual airplane (see, e.g., Rehmann 1995).
2   The linear movements are called Heave (up and down), Sway (sideways left and right) and Surge (longitudinal acceleration and deceleration).
3   The rotations are Pitch (nose up and down), Roll (one wing up, the other wing down) and Yaw (nose left and right).

roles and aviation language (see 3.3) and, finally, the use of standard operating procedures and various checklists on the flight (see 3.4). Secondly, this chapter offers a detailed description of the data used in the study containing sections on the video-recordings of the LOFT training sessions (see 3.5), the process of data analysis and transcription (see 3.6) and the ethnographic methods and strategies used in making sense of the data (see 3.7). The 'Glossary' at the beginning of the dissertation defines the key aviation terms and abbreviations relevant to this study.

3.1   TASK PERFORMANCE IN THE COCKPIT

The airline cockpit is a complex socio-technical setting in which the flight crew members coordinate their talk and non-talk activities to perform the tasks necessary to fly the plane. The term 'socio-technical' indicates that the participants interact as they use and respond to a complicated technical system that links mechanical, electronic and computerized components (see Hutchins 1995b). In the cockpit and other technologically informed working environments, teams of professionals collaborate with each other in order to carry out tasks, assess situations, make decisions, solve problems, etc. The members of the teams have formal statuses and roles that are allocated beforehand and recognized within the team. (See, e.g., Dyer 1984; Nevile 2004a.) The multiple participants collaborating in the socio-technical settings may be either in the same or distributed physical locations. The airline pilots' joint interaction occurs within the shared milieu of the cockpit. The flight crew members also interact with a large number of participants outside the cockpit, such as ramp agents, ground crew members, air traffic controllers, cabin crew members, passengers, company representatives and pilots of other aircrafts.

The talk-in-interaction between airline pilots orients mainly to the performance of the flight tasks in the cockpit. A 'task' can be defined as a piece of work in which participants conduct talk and non-talk activities in collaboration with each other to accomplish an intended and agreed outcome, such as reaching an assigned altitude, obtaining clearance from air traffic control, configuring the aircraft for landing and executing the checklist. In socio-technical settings, reasoning and understanding is made accountable and observable through talk and other available resources like gestures, gaze movement, handling of objects and artefacts as well as bodily orientations within the local surroundings. The salient non-talk activities in an airline cockpit include rotating and pushing knobs, monitoring displays, moving levers, reading checklists, charts and manuals, writing notes, looking out of the window, and so on. In the course of their talk and non-talk activities, the airline pilots develop and demonstrate their situated understandings of what they are doing, what is happening around them, and where they are relative to the team's goals. (Nevile 2001b; 2004a.)

The flight crew members need to perform the tasks and talk and non-talk activities required for them in a strict sequence. The airline cockpit is a multi-task setting in which the performance of a particular task becomes relevant and appropriate only after some other tasks have been completed and certain circumstances prevail (see Nevile 2002; 2004b; 2006). To

mention some highly simplified examples, the Co-pilot may start to read the taxi checklist only after the Commander has formally initiated the reading with the standard wording '*taxi checklist*;' the crew can begin to raise the aircraft's nose wheel into the air only after reaching the specified take-off speed on the runway;[4] the crew is not allowed to land until it has received a clearance (or permission) from the air traffic control to do so. One large-scale task consists of multiple sub-tasks that are to be performed in a predefined order during the flight. For example, completing the 'take-off' task provides, at the very least, that the pilots release the brakes, start the engines, extend the flaps, taxi to the assigned runway, receive clearance and the necessary information from the air traffic control, accelerate down the runway, achieve the required speed, and raise the aircraft's nose wheel off the runway in order for the aircraft to become airborne (see Nevile 2006). However, whilst the performance of flight tasks is based on sequences, each pilot is obliged to perform a number of tasks concurrently in the course of even the most routine flights (Loukopoulos, Dismukes & Barshi 2003; see also Dismukes & Nowinski 2006).

3.2   TECHNICAL FEATURES OF THE COCKPIT

In an airline cockpit, two pilots sit next to each other. Looking from behind the pilots towards the forward cockpit window, the Commander is always seated on the left and the Co-pilot is always seated on the right. There are also side windows left of the Commander and right of the Co-pilot. The pilots work as a team in a highly computerized and automated 'glass cockpit' which is present in all current airliners, a concept referring to the multitude of electronic instrumental displays. Where a traditional cockpit relies on multiple mechanical gauges and indicators to display information, the glass cockpit utilizes six computer-controlled displays situated on the instrument panel (see Figure 3.1).

    The first component of the glass cockpit, the EFIS (Electronic Flight Instrument System), presents various flight parameters such as speed, altitude, aircraft attitude and heading on the Primary Flight Display (PFD). It also shows data on the aircraft's position and course on the Navigation Display (ND). These two displays are placed in front of each pilot. The second component of the glass cockpit, the ECAM (Electronic Centralized Aircraft Monitor), shows data on the Engine/Warning Display (E/WD) and System Display (SD), which are located in the centre of the instrument panel. The data on the ECAM screens concern aircraft system conditions and engine performance. The glass computer displays are useful in the sense that they can be adjusted to show the flight information as needed. The possibility of concentrating on the most pertinent information has simplified the working conditions of airline pilots and made the whole activity of flying easier. (See also Glossary for 'EFIS' and 'ECAM').

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4   The velocity under discussion is called the 'rotation speed'.

Engine/Warning Display
(Primary Engine Display)

System Display
(Secondary Engine Display)

Primary
Flight
Display

Navigation
Display

Navigation
Display

Primary
Flight
Display

Commander's
Flight Management System

Throttle
Levers

Co-pilot's
Flight Management System
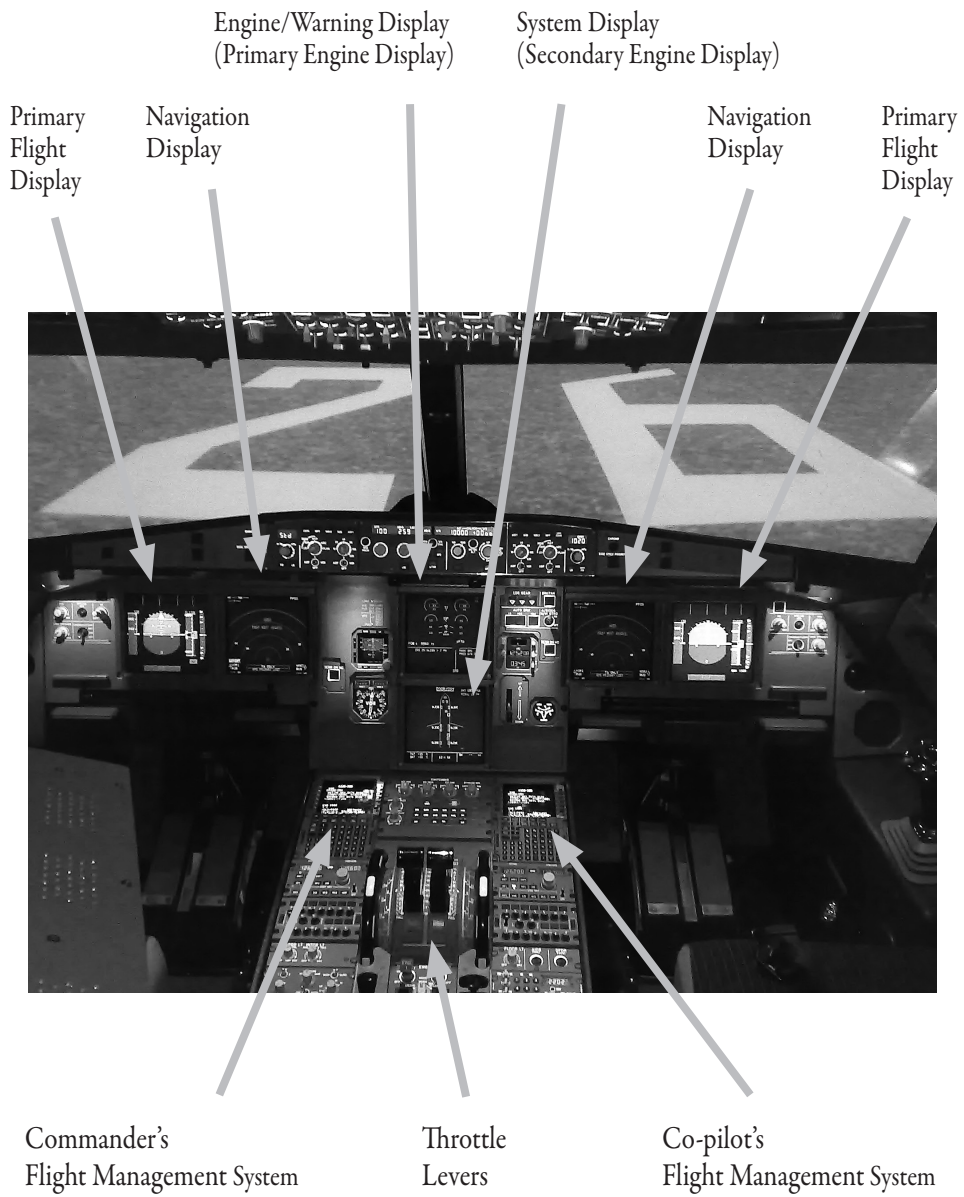
Figure 3.1
Airbus A320 flight simulator

Along with six electronic displays, the instrument panel includes the EFIS control panel and warning/caution lights. At the top of the panel is the Flight Control Unit (FCU) with knobs, switches, lights and associated displays for pilots to make selections for the aircraft's automated systems. For example, autopilot one (1) will be engaged by pushing the 'AP1' switch on the Flight Control Unit; the switch glows green when the selected autopilot is engaged. The instrument panel also includes the lever for extending and retracting the landing gear as well as many other technical tools not noted here. As shown above, some controls and displays on the instrument panel are double, i.e., one set located in front of each pilot. The duplication of cockpit technology has two implications: it allows both pilots to monitor and become aware of the progress of the flight, and it enables either pilot to be at the controls of the aircraft. There is thus a side-stick controller (or joystick) both left of the Commander and right of the Co-pilot. By manipulating the side-stick, the pilot can turn the aircraft, raise and lower the aircraft's nose to climb and descend, etc.

Between the pilots there is a pedestal with the thrust control system for manually adjusting the engine thrust and the lever for extending and retracting the flaps on the wings. The flaps are hinged control surfaces most often used during takeoff and landing to increase the lift generated by the wings at a given speed. The flight is controlled and managed by the dual Flight Management System (FMS) on the pedestal, one on the Commander's right and the other on the Co-pilot's left. The FMS assists pilots in a range of tasks such as flight planning, navigation, performance management and flight monitoring. The primary function of the FMS is to automatically follow a desired flight path[5] and profile from takeoff to landing. Prior to any flight, the pilots program the FMS by entering the target values[6] for flight path parameters such as airspeed, heading and altitude into it (see also Glossary for 'FMS'). The pedestal also includes the ECAM and TCAS control panels (Traffic Collision Alert System; see Glossary), as well as switches and knobs associated with navigation and communication radios. Finally, the glass cockpit consists of an overhead panel with selectors and switches for controlling various aircraft systems like lighting, temperature, hydraulics, electronics and emergency evacuation systems.

The emergence of the glass cockpit has considerably changed the nature of the pilot's role on the flight. Instead of exercising direct authority over all aspects of controlling the aircraft, the airline pilots nowadays monitor and manage various aircraft systems and intervene only when changes are necessary or when an unforeseen situation occurs (Billings 1991). In a glass cockpit, indirect control of the aircraft by the pilot giving instructions to the aircraft's automated systems has largely replaced flying manually. The pilots may occasionally face some problems in understanding and operating the highly automated cockpit technology (see, e.g., Sarter & Woods 1992; 1995; 2000).

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5   The flight path is a trajectory along which an aircraft is flying or intended to be flown.
6   The target value refers to the value which a quantity is meant to have at a specific point in time.

3.3   COCKPIT ROLES AND LANGUAGE

To ensure flight safety, each pilot must know what s/he as well as the other crew member is supposed to do in a cockpit. The airline pilots' duties and responsibilities are described in line with the cockpit roles in flight crew operating manuals, training materials and other forms of documentation. The pilots will always have two formal roles in a cockpit. The first comprises their official rank or status as either Commander (CDR) or Co-pilot (COP), of which the former is usually the more experienced and trained crew member than the latter. Since an individual pilot's rank is commensurate with a particular level of qualification and flight skill, it cannot change from flight to flight. The second role is to be either Pilot-flying (PF) or Pilot-not-flying (PNF). The PF controls (flies) the aircraft, making the immediate inputs to control the performance of the plane and taking responsible for routine planning and decisions for the flight. The PNF typically assists the PF by setting up instruments, reading charts, communicating with the air traffic control (ATC) and monitoring the PF's performance. An individual pilot may be PF and PNF on separate flights made during a day, because these roles are not determined by the rank of the crew member. The roles of PF and PNF are usually constant throughout the flight. In abnormal and emergency situations, a Commander who has the role of PNF can take control duties for him/herself and assume the role of PF. Irrespective of who is at the controls of the aircraft, the Commander is always responsible for the major strategic and tactical decisions on flight. As the more experienced and high-ranking crew member, the Commander has primary responsibility for the conduct and welfare of the flight. (Jentsch, Barnett & Bowers 1999; Nevile 2004a.)

Flight safety depends greatly on strictly following the 'scripts' provided by the flight operating manuals and standard operating procedures. These documents include formal descriptions of (i) what the pilots should say during the flight, (ii) when exactly to say it and, (iii) who is responsible for saying it. The official language of aviation is English, which is used in all operational communications with air traffic control worldwide. Thus, the radio communications between Finnish pilots and air traffic controllers is conducted in that language. The Finnish pilots also perform the flight checklists and other standard operating procedures in English. Another official language used by them is Finnish, in which, for example, the take-off and approach briefings are conducted. Besides the fact that the cockpit language is highly scripted, it is also precise and economical. The airline pilots need to basically deliver only a few standard wordings to achieve a shared understanding of what is going on in flight. For example, when the Pilot-flying gives control and navigation duties to the Pilot-not-flying, s/he simply says '*Your controls*;' the Pilot-not-flying takes over control and navigation duties with the simple '*My controls*'. As a checklist example, one flight crew member may call out '*beacon*', to which the other one responds in a simplified manner '*on*'. This kind of language use relates to the task orientation and time-sensitivity in the airline pilots' work; i.e., the cockpit language must be short and succinct enough so that the pilots are able to complete the flight tasks within strictly defined time limits.

A great deal of the pilots' cockpit language takes the form of acronyms like 'NDB' (Non-Directional Beacon), 'ILS' (Instrument Landing System), 'DME' (Distance Measuring Equipment) or the meteorological term 'CAVOK' [7] (see Glossary). Along with being abbreviated in nature, the cockpit language is characteristically repetitive. For example, when the air traffic controller instructs the crew to '*climb to flight level 240*' (i.e., up to 24,000 feet), it is usually the Pilot-not-flying who responds or reads back to the controller '*climb to flight level 240*'. The repetition assures that the instruction has been heard and understood completely and that the crew will comply with it on the flight (Orlady & Orlady 1999, 140).[8] Once the pilot-controller conversation has come to an end, the Pilot-flying[9] orders the Pilot-not-flying to '*set flight level 240*'. As the Pilot-not-flying has set the value given by rotating the altitude knob on the Flight Control Unit, s/he verbally confirms '*flight level 240 set*'. The repetitions of wordings are an important form of redundancy in aviation, since they allow participants to recognize and respond to possible problems in hearing and understanding the talk, or performing actions.

The pilots may have a special meaning for the words commonly used in everyday settings. In aviation parlance, an 'attitude' does not mean the positive or negative view of some person, behaviour or event, but the lateral and longitudinal relationship of the aircraft to the horizon. For the pilots, an 'elevator' does not allude to a transport device used to move goods or people vertically, but a control surface changing the aircraft's direction. The 'spoilers' do not refer to revelations of the crucial episodes of a story, but to the control surfaces destroying (or spoiling) the lift produced by the wings. A 'clean' plane is not recently washed, but is configured for the cruise flight (the landing gear is retracted, etc.). 'Clean' wings are free from snow. The aviation industry also has a special vocabulary for its relevant activities and tools. For example, a 'go-around' is a procedure followed by a pilot who decides to abandon an approach or landing.[10] The pilot may control the bank and roll of the aircraft with the 'ailerons', which are the control surfaces on the tips of each wing. The numbers are regularly used in cockpit language to describe and identify, for example, runways ('runway 04 right'), engines ('engine number 1 and 2'), aircraft call signs ('Finnair 651 Romeo') and aircraft types ('Airbus 320'). The numbers are also used to specify altitudes ('5,000 feet' or 'Flight level 100'), speeds ('155 knots'), wind directions and speeds ('100 degrees at 25 knots'), headings ('heading 270 degrees'), radio frequencies ('126.72 Megaherz'), transponder codes ('squawk 2003')[11] and the positions of other aircraft ('twelve o' clock low').[12]

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7   CAVOK (pronounced *kav-oh-kay*) is an abbreviation of the words 'Ceiling And Visibility OK'.
8   For an analysis of problems that disrupt pilot-controller communication, see, e.g., Morrow et al. 1993.
9   The Pilot-flying is able to hear the radio talk between the Pilot-not-flying and controller through the headset.
10 The term 'go-around' arises from the traditional use of circuits at airfields: a landing aircraft will first join the circuit pattern and prepare for landing in an orderly fashion. If for some reason the pilot decides not to land, s/he can simply fly back up to circuit height and complete another circuit, i.e., go around again. The term is still used even for modern airliners, though they do not use traditional circuit patterns for landing. Retrieved 21 February, 2006 from http://en.wikipedia.org/wiki/Go_around
11 A transponder code (often called a squawk code) is a four-digit number broadcast by the transponder in an aircraft in response to a secondary surveillance radar interrogation signal to assist the air traffic controller in traffic separation.
12 This means that the other aircraft is straight ahead of you but lower.

3.4   STANDARD OPERATING PROCEDURES AND CHECKLISTS

An individual flight can be broken down into the phases of (a) pre-flight and engine start, (b) taxi and takeoff, (c) climb, (d) cruise, (e) descent, (f) approach, (g) landing, and (h) taxi and engine shutdown (see Glossary for phases relevant to this study: 'taxi', 'takeoff', 'climb', 'descent' and 'landing'). The airline pilots are required to follow the written procedures that prescribe in detail how the aircraft is to be operated at each phase of the flight, who needs to do what and in what order. The standard operating procedures list the sequence of actions the pilots must take in setting each switch and control and checking the status of the aircraft systems. The pilots normally set the aircraft systems by heart and then check that the most critical items have been completed by reading the appropriate checklist (see Glossary for 'standard operating procedures' and 'checklist'). The procedures provide some further general directions on how the aircraft is to be flown, how the automation is to be used, and how the crew will interact with other personnel in the system, such as the air traffic controllers. The scripted approach to the operating procedures is highly advantageous since the flight crews need to complete numerous flight tasks in a very short time. The scripting allows pilots to perform procedural tasks consistently so that the activity of flying becomes highly automatic with practice. (see Loukopoulos et al. 2003.)

   The checklists form the basis of procedural standardization in the airline cockpit. In the Airbus family, the checklist procedures can be categorized by the type of device used (paper or electronic) and by the context of use (normal, abnormal and emergency) (see de Brito 2002). The procedures for the normal situations assume that all aircraft systems are functioning well and are being used correctly by the pilots. The main function of the normal checklist procedure is to assure that the crew will configure the airplane appropriately for any given flight phase segment (Degani & Wiener 1993, 347). The transition between flight phase segments is sanctioned by reading the normal checklist in paper form.[13] A paper checklist has a list of items written on a card that is usually held in the airline pilot's hand during the reading. The checklist procedures are completed by coordinated actions and communication between the Commander and Co-pilot (Degani & Wiener 1993, 353). A 'challenge-response' is the most common method of conducting the normal checklist procedure: one crew member[14] calls an item on the list to be checked (i.e., the challenge). The other crew member[15] responds to the call by saying, e.g., '*set*' after having checked the status of the item. The normal checklist procedure is embedded with the principle of backup and redundancy (Degani & Wiener 1993, 348): the pilots first configure the aircraft from memory and only then use the relevant checklist procedure to verify that all items have been completed properly. In the execution of the check-

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13   Some normal checklist items are shown in electronic form on the ECAM: five items before take off and four items for landing (de Brito 2002, 235).
14   When the aircraft is on the ground, it is the Co-pilot; when the aircraft is airborne, it is the Pilot-not-flying.
15   When the aircraft is on the ground, it is the Commander; when the aircraft is airborne, it is the Pilot-flying.

list procedure, the crew members also monitor one another to ensure that the aircraft will be configured correctly.

Emergency and abnormal situations may range from life-threatening and highly time-critical to mundane and relatively trivial ones (see Glossary for 'abnormal' and 'emergency' situations). Because they are different and unpredictable in nature, the abnormal and emergency situations are much more difficult to standardize than normal situations. Some of the problematic situations are so new and unanticipated that no procedures have been developed to guide the pilots to deal with them. (See Burian, Barshi & Dismukes 2005.) When an abnormal or emergency situation occurs, the flight crew members usually perform actions prescribed in 'do-lists'[16] to recover from the situation safely. While the actions listed in the normal checklists are done prior to the reading, the actions on the do-lists are carried out parallel with the reading. The emergency checklists are supplied both in paper and electric form in the cockpit.[17] The extensive paper versions are in the Quick Reference Handbook (QRH)[18] and Flight Crew Operating Manual (FCOM, Volume III, see Glossary for 'QRH' and 'FCOM'); the electronic versions are shown on the ECAM (Electronic Centralized Aircraft Monitoring) Engine/Warning Display (E/WD) and System Display (SD). In the case of an abnormal or emergency situation, the ECAM transmits real time information about the nature of the failure and the actions to be taken in a cockpit. The line containing the pertinent information disappears from the screen automatically as the action is carried out, the extinguished line indicating that the current action has been performed correctly and the crew members can move on to the next.[19] (de Brito 2002.)

Loukopoulos et al. (2003) have criticized the written procedures and classroom training for emphasizing the serial manner of task accomplishment in the use of procedures – as if flight tasks could all be performed sequentially, each being completed before the next is initiated. They argue that in real-life operations, both crew members are frequently required to manage multiple tasks concurrently (see also Dismukes & Nowinski 2006). For example, while taxiing the aircraft towards the take-off runway, the Commander is required to (1) manually control the aircraft, (2) verify the status of the checklist items called by the Co-pilot, (3) respond to those checklist items, (4) keep track of the aircraft's position in relation to the taxi clearance by the air traffic controller and (5) watch for crossing traffic. Similarly, the Co-pilot is expected to (1) read the checklist, (2) verify the checklist items, (3) monitor the course of the taxi and (4) handle radio communications. In the airline cockpit, the appropriate task management means that the pilots initiate and terminate the tasks at the right times and that attending to lower prior-

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16   The term do-list is specific to the Airbus family and it amounts to the abnormal and emergency procedures.

17   In abnormal and emergency situations, it is the Pilot-not-flying who reads the electronic messages and paper checklist items aloud and executes the actions required by the procedure; at the same time, the Pilot-flying is responsible for controlling the aircraft, communicating with the air traffic control, etc.

18   On an individual pilot's experiences with the use of QRH, see McCarthy & Wright (2004, 147-159).

19   As a curiosity, the ECAM presents 262 do-lists for abnormal situations and 26 do-lists for emergency situations (de Brito 2002, 235).

ity tasks does not prevent the correct and timely completion of higher priority tasks (Chou, Madhavan & Funk 1996, 308). According to Loukopuolos et al. (2003), written procedures and classroom training insufficiently characterize the concurrent nature of cockpit tasks and provide negligible guidance on how to manage concurrent task demands during flight. By and large, the flight crews handle concurrent task demands well in the cockpit; however, the crew's preoccupation with one task to the detriment of others is a significant source of error in a cockpit, contributing to both aircraft accidents and incidents. (Chou et al. 1996; Dismukes, Young & Sumwalt 1998.)

3.5   THE DATA

The research data was collected by videotaping official Finnair pilot training sessions in the Airbus A320 flight simulator at the Finnair Flight Training Center, Vantaa, Finland. The already experienced, licensed pilots are obliged to attend this particular kind of flight training semi-annually. The video-recordings of the training sessions were made between summer 2003 and spring 2004. In total twenty-five (25) flight crews agreed to participate in the recordings. When a single videotaped session lasted nearly three hours on average, the overall amount of data increased to over sixty (60) hours of recorded materials. In order to keep the data manageable, the analysis was limited to the examination of twelve (12) crews. It is important to note that the study does not cover the videotaped sessions as a whole, but focuses on two flight segments each crew conducted as part of the session.[20] The actual amount of data is thus 26 hours 23 minutes of videotaped materials (i.e., 43% of the total data). The entire course of the training sessions, including the two flight segments analyzed, is described later in this section. The pilots were informed beforehand about the study and the ways in which data would be collected; it was highlighted that participation in the study was voluntary and the confidentiality and anonymity of participants were protected; it was also pointed out that the recorded data would be used for research purposes only. After data collection, the pilots were informed about the completion of the recordings and thanked for their participation in the study.

In the videotaped sessions, the flight crew members practice a training technique called Line-Oriented Flight Training (LOFT), in which the pilots can rehearse various line operations such as flight manoeuvres, operating skills, systems operations, and airline procedures in a simulated, realistic environment. During LOFT training, the flight crew members must handle a variety of scripted real-time scenarios including routine, abnormal and emergency situations; they are simultaneously able to practice and improve various Crew Resource Management (CRM) skills, such as crew coordination, judgment, decision-making and communication skills (see also Glossary for 'LOFT' and 'CRM'). The LOFT training was introduced in the mid-1970s in response to the accident reports and investigations indicating that pilot

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20   A flight segment (also: flight leg) is a flight from point A to point B.

error was a contributing factor in most aircraft accidents and incidents, including fatal crashes (for statistics on causes of fatal accidents by decade, see http://www.planecrashinfo.com/cause.htm; see also Ruffell Smith 1979; O'Hare, Wiggins, Batt & Morrison 1994; Wiegmann & Shappell 2001). It was also shown that pilot errors were linked to poor communication, coordination and management in the cockpit under abnormal and emergency situations. The LOFT training method was established to provide practice in team-building and crisis management, with the overall goal of preventing incidents and accidents during operational flying. (Advisory Circular 2004b; CAP 720, 2002; Lauber & Foushee 1981.)

The LOFT scenarios include real world, line operational situations, progressing in real time. During simulated scenarios, the crew members use all the appropriate flight documents (e.g., weather reports, flight plans), accomplish specific pre-flight activities (e.g., cockpit setup, computation of take-off data), conduct the flight from point A to point B (all flight phases included), perform all the relevant checklist procedures, communicate with the air traffic controllers, flight attendants, and so on. The main distinction is that in LOFT scenarios, the flight crews need to cope with the various malfunctions and anomalies more often than in real line operations, including, for example, adverse weather conditions, technical failures and airport difficulties. Despite the multiple problems presented, the training goal is not to 'bury' or overload the flight crews. The difficulties and emergencies are thus not introduced simultaneously but separately, as the flight proceeds. The LOFT scenarios are allowed to run uninterrupted, without instructor intervention; the basic idea is that the pilots learn to solve problems for themselves by experiencing the ultimate consequences of their decisions. Since the scenarios are often designed to offer several choices and options for the crews, there may be no 'one correct' solution to the situation. The main aim for the crews is to make and act upon an array of low-risk operational decisions leading to the successful completion of the exercise – a safe landing. (Advisory Circular 2004b; CAP 720, 2002; Lauber & Foushee 1981.)

In the videotaped training sessions, all cockpit crews went through the following scenarios, composed of two flight segments: the pilots were firstly assigned to fly from Helsinki-Vantaa Airport, Finland, to Gardermoen Airport, Oslo, Norway. During this segment, the flight crews encountered a problem situation in which a crossing aircraft was flying dangerously close causing the activation of the TCAS (Traffic-Alert and Collision-Avoidance System) alerts in the cockpit. Once properly diagnosed and corrected, this event had no further impact on the rest of the flight. A more complex problem the pilots had to deal with was a fire breaking out in a cabin lavatory because of a passenger smoking there. At this point, the flight crews were obliged to perform an emergency landing at the closest suitable airport, that is, Stockholm-Arlanda Airport in Sweden,[21] and evacuate the passengers (see Glossary for 'emergency landing'). Secondly, the pilots were to fly from Arlanda to Gardermoen. Along with the crossing traffic (see above), another problem was a severe hydraulic failure occurring in the aircraft's technical systems dur-

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21   Two out of eleven flight crews (one tape is missing the first flight segment) conducted an emergency landing at Turku Airport, Finland.

ing climbing. Because of this malfunction, the flight crews had to divert back to Arlanda. In doing so, the crew members went through a lengthy and complicated emergency procedure as directed by the ECAM (Electronic Centralized Aircraft Monitoring) system and the two emergency manuals: the Quick Reference Handbook (QRH) and the Flight Crew Operating Manual (FCOM, Volume III). After completing these two flight segments, the crew members practiced the use of the rudder[22] in crosswind take-off and landing. Because it included partial flight segments only, this training exercise was left out of the analysis. Following the simulator sessions, there was a 'debriefing' in which crew members critically analyze themselves, and get feedback on their performance in the scenario (see Dismukes, Jobe & McDonnel 1997). These final discussions were not video-recorded since they involved somewhat sensitive issues and considerations about each pilot's individual and crew skills, and the like.

There are three participants in the videotaped sessions: the Commander, the Co-pilot and the Instructor. During the simulator period, importantly, the Instructor is not a 'teacher' in the traditional sense of the word. The role of an Instructor is not to teach the right solutions to pilots or to test them; the Instructor manages a LOFT scenario rather than actively participating in it. Before the simulator session, the Instructor usually conducts a 'pre-flight briefing' in which the purpose and principles of LOFT training is discussed with the participant pilots. In the simulated flight, the Instructor controls and manipulates the environmental and physical conditions of the scenario in a realistic manner. In this stage, the Instructor maintains appropriate communication with the pilots by role-playing the air traffic controller, mechanic, cabin crew member, etc. The task of an Instructor is also to observe and assess each pilot's technical and CRM skills during the exercise; the objective feedback on these issues is finally provided by the Instructor in the debriefing. (Advisory Circular 2004b; CAP 720, 2002; Lauber & Foushee 1981.) Further, in terms of this research, the data was collected by the Instructors, who made recordings with the analogue video camera built into the simulator. Well before the initiation of data collection, the Instructors were informed about the ongoing research and their permission to make the recordings was requested; they were also notified about the completion of data collection and thanked for managing the recordings. The Instructors are physically located behind the pilots in the flight simulator. Although present, they are only rarely shown on the video-tapes. This is in line with the LOFT principles dictating that the Instructors should not intervene or intrude into the scenario, but remain as unobtrusive as possible during simulator sessions.

The LOFT is a group performance training exercise that requires the coordinated efforts and activities of both flight crew members. The 'recurrent LOFT' training described is directed to the line-qualified[23] professional pilots only (for flight hours of pilots in this study, see Appendix 1). The recurrent LOFT is designed to ensure that the pilots maintain proficiency

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22   The rudder is a control surface at the rear of vertical tail (fin) controlling the yawing movement of aircraft; the rudder's direction is manipulated by the pilot with the foot pedals.
23   Line-qualified describes a flight crew member who is current and qualified to conduct actual flight operations in an assigned aircraft and duty position.

in the type of aircraft and crew member position involved. The training provides airline pilots with greater knowledge and skills in utilizing and managing all available resources – whether human, technical or informational – effectively during flight. As in real line operations, each crew member performs both as an individual and as a member of a team during simulated scenarios. The pilots in LOFT training also use the headsets and emergency breathing equipment as required in line operations. LOFT is defined as 'no-jeopardy' training, i.e., the Instructor does not issue a passing or failing grade to the participating pilots. The training scenarios are allowed to continue without interruption so that the flight crew members can learn by experiencing the results of their operational decisions. Basically, then, the decisions leading to unwanted consequences do not indicate a training failure, but serve as learning experience. (Advisory Circular 2004b; CAP 720, 2002; Lauber & Foushee 1981.)

3.6   ANALYZING THE DATA

In the conversation analytic work process, the initial and essential stage of data analysis is data transcription (see, e.g., Jefferson 1983; 1985; 1989; Hutchby & Wooffitt 1998, 73-92; Arminen 2005a, 64-67; see also Atkinson & Heritage 1984, IX-XVI). It is important to note that in CA, the transcripts are not seen as 'the data' but as the 'representation' of the data. The actual data consists of audio and/or video recordings of naturally occurring interactions; these tapes are further considered as the 'reproduction' of a particular social event. The transcript is a practical tool enabling the analyst to get beneath the surface of the data to understand and obtain insight into the participants' conduct. During this process, while the analysis itself is based on recordings, the accuracy of the transcripts can be checked and salient features added to the original transcripts. (Hutchby & Wooffitt 1998, 73-75; Arminen 2005a, 64-65.) Conversation analysts worldwide, including me, use and apply a standardized notation system developed mainly by Gail Jefferson. Despite the range of the detailed conventions used, there is, however, no perfect transcript. One reason for this 'incompleteness' is recordings that reproduce only fraction of what went on in some social situation.[24] A good transcript renders a conversation, or any other form of social interaction, meaningful and accessible to readers, as well as highlighting and foregrounding the aspects of an interactional practice that are relevant to the analysis. (Arminen 2005a, 64-66.)

The transcripts used in this work describe the talk, embodied conduct, and their sequential relationship in an evolving cockpit interaction. The descriptions of verbal activity specifically illuminate the dynamics of turn-taking and the characteristics of speech delivery. The former includes details about the turn initiations, turn closings, overlapping turns, and the gaps/pauses between turns; the latter contains the essential features of stress, intonation, pitch, loudness and speed. (Hutchby & Wooffitt 1998, 76.) With regard to embodied activity, the descriptions

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24   But, as Sacks (1984, 26) pointed out, the tape-recorded materials constitute a 'good enough' record of what happened.

are prepared at two levels of detail: the bodily conduct marked by doubled parentheses and in italics represent the 'standard' level of detail: *((Cop points to his FMS))*. This level of transcription employed throughout Chapters 4 and 5 addresses the temporal relationship between talk and embodied conduct in an approximate way, the transcripts showing the initiation but not the whole duration of visual action relative to talk. The descriptions indicating the exact beginning and ending of gestural activity relative to talk (or a period of non-talk) have been done at the 'high' level of detail. This highly elaborated notation system is adapted from work by Nevile (2004a, Part II) and used throughout Chapter 6 (for further explication of the transcription notation, see section 6.2). Appendix 2 gives a comprehensive list of the transcription conventions used in this study.

As mentioned, the Finnair pilots use both English and Finnish as their main working languages in flight. When the pilots speak Finnish, the transcripts follow a two-line format including, firstly, an original Finnish version and secondly, an idiomatic or vernacular English translation. What is specific to my cockpit data is that the participants may use both English and Finnish, or a mixture of them, within a single turn at talk. In order to discern the occurrence of code-switching, i.e., the alternations between two languages (see, e.g., Auer 1984; 1998), the Finnish words with English translations and, as shown in the next example, the Finnish parts of words, are bold in the transcripts. Therefore, in saying, '*briiffaus*' ('briefing'), the airline pilot is mixing English and Finnish together within one word. This kind of language use is marked in the transcript as 'brii**ffaus**': the first 'English' part of word appears in normal font style, while the second 'Finnish' part of it is bold. This latter part is shown in italics 'brief-*ing*' in English translation. Some transcripts also include still pictures taken from the video recordings. In order to do this, the original VHS tapes were digitalized. The still pictures were slightly edited and retouched by digital image editing technique to protect the anonymity of the pilots.

The main purpose of the still pictures is to visualize and highlight those aspects of cockpit interaction that are relevant for the analysis. Consequently, the still pictures or frame grabs capturing specific moments in a cockpit interaction are to be found in Chapters 5 and 6; for analytical reasons, the use of still pictures is most frequent in Chapter 6, including detailed analysis of the temporal relationship between talk and gesture. In Chapter 4, however, the salient features of the cockpit talk-in-interaction are already describable and recognizable by the written transcripts only. In other words, there are no still pictures in that chapter, mainly because they are not considered to contribute significantly to the understanding of ongoing (inter-)action. Overall, the still pictures are seen as serving the analysis of cockpit interaction in three interrelated ways. First, the pilots' mutual interaction occurs in the airline cockpit, that is a highly complex and, to many people, relatively unfamiliar environment. The use of still pictures enables the researcher to make interaction in this multifaceted socio-technical setting more understandable and accessible to readers, therefore enhancing communicative aspects of the analysis (see also Arminen 2005a, 66). Second, reading and making sense of the transcripts and the micro-analyses of interaction in all their detail can be a slow, sometimes tiring process. The still pictures are thus inserted into the transcripts to illustrate and give context to the evolv-

ing social interaction under scrutiny. In this way, by as it were bringing the pilots' interaction to life, the still pictures can increase the reader-friendliness of the transcripts and the analysis. Third, along with the data transcripts, the still pictures provide 'extra' evidence from which to draw conclusions about the details of interaction. At their best then, the still pictures confirm the validity of analysis by enhancing what Peräkylä calls "the transparence of analytic claims" (1997b, 208).

The videotapes from twelve (12) flight crews were first selected in order of arrival and then in random order. The recordings chosen were copied onto new tapes for transcription. I started working with the data by making 'rough' transcripts of the tapes. The ways of doing these transcripts differ from the 'strict' transcription conventions of CA in that, although describing who spoke and what was said, they do not show when exactly and how it was said. The transcription process, including the twelve videotapes analyzed,[25] started in summer 2003 and ended in spring 2005. The research assistant, Miss Päivi Hannila, transcribed the first videotape, whereas I prepared the remainder. The large-scale production of the transcripts proved especially valuable at the beginning of the data analysis, when I was trying to find an analytically interesting phenomenon in the data. The research topic, the patterns of repair activity in the sequential organization of cockpit talk-(and-action)-in-interaction, gradually started to be revealed through the intensive transcription work. The analysis of different types of repair practices made the problematic understandings between pilots visible and recognizable. By the end of 2004, I had assembled an extensive corpus of data in which the cases were categorized according to the problem dimensions. This dual typology between linguistic problems and the problems in task sequences forms the basis for the empirical analysis (see Chapters 4-5).

The data extracts used in this study were selected keeping the following twofold criteria in mind: on the one hand, the cases under scrutiny should be clear and simple enough in socio-technical terms. Thus, cases including some tricky terminology, complicated flight operating procedure and/or the use of complex technology should be avoided for the sake of simplicity and readability. On the other hand, the cases chosen should contain and represent a transparent type of repair activity. In accordance with this, the few instances in which misunderstandings seemed to involve disagreements were left out of the analysis.[26] Despite strenuous efforts, I found it sometimes difficult to meet the criteria for case selection. It is thus possible that some cases still seem rather complex, especially to those readers who are not all that familiar with the airline cockpit as an institutional setting. In fact, with regard to two cases to be found in Chapter 5, I consciously deviated from the criteria outlined above. Firstly, case 4; in which the pilots incorporate their interaction with the computerized ECAM system into the course of their joint interaction in a cockpit environment, can be described as both technically and

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25   In other words, the transcription work included in total 23 flight segments: 12 videotapes x 2 flight segments each crew conducted = 24 flight segments – 1 flight segment = 23 flight segments (one videotape includes a single flight segment only; this is because the Instructor forgot to turn on the videotape recorder).

26   Disagreements between airline pilots are naturally an interesting topic in their own right, but would justify a separate study.

interactively challenging. Secondly, while technically and procedurally relatively simple, case 6 simultaneously includes and describes a complex repair. These cases were chosen for the analysis because their complexities specifically illuminate the characteristic features of the airline cockpit as a socio-technical setting.

3.7   UNDERSTANDING THE DATA

Along with its usefulness in the process of identifying the research topic, the preparation of transcripts helped me in understanding and making sense of the data. The initial transcription work was thus a learning experience for me, providing a large body of general ethnographic knowledge on such things as the cockpit communications and responsibilities, the conduct and coordination of normal and emergency operating procedures, the use of cockpit technologies, and the task sequences 'embedded' in the various phases of flight. The two-day working seminar in Hotel Haikko Manor, Porvoo, Finland on 9-10 June, 2004 also proved valuable in enhancing comprehension of the data. Together with professional pilots and other aviation experts, we went through and analyzed three data extracts that were included in this study.[27] These joint 'data-sessions' provided relevant background information on cockpit interaction in general, and the intersubjective problems between airline pilots in particular. Additionally, I was given a chance to do some ethnographic fieldwork in real operational settings. Thus, on 26th November 2003, I participated in four domestic flights operated by Finnair (aircraft type: ATR7) as an observer.[28] Sitting in a seat behind and between the pilots, I was watching, listening and asking questions to get a practical sense of the various work and social practices used on routine flights.

I did also other ethnographic work to understand what it is to be an airline pilot and what the activity of flying is all about. In August 2002, for example, there was a pilot training course on 'Multi-Crew Co-operation' (MCC) at the Finnair Flight Training Center. Being a combination of both classroom and simulator training, the course aims to teach students the principles and basics of the co-operation necessary to safely operate a multi-pilot airplane (as distinct from a single-pilot airplane). For two days out of three, I spent sixteen hours in all participating in the MCC classroom course, which consisted of the theoretical training and exercises on areas including crew communication and co-operation, situational awareness, decision-making and leadership/followership.[29] In the summer of 2002, I worked for twenty days as an ethnographer in three physically distributed but functionally integrated organizations at Helsinki-Vantaa Airport: the approach control, the aerodrome control tower and the

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27   See cases 6, 9 and 10 in Chapter 4

28   (1): Helsinki-Vantaa Airport – Kuopio Airport, (2): Kuopio Airport – Helsinki Vantaa Airport, (3): Helsinki-Vantaa Airport – Tampere-Pirkkala Airport and (4): Tampere-Pirkkala Airport – Helsinki-Vantaa Airport

29   The subjects discussed on the day I was absent from the classroom course included standard operating procedures, standard phraseologies, task distribution and crew coordination.

AIS (Aeronautical Information Services) centre. During that time, I was observing, interviewing and making notes about everyday work practices and the use of complex technology in these settings, the main aim being to understand how these organizations collaborate with each other, and especially with airline pilots. The AIS officers, for example, receive and disseminate the pilots' flight plans (i.e., a document that covers the expected operational details of a flight such as destination, route, fuel on board, etc.) and transmit the real-time weather information to aircraft in flight.

For me as a researcher, the most important key informant from the company was the Finnair Captain, Chief CRM instructor, Mr. Arto Helovuo. Through the whole research process, he has been helpful in providing me with information about a broad range of 'pilot-related' issues, including the areas of work (flight terminology, procedures and practices, aircraft tools and technologies, and so on), pilot training and research. In addition to sharing his knowledge as a professional pilot and flight instructor, Mr. Helovuo has significantly contributed to the data collection by expediting the initiation of the recordings. Access to the standard operating procedures and checklists used by the Airbus pilots at Finnair enabled me to learn about the sequential organization of flight tasks, the use of 'standard callouts' (see Glossary), role assignments in the cockpit, etc.; at the same time, importantly, I was able to analyze and make sense of the data in relation to the 'ideal' course of conduct (i.e., identifying the situations in which pilots follow or deviate from the official procedures). Finally, the aviation journals, 'The International Journal of Aviation Psychology' and 'Human Factors', the publications by M. Nevile (2006; 2004a&b; 2002; 2001a & b) and the Google search engine on the Internet have been extensively used sources of ethnographic information in this study.

To summarize, the data analysis is based on ethnography and video-recordings of cockpit (inter)actions. The different data sources are not treated separately but are utilized to complement each other. The ethnographic materials offer the necessary background understanding of the coordination of work and action by the pilots in the complex setting of an airline cockpit. The videotaped data of cockpit practices and activities are analyzed in relation to their ethnographic context. The use of audio-visual data is indeed essential in conducting reliable and valid conversation analytic research on cockpit interaction. The video-recordings provide access to a large array of verbal, visual and material practices through which pilots not only perform their institutional tasks, but also process intersubjective understandings on the flight. The videotapes are a public record in the sense that through them the findings become available for criticism and discussion by the scientific community. As a final point, our initial intention was to collect data by videotaping the pilots' interaction in a real cockpit. The original plan was dropped for causes related to the tightened security policy after the events of September 11th 2001. The analysis of videotapes from the simulator training sessions, however, proved highly advantageous because in this way we can achieve systematic knowledge and understanding about the organization of cockpit (inter)action both in normal and emergency situations.

Achievement of intersubjectivity in cockpit talk-in-interaction

The airline pilots' intersubjective sense of ongoing action is an important precondition for the safe and efficient conduct of the flight. The shared understanding between Commander and Co-pilot is constantly established and updated through a range of verbal and non-verbal interaction practices. The creation and maintenance of intersubjectivity is an evolving process in which the pilots may occasionally have difficulties. The flight crew members locate and manage these problematic understandings by means of conversational repair mechanism – an organized set of practices crucial for the achievement of intersubjectivity. This chapter concerns the ways in which airline pilots deal with problems in speaking, hearing and understanding the cockpit talk. The scope of analysis is the 'sequence structure' concerning the relationship between turns at talk, or, more specifically, the organization of cockpit talk-in-interaction (see Arminen 2005b; Schegloff 2007).

The approach of Chapter 4 is both descriptive and comparative. The purpose is 1) to describe the ways in which the airline pilots use conversational repair practices in recognizing and resolving problems of intersubjectivity in cockpit talk-in-interaction and 2) to compare the repair practices in an airline cockpit with the organization of repair in everyday settings. The chapter aims to show how airline pilots drew regularly on the practices of ordinary conversation in processing intersubjectivity in cockpit talk-in-interaction. The purpose is also to reveal how the particular types of repair practice – namely, other-initiated other-repairs, are employed and oriented to by the pilots in a way specific to the cockpit setting. In this fashion, by locating and exhibiting the repair practices differentiated from ordinary talk, Chapter 4 reveals some characteristic features of cockpit talk-in-interaction.

The data analysis centers on interactions between two flight crew members, the Commander and the Co-pilot, who are doing the talking in the cockpit setting. The research focus is on what I call 'work-related-talk', i.e., the talk through which the airline pilots accomplish their institutional tasks and goals during the flight. Consequently, any talk referring to something other than the performance of flight tasks and activities (such as more informal conver-

sations about the simulator technology and design, in-flight meals, etc.) remains outside the analysis. The pilots' talk with the air traffic controllers and ground and cabin crew members is not included in the analysis either because of the 'unnatural' setting of these interactions; for example, the controller, played by the Instructor, communicates with the pilots not from the air traffic control unit, as usual, but from the airline cockpit itself.

At the outset of the chapter, I describe the organization of repair and the ways it operates in ordinary conversation (see 4.1). The ensuing data analysis includes ten (10) cases in which the pilots resolve difficulties in speaking, hearing and understanding the cockpit talk by using different types of repair practice: self-initiated self-repairs, other-initiated self-repairs, other-initiated other-repairs and third position repairs (see 4.2: 4.2.1-4.2.4). The speaking problems consist of examples in which an airline pilot uses the 'wrong' word or cannot find the proper term in talk; in terms of hearing troubles, a pilot cannot catch what the other flight crew member has said; the problems of understanding include examples of a pilot not recognizing the referent of talk or the action being done through talk. At the end of Chapter 4, I summarize the similarities and differences in repair organization between cockpit talk-in-interaction and ordinary conversation. The implications of the results for the characteristics of cockpit interaction and, more generally, for the relationship of institutional talk to ordinary talk are also discussed (4.3).

4.1   ORGANIZATION OF REPAIR

The term 'repair' refers to the practices for dealing with problems in speaking, hearing and understanding talk in conversation (Schegloff 1979; Jefferson 1987; Drew 1997; Sorjonen 1997), practices which form an orderly repair organization (Schegloff et al. 1977). The episodes of repair activity are composed of repair initiation marking possible disjunction with the preceding talk, and the production of repair, solving or abandoning the problem. The problematic talk which the repair addresses is referred to as the 'trouble-source' or 'repairable'. The organization of repair becomes understandable through two basic dimensions. The first concerns who initiates repair, which may be the speaker of the problematic talk or some recipient – self-initiation and other-initiation respectively. The second dimension concerns the sequential location of repair initiation. Virtually all repair initiations are launched in a very narrow window of opportunity following the trouble source. Self-initiated repairs start in three main positions: within the same turn as their trouble source, in the trouble source turn's transition space[1] or in the third turn from the trouble-source turn. The other-initiated repairs start mainly in the turn subsequent to the trouble-source turn. Another way of referring to them is 'next turn repair initiations' or 'NTRIs'. (Schegloff et al. 1977.)

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1   The transition space is the environment of a turn's possible completion, at which transition to a next speaker becomes relevant (see Sacks et al. 1974, 702-706).

The self- and other-initiations are started by means of various practices. Self-initiations within the turn use a variety of non-lexical speech perturbations, such as word interruptions, sound stretches and '*uhs*' to signal the possibility of repair initiation. The repair initiation practices of other parties include questioning terms and forms like '*huh*' and '*what*' as well as category-specific question words such as '*who*', '*where*' or '*when*'. Additional techniques for other-initiation are partial or full repeats of the trouble-source turn or putting the trouble-source or part of it in other words, which is often framed by '*Y' mean*'. Other-initiation techniques may involve combinations of these practices, like a partial repetition of the trouble source with the question word (e.g., '*you went where*').[2] The course from initiation to completion of repair depends on the location and type of initiation. Most self-initiated repairs that are started in the turn containing the trouble-source are completed successfully within the same turn. The repairs that are self-initiated in a transition space or third turn are mainly completed within the turn continuing the initiation. By contrast, the other-initiated repairs take multiple turns to get accomplished. (Schegloff et al. 1977, 367-369.)

The trouble source turns are frequently interrupted by self-initiation of repair. Others prefer to withhold repair initiations from placement while the trouble-source turn is in progress. As mentioned, other-initiations take place predominantly in the turn next to the trouble-source turn. The other-initiations occur after a slight gap following the possible completion of the trouble source turn. The withholding of other-initiation allows the speaker of the repairable to take the opportunity to self-initiate a repair. If this opportunity is not taken, other-initiation of repair can occur. Other-initiated repairs are used to locate the trouble source; they are regularly occupied with nothing else. Other-initiated repairs provide the speaker of the repairable with another opportunity to (self-) repair the trouble source in the following turn. In consequence, the completion of repair by the other is rare in ordinary conversation. (Schegloff et al. 1977, 372-375.)

With certain other-initiation techniques, the participants in conversation can locate the source of trouble in the previous turn. In terms of other-initiations like '*who*', '*when*' and '*where*', the trouble sources can be connected to a person, time and place respectively. Some forms of other-initiation do not locate the repairable items in the preceding turns or specify the nature of the difficulty which the speakers might be having in conversation. The next turn repair initiations like '*sorry*', '*pardon*' and '*what*' do not identify what exactly the repairable trouble in the prior turn is. Drew (1997) has examined the use of these open class repair initiators in their sequential environments. Repair initiation like '*what*' seems to be associated with the recipient actually recognizing the literal sense of the previous turn, but not the topical connection or the sequential appropriateness between that turn and what went on before; from the recipient's perspective, the previous speaker may have appeared to shift topic suddenly or may have failed to produce a sequentially fitted response to the previous turn. (Ibid., 74-98.)

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2   In addition to 'initiating repair', certain other initiation practices may be used to implement some alternative actions, e.g., 'pursuing a response' with '*huh*' or 'registering receipt' with a repetition (see Schegloff 1997).

The means of repair initiation are organized so as to favour or prefer self-initiated self-repair. Despite the empirical preponderance of self- over other-corrections, the latter do occur in conversation. When the other-correction is done it is often modulated in form, perhaps downgraded through uncertainty markers or question format. The other-corrections may be further modulated by the use of form '*Y' mean X*' where X is a possible correction or replacement word. The '*Y' mean X*' form may also be used to check understanding, i.e., the recipient tests his/her appreciation of the turn. The modulated other-corrections and understanding checks are not asserted, but proffered for acceptance or rejection. The other-corrections which are not modulated are frequently done in the turn after an understanding check or a modulated other-correction. The regular format used in the production of un-modulated other-correction is '*no*' plus correction. Overall, the other-corrections tend to be specifically marked or positioned, exhibiting an orientation to their dispreferred status in conversation (Schegloff et al. 1977, 375-379).

Jefferson (1987, 88-90) clarifies the formation of other-correction or 'correction of one speaker by another' with the following series: the speaker produces an object (X) = e.g., '*John*;' the recipient delivers an alternative (Y) = e.g., '*Jim*;' the previous speaker produces the alternative (Y) = '*Jim*' when accepting the correction or object (X) = '*John*' when rejecting it – the series of (X, Y, Y) and (X, Y, X) respectively. The participants may use exposed or embedded correction as a device for repairing the problematic talk. In the course of correcting, one can find attendant activities, or accountings, which address lapses in competence and/or conduct.[3] The ongoing activity discontinues and the correction is exposed by accounting, i.e., the interactive business in its own right (e.g., '*Well, we were talking about Jim, don't you remember*'. / '*Yeah, it was Jim of course, you were right*'.). Correcting may also be treated as a contingent occurrence by the participants. In these cases, the correction is embedded into the ongoing course of talk and there is no room for accounts. (Jefferson 1987.)

Third position repair

The vast majority of problems in speaking, hearing and understanding are dealt with immediately in talk. There is still a set of circumstances where the troubles in comprehension are repaired in the third position from the trouble-source turn. Schegloff (1992a, 1301-1304) describes what he terms 'third position repair' as follows:

A: Turn 1   (*T1*)
B: Turn 2   (*T2*)
A: ←

---

3   Not only other-corrections but also self-corrections can be invested with accountings (see Jefferson 1987, 95-97).

The speaker A launches the turn *(T1)* as adequate. The turn's recipient, B, does not find any problem with it that would warrant initiating repair in the next turn position. Recipient B delivers the next turn *(T2)*, which is sequentially appropriate to his/her understanding of what speaker A was doing in the previous turn *(T1)*. The turn of speaker B is built to be, and understood as, responsive to *T1*, since it displays to the speaker of the previous turn the understanding that has been accorded to it – an understanding that the speaker of *T1* may treat as problematic. In the third position (←), speaker A can undertake to address the trouble by engaging in a repair operation relative to the talk in *T1*. In the sequential context of 'repair after next turn', the third position repair supplies and is dedicated to "the last structurally provided defense of intersubjectivity in conversation" (Schegloff 1992a).[4]

Third position repair may be composed of four elements, A, B, C and D (Schegloff 1992a, 1304-1317). The A component initiates the repair with the particle '*no*'. The initiation component signals that the progression of the talk may be interrupted for the repair. The B component occurs infrequently in third position repair. This agreement-acceptance component is used on an occasion where recipient B treats the *(T1)* as a complaint by responding with an apology or excuse in *(T2)*. Speaker A may agree with or accept the 'response to the complaint' with something like '*that's okay*', even though his/her previous turn was not meant to be complaining in the first place. The C component is called the rejection component. The speaker of the third position repair uses it to reject the understanding that the previous turn *(T2)* shows its speaker to have accorded with the trouble source turn *(T1)*. The C components are used for the two most common types of misunderstanding (see Schegloff 1987c): in the case of problematic reference; i.e., when recipient B displays misunderstanding of the reference of the previous turn *(T1)*, the rejection component is commonly in the form '*I don't mean X*'. In the case of problematic sequential implicativeness; i.e., when recipient B reveals misunderstanding about what action the previous turn *(T1)* was meant to be doing, the C component is mainly formed as '*I'm not Xing*', where X names some action. (Schegloff 1992a, 1306-1308.)

The D component may be termed the repair proper. Speaker A uses this component to conduct one or more operations on the trouble source turn *(T1)* to address the misunderstanding revealed by speaker B's response in *(T2)*. The format of the repair proper is commonly the repair marker '*I mean*' followed by one or more of four operations on the trouble source *(T1)*: 1) contrast, i.e., using an idiom which is contrastive with the one in the trouble source, 2) reformulation, i.e., re-saying the trouble source in different words, 3) specification, i.e., introducing specific candidates for the formulation of the trouble source and 4) explanation, i.e., giving an account for the trouble source. Not all of these components (A, B, C, D) need be present in any particular third position repair, but whichever components are used in any instance, they are produced in their canonical order, A → B → C → D. The repair proper is the final component in

---

4   Along with third position repair, Schegloff (1992a, 1320-1326) examines 'fourth position repair' which also provides a defense of intersubjectivity.

third position repair since it provides for another opportunity to respond to the trouble source. (Schegloff 1992a, 1308-1315.)

4.2   REPAIR PRACTICES IN COCKPIT TALK-IN-INTERACTION

The organization of repair provides the airline pilots with the resources for locating and resolving the problems of speaking, hearing and understanding the cockpit talk. The data analysis 1) describes how airline pilots use various repair practices in dealing with the problems of intersubjectivity in cockpit talk-in-interaction, and 2) compares the use of repair practices in the cockpit with the operation of repair in everyday settings. The data analysis reveals how the repair practices used in cockpit talk-in-interaction are structurally similar to those of ordinary conversation. Along with this resemblance, the analysis shows how the preference organization of repair differentiates between the two settings. In other words, correcting the other flight crew member is not oriented to as normatively dispreferred activity in cockpit talk-in-interaction, as opposed to ordinary settings in which other-initiated other-repairs are frequently treated as having this rather 'unfavourable' status in interaction.

The data analysis is composed of ten (10) cases that are organized according to the repair type (see 4.2.1-4.2.4): 2 self-initiated self-repairs (n = 190), 4 (plus 1) other-initiated self-repairs (n = 28), 2 other-initiated other-repairs (n = 9) and 2 third position repairs (n = 4). Prior to each transcription, I define the situation of action and specify the line numbers of my analytical interest. In these focus lines, marked with the arrows (→) on transcriptions, the airline pilots produce trouble-source turns and repair initiations and completions. The transcription numbers, the flight crew 'identifiers', the starting times of the episodes, and the formal roles of the participant pilots are also described. The analysis concerns the inner dynamics of cockpit talk. While producing the sequences of talk, however, the pilots simultaneously display their orientation to the sequential action-in-progress through their bodily posture and gesture. The different types of bodily action (including pointing gestures towards the materialized objects, holding the checklist, etc.) are marked in the transcripts where they are relevant for better understanding of the situated cockpit talk-in-interaction.

4.2.1 Self-initiated self-repairs

In cases 1 and 2, the pilots are producing self-initiated self-repairs within the same turns as their trouble source. In the first case, the repair technique used by the Commander is an addition.

The flight crew is performing an emergency landing at Arlanda Airport, Stockholm, due to fire in a cabin lavatory. The Commander is describing the activities to be done to the Co-pilot and simultaneously entering flight data onto the Flight Management System (FMS). At lines 2-4, the Commander initiates a (self-) repair within the same turn as the trouble source.

Transcription 1   CDR = PF
Crew 6   COP = PNF
Time 0:43


```
01          ((Cdr is entering data onto the FMS; (2.3)))

02 → CDR:   [Pyydetään siltä ve- (.) radar
            [Let's request from it the ve-(.)radar

03          [((Cdr is entering data onto the FMS))

04 → CDR:   [vektoreita sitte#,=
            [vectors then#,=

05          [((Cdr stops entering data onto the FMS))

06    COP:  =Joo,
            =Yeah,

07          (0.4)

08    CDR:  ja kysytään mikä rata siellä on käytössä ja#,
            and let's ask which runway is in use and#,
```

At lines 1-5, the CDR is entering flight data specific to Arlanda Airport onto the FMS. Simultaneously with the data entry, the CDR is informing the COP that the crew will request 'the ve- (.) radar vectors' for landing (lines 2-4) from Stockholm control. The CDR initiates a (self-) repair with the discontinuous 've-', which may be either 'vektoreita' or 'vektorit' [vectors], and a micro-second pause within the turn. At her repair, the CDR complements this talk with 'radar' (line 2).[5] The COP acknowledges the CDR's previous talk with the response token 'yeah' at line 6. After a pause in talk, the CDR continues that the crew will ask Stockholm control which runway is 'in use' at Arlanda (lines 7-8).

In this case, the Commander was dealing with the problem of speaking during the flight. The concurrent activity of data entry may have contributed to the emergence of this particular problem. The second case also concerns speaking difficulty in cockpit talk; the Co-pilot initiates a (self-) repair repeatedly, his repair operation being a replacement.

_____

5   The meanings of the terms 'vector' and 'radar vector' are congruent (see also Glossary for 'vector').

The flight crew is *en route* to Oslo from Helsinki-Vantaa Airport. The pilots have received an automatic warning about smoke in a lavatory in the cabin. They are now checking the nearest airports for landing from the cockpit displays in case there is a fire on board. At lines 7 and 9, the Co-pilot repeatedly initiates a (self-) repair within the turn which contains the trouble source.

```
Transcription 2          CDR = PF
Crew 4                   COP = PNF
Time 0:40


01      CDR:   [Tuk  [holma on],?
               [Stock[holm is ],?

02             [((Cdr is oriented to his Navigation Display))

03      COP:        [Turku,Po]ri,ja Helsinki,
                    [Turku,Po]ri,and Helsinki,

04                  [((Cop points to his FMS screen))

05             (0.3)

06      CDR:   Joo:.=
               Yeah:.=

07   →  COP:   =Turku. [Tos ei oo Turkuu lainka#-
               =Turku. [There is no Turku at al#-

08                     [((Cop points to his FMS screen))

09   →  COP:   [<eiku Tu#-(.)Arlandaa<mut se on      [edessä],
               [<no I mean Sto#-(.)Arlanda<but it is[ahead ],

10             [((Cop points to his Navigation Display))

11      CDR:                                         [Turku ]
                                                     [Turku ]
```

```
12    CDR:  on[tossa noin <se on,(.) [ihan lä  ]hellä
            is[right there <it is,(.)[very ne  ]ar

13            [((Cdr points to his Navigation Display))

14    COP:                            [Niin on  ],
                                      [Yes it is],

15    CDR:  tossa noin,
            right there,
```

At lines 1-2, the CDR is locating Stockholm on his Navigation Display. The COP takes the floor in overlap with the CDR's turn by reading the closest airports, 'Turku, Pori and Helsinki', aloud from his FMS screen (lines 1-4). Following a pause in talk, the CDR acknowledges the COP's previous turn with 'yeah' (lines 5-6). At line 7, the COP repeats 'Turku' once more and continues with 'there is no Turku at al-'. The COP's pointing gesture reveals that the deictic word ('there') refers to the FMS screen (lines 7-8). The COP initiates a repair by interrupting his talk at line 7. The COP's expression 'eiku' [no I mean] delivered at line 9 is also a repair initiation, the COP implying he is going to replace something he has just said. What follows is the discontinued 'Tu-', which is probably meant to be 'Tukholma' [Stockholm]. The COP uses the interrupted word ('Tu-') and a micro-second pause within the turn as a means to initiate a repair again (line 9). He then delivers the actual replacement for his prior talk by saying 'Arlanda' at line 9; by replacing 'Turku' by Stockholm 'Arlanda' Airport, the COP produces a self-repair. As the COP's talk and visible conduct implies, the FMS does not offer Stockholm-Arlanda Airport one of the closest airports at the moment. The COP concludes his turn with the contrary utterance 'but it is ahead' at line 9. The COP's verbal and visual conduct indicates that, based on information shown on the Navigation Display, Arlanda Airport is located ahead from the cockpit point of view (lines 9-10). As a response, the CDR starts to locate Turku Airport on his Navigation Display in overlap with the COP's turn; the COP confirms the CDR's talk with the overlapping 'yes it is' (lines 9-15).

In cases 1 and 2, the airline pilots used self-initiated self-repairs in dealing with the problems of speaking in cockpit interaction. Consequently, the speakers of the problematic talk both recognized and resolved the difficulties they had in the production of talk. The recipients of talk, for their part, did not orient to the speaker's verbal conduct as intersubjectively problematic; i.e., the recipients neither initiated nor completed the conversational repair. In these cases, then, the self-initiated self-repairs were rather used to maintain and ensure intersubjectivity in the course of cockpit talk-in-interaction: the airline pilots could use them to proactively prevent the possible problems of intersubjectivity from occurring. In the remaining cases (3-10), however, the problems in cockpit talk-in-interaction take multiple turns to be identified and resolved collaboratively by the pilots.

4.2.2 Other-initiated self-repairs

Just as in cases 1 and 2, the pilots are producing self-repairs in the next four cases (3- 6). This time, however, the (self-) repairs are not initiated by the speaker of the problematic talk, but by its recipient. All of these repair initiations by the other party are done in the next turn from the trouble source.

The crew has conducted an emergency landing at Stockholm-Arlanda Airport due to fire in a cabin lavatory. At this moment, the pilots are going through the 'on ground emergency / evacuation' checklist. At line 9, the Commander initiates a repair as he is claiming to have problems in hearing the Co-pilot's turn at line 7; the repair is completed by the Co-pilot at line 11.

Transcription 3   **CDR = PF**
Crew 5   **COP = PNF**
Time 1:11

```
01    COP:   Deltta pee check zero,
             Delta p: check zero,

02           (0.7)

03    CDR:   Checked,

04           (1.5)

05    COP:   Ja,(.)if not zero,<oli.
             And,(.)if not zero,<it was.

06           (.)

07 →  COP:   Engine master yks plus kaks off, hh
             Engine master one plus two off,

08           ((Cdr brings his right hand to
                the Engine Start and Ignition Panel; (2.1)))

09 →  CDR:   Sano uudestaan en kuullu,
             Say again I didn't hear,
```

```
10          (0.7)

11 →  COP:  ENGINE MA-(.)engine master yks ja kakkonen off,
            ENGINE MA- (.) engine master one and two off,

12          ((Cdr starts to operate the engine master
              switches; (1.0)))
```

At line 1, the COP reads the checklist item 'delta p check zero' aloud, meaning that the pressure indicator called 'delta p' needs to be at zero. After a pause in talk, the CDR confirms that the value of delta p is indeed zero with 'checked' (lines 2-3). Following a (1.5)-second pause in talk, the COP reads the contingency in which the delta p is 'not zero' aloud. Instead of completing his reading, the COP produces a responsive utterance 'it was' (line 5). The COP's talk implies that the current checklist item is not relevant here and now since the value of delta p has already been confirmed as zero. After a micro-second pause in talk, the COP continues with the execution of the checklist with the item 'engine master one and two off' (lines 6-7). This item implies that the CDR needs to operate engine master switches 1 and 2 on the engine start and ignition panel in order to close the high-pressure and low-pressure fuel valves there. During the succeeding (2.1)-second period of non-talk at line 8, the CDR brings his right hand to the appropriate panel. Instead of starting to operate the engine master switches, the CDR initiates a repair at line 9, with which the CDR asks the COP to 'say' the checklist item 'again'; the CDR accounts for the request by referring to his hearing problems in conversation. After an (0.7)-second pause in talk, the COP produces a (self-) repair by repeating the troublesome checklist item almost verbatim (lines 10-11). The COP orients to the CDR's hearing problem by beginning his turn with the loud 'ENGINE MA-'(line 11); the repair proper is launched at normal level relative to the surrounding talk. During the (1.0)-second period of non-talk at line 12, the CDR starts to operate the engine master switches on the Engine Start and Ignition Panel.

In this case, the Commander's repair initiation was occasioned by the reported hearing difficulty. Case 4 also concerns the problem of hearing, since the Co-pilot does not catch the Commander's previous talk completely.

The crew is returning back Arlanda Airport, Stockholm, because of hydraulic failure in the aircraft's technical systems. At line 7, the Co-pilot initiates a repair in regard to the Commander's order at line 5; the repair completion by the Commander takes place at line 9.

Transcription 4   CDR = PF
Crew 6   COP = PNF
Time 2:29


```
01    CDR:   No nii: flaps one,
             Okay: flaps one,

02           (.)

03    COP:   Speed checked flaps one,

04           (9.0)

05  → CDR:   Set speed ööö one öö >niner five<,
             Set speed uhm one uh >niner five<,

06           ((Cop starts to lift his left hand to the
               speed/mach switch (1.3)))

07  → COP:   One,?

08           (0.5)

09  → CDR:   nine five,

10           ((Cop rotates the speed/mach switch; (3.7)))

11    COP:   One ninety five,(.) set,
```

At line 1, the CDR orders the COP to extend the 'flaps' to position 'one'. After a microsecond pause in talk, the COP responds to this turn with standard callouts 'speed checked flaps one' (lines 2-3). In talk, the COP indicates that he has checked that the speed is appropriate for the flaps extension and that he is now selecting the correct flap position. Following a (9.0)-second pause in talk, the CDR orders the COP to 'set speed uhm one uh >niner five<' at lines 4-5. This means that the COP needs to rotate the speed/mach switch to set the speed value provided. The hesitation sounds ('uhm', 'uh') used in the CDR's turn may display information search, since the intended speed value is not directly available to the CDR. As a possible consequence of this searching activity, the CDR delivers the final numbers of 195 faster (>niner five<) than

the surrounding talk. During a (1.3)-second period of non-talk, the COP starts to lift his left hand to the speed/mach switch (line 6); instead of rotating the switch, he initiates a repair with 'one?' at line 7. The COP's repair initiation locates the hearing problem in the speed value of the CDR's turn. The use of a slightly rising intonation in 'one?' indicates that the COP is asking for the CDR to complete the speed value. Following an (0.5)-second pause in talk, the CDR produces a (self-) repair by complementing the COP's turn with 'nine five' at lines 8-9. During (3.7)-second period of non-talk, the COP is rotating the speed/mach switch (line 10); he also confirms verbally that the speed value provided is 'set' at line 11.

In cases 1-4, the airline pilots were dealing with the problems of speaking or hearing the cockpit talk. In case 5, the repair initiation by the Co-pilot leaves open what exactly the repairable trouble he is having in the Commander's preceding turn is.

The crew is *en route* to Oslo from Helsinki-Vantaa Airport. The pilots have been informed about the smoking passenger in a cabin lavatory and now there is a risk of fire on board. The Commander and Co-pilot are considering whether to land in Turku or Stockholm if there is an emergency on the flight. They have already discussed which airport is the closest, but the final decision on which airport to choose is still pending. At line 7, the Co-pilot initiates a repair related to the Commander's turn at line 5; the repair is completed by the Commander at line 9.

Transcription 5   CDR = PF
Crew 1   COP = PNF
Time 0:38


```
01    COP:   Toivottavasti ei tar    [vii ] lähtee
             Hopefully there is no ne[ed  ] to go

02    CDR:                           [Joo ],
                                     [Yeah],

03    COP:   mi(h)hinkää m(h)utta>,
             an(h)ywhere b(h)ut>,

04           (7.0)

05 →  CDR:   Kavokin↑ kelit kummassaki,
             It's cavok↑ weather at both,

06           (1.7)
```

```
07 →  COP:    Tch mitä,? h
               Tch what,? h

08             (.)

09 →  CDR:    KAVOKKIA KUMMASSAKIN [ETTÄ siin        ]
               IT'S CAVOK AT BOTH   [SO in that       ]

10    COP:                          [Niin on joo      ],
                                    [Yeah that's right],

11    CDR:    mieles [ihan sama          ],
               sense  [it's just the same],

12    COP:           [Niin on            ]°joo°,
                      [Yeah that's        ]°right°,
```

At lines 1-3, the COP closes the previous discussion about which airport to choose with a particular idiom: he is hoping that the crew will not have to conduct an emergency landing 'an(h)ywhere b(h)ut'. The CDR acknowledges the COP's talk with an overlapping 'yeah' (lines 1-2) and a (7.0)-second pause in talk ensues (line 4). Following this considerable pause, the CDR continues with the earlier topic by introducing a meteorological viewpoint into the conversation at lines 4-5. By saying 'it's cavok weather at both', the CDR indicates that the weather conditions are fine both in Turku and Stockholm (see Glossary for further details on 'cavok'). After a (1.7)-second pause in talk and smacking his lips, the COP initiates a repair with the question word 'mitä' [what] at lines 6-7. In this way, the COP leaves open what the repairable trouble he is having with the CDR's turn is. The COP may find it difficult to understand the topical connection between the trouble source turn and what went on before; from the COP's perspective, the CDR may have shifted the topic abruptly in conversation. (See Drew 1997.) Following a micro-second pause in talk, the CDR repeats his earlier turn by uttering louder than the surrounding talk 'IT'S CAVOK AT BOTH' and continues by explaining 'so in that sense it's just the same' (lines 8-9, 11). As the CDR is using the loud, repetitive and explanatory elements in his (self-) repair, he seems to consider the COP's trouble as related both to hearing and understanding the talk. The CDR's turn indicates that since the weather is 'cavok' both in Turku and Stockholm to conduct an emergency landing at either of these airports is 'just the same'. In his response, the COP agrees with the CDR's prior repair by saying twice 'yeah that's right' in overlap at lines 9-12.

In the following case (6), the Co-pilot produces two repair initiations: the first one leaves open what the repairable trouble he is having with the Commander's talk is; the second one reveals that the Co-pilot does not understand the referent of the Commander's turn. The crew

is performing an emergency landing at Stockholm-Arlanda Airport because of fire in a cabin lavatory. The Commander makes an inquiry concerning the approach briefing that is conducted on each flight to ensure that the pilots have a shared understanding of the approach and landing procedure. In the approach briefing process, the Pilot-flying inserts all the flight data relevant to the approach and landing (the runway in use, approach type, terminal weather conditions, etc.) into the Flight Management System and informs the Pilot-not-flying of the data. Prior to the beginning of this instance, the briefing operations conducted by the Co-pilot had been interrupted three times for various reasons.[6] In the extract, the Co-pilot initiates a repair twice. The first repair initiation at line 6 is related to the turn at line 4 while the second, at line 15, relates to the turn at line 13. The repairs are completed by the Commander at lines 13 and 16 respectively. The conversation between the Commander and Approach controller, which is a separate inserted sequence at lines 7-12, is omitted from the transcription.

Transcription 6   CDR = PF
Crew 2   COP = PNF
Time 0:50


```
01   COP:  Passing [( )(teen)] thousand feet,

02   CDR:          [( ) ( )  ],

03         (4.0)

04 → CDR:  Mites se sanoo se sun< ö ↑briiffaus homma siellä.
           How is it that your< uh  ↑briefing job there.

05    (0.5)

06 → COP:  Mitä,?
           What,?

           ((six lines of talk between approach control and
             Cdr omitted))
```

---

6   The briefing process was interrupted firstly because of insufficient flight data, i.e., the Co-pilot had not entered the weather information into the FMS, so that the crew discontinued the actual briefing and the Co-pilot went back to enter the omitted data; secondly, because of the technical problem in the cockpit simulator requiring immediate action from the crew; thirdly, because of the Instructor's intervention with his indirect suggestion for the crew to proceed to the execution of the emergency descent checklist.

```
13 →  CDR:   ä:: se ↑briiffaus (.) homma.
              e:: the ↑briefing (.) job.

14            (1.2)

15 →  COP:   M:::: mikä briiffaus homma,=
              M:::: what briefing job,=

16 →  CDR:   =ä:[tämä,(.)o:nks[(se valmis jo),    ]
              =e:[this,(.)i:s  [(it done already),]

17               [((Cdr points at the Cop's FMS))

18    COP:                    [Siin on se >mato  ]laatikko
                              [There's the >worm ]box

19    COP:   eikö vaa<,(.) [se on valmis,
              right<, (.)   [it's done,

20                         [((Cop points to his FMS))

21            (.)

22    CDR:   Okei.
              Okay.
```

At line 1, the COP informs the cabin crew about the aircraft's current altitude. Next, the CDR makes an inquiry about the briefing (line 4). A syntactic redirection and hesitation display a word search, since the CDR has difficulty in finding the proper wording. He ends up with the verbalization 'briiffaus homma' [briefing job] after the word search. The possessive adjective 'your' locates the referent in the COP's territory and the deictic expression 'there' suggests its proximity to the COP. The pronoun 'se' [it] marks the referent as known to the recipient (see Laury 1991). Following an (0.5)-second pause in talk, the COP responds with the open repair initiation 'mitä' [what] at lines 5-6. The interaction is then disrupted by the approach controller's call (omitted from the extract). At line 13, the CDR returns to his inquiry, thereby producing a correction for the COP's repair initiation. The CDR seems to consider the COP's problem as having been hearing rather than understanding the talk. After a pause, the COP re-initiates a repair by locating the trouble source in the referent of the prior turn (lines 14-15): the COP does not understand what 'briefing job' the CDR is referring to in his talk. At line 16, the CDR produces a repair with the demonstrative pronoun 'this', simultaneously with a point-

ing gesture towards the COP's FMS (line 17). After the ostensive clarification of the referent, the CDR reformulates his inquiry as concern about whether the FMS data input has been done (line 16). The question reveals that the CDR does not know whether the data entry on the FMS has been completed. The COP first checks his understanding of the referent by stating its nickname[7] and then answers the question at lines 18-19, while simultaneously pointing towards the FMS (line 20). Subsequently, the CDR acknowledges the COP's answer that the data has already been entered on the FMS (lines 21-22). In this case, the imprecise terminology used by the CDR may contribute to the referent recognition problem, since, as revealed at lines 15-16, the term 'briiffaus homma' [briefing job] can refer both to the thing (i.e., FMS) and to the activity (i.e., data entry onto the FMS).

In the previous cases (1-6), the pilots were using either self- or other-initiated self-repairs in dealing with the problems of speaking, hearing or understanding the talk. The next two cases concern (other-initiated) other-repairs used in cockpit talk-in-interaction. In extracts 7 and 8, it is the Commander who is correcting the Co-pilot's talk with an un-modulated repair.

4.2.3   Other-initiated other-repairs

In the first instance of other-repair, the airline pilots are dealing with problematic reference in talk.

The crew is going through the 'taxi' checklist at Stockholm-Arlanda Airport before taking off. At line 6, the Commander repairs the Co-pilot's talk at line 3 in which the Co-pilot offers an incorrect departure route for the current flight.

Transcription 7   **CDR = PNF**
Crew 3   **COP = PF**
Time 1:22

```
01    COP:  R:iiffinki,
            B:riefing,

02          (0.5)

03 →  COP:  [>Se oli mun< heiniä elikkä: Ru:nen four Deltta
            [>It was my< job that is: Ru:nen four Delta

04          [((Cop orients to the notes on his right side))
```

---

7   'Worm-box' is a nickname for the Flight Management System.

```
05    COP:   ja <siel   [oli five thousa]n-,
             and <there [was five thousa]n-,

06  → CDR:              [A:ros two    ]Charlie.

07           (1.0)

08    COP:   Ö::↓
             Uhm↓

09           (1.4)

10    COP:   [Mä laitan ton vanhan tosta pois,
             [I'll put that old one somewhere else,

11           [((Cop shifts the notes away from his right
                side))

12           (.)

13    CDR:   Joo,
             Yeah,

14           (0.3)

15    COP:   he he he h,

16           ((Cop orients to the notes on his sliding table;
                (2.0)))

17    COP:   Joo.(.) Arsi two Charlie ja five thousand blue,
             Yeah.(.) Ars two Charlie and five thousand blue,

18           (.)

19    CDR:   Confirmed not changed,
```

The COP reads aloud the item 'briefing' on the taxi checklist at line 1. The item amounts to a short confirmation of the more thorough take-off briefing made earlier in the preparatory phase of the flight. Following a pause in talk, the COP takes on the responsibility as a Pilot-

flying to deliver the take-off briefing with 'it was my job' at lines 2-3. The COP initiates the briefing with 'that is' at line 3. The actual briefing consists of the departure route 'Runen four Delta' read from the notes on the COP's right, and the assigned altitude of 'five thousand' feet (lines 3-5). The CDR takes the floor in overlap with the COP's turn at lines 5-6. With his (other-) correction 'A:ros two Charlie', the CDR replaces the previous 'Runen four Delta'; the CDR's talk indicates that instead of 'Runen four Delta', the departure route cleared for the current flight is 'A:ros two Charlie'. After a (1.0)-second pause in talk, the COP responds to the repair with the hesitation sound 'uhm' (lines 7-8). Following a (1.4)-second pause in talk, he continues with 'I'll put that old one somewhere else', simultaneously moving the notes to his right away (lines 9-11). Next, the CDR acknowledges the COP's turn with 'yeah' (lines 12-13). After a pause in talk, the COP produces solo laughter (lines 14-15). The COP's laughing by himself implies that the erroneous referral (false departure route), that is based on the use of an incorrect information source (old notes), is a potentially awkward issue in cockpit interaction (on solo laughter in medical encounters, see Haakana 1999). During the following (2.0)-second period of non-talk, the COP orients towards the notes on his sliding table (line 16). At line 17, the COP receives the information written on those notes with 'yeah' and delivers the relevant take-off briefing, which consists of the departure route of 'Ars two Charlie' and the assigned altitude of 'five thousand' feet. Next, the CDR confirms the take-off briefing and ensures it is congruent with the delivery clearance (lines 18-19).

In the second example of other-repair, the pilots are dealing with problematic action description in talk.

The crew is returning to Stockholm-Arlanda Airport because of hydraulic failure in the aircraft's mechanical systems. The pilots are going through the instructions transmitted by the electronic Ecam system. At line 12, the Commander repairs the Co-pilot's talk delivered at lines 6, 9 and 11, in which the Co-pilot launches a fallacious description of how to operate the flaps during this abnormal situation (see Glossary for 'flaps').

Transcription 8   **CDR = PF**
Crew 4   **COP = PNF**
Time 1:57

```
01    COP:  [Ja,
            [And,

02          [((Cop's gaze is oriented to the notes
               on his sliding table))

03          ((Cop's gaze is oriented to the notes
               on his sliding table; (0.4)))
```

```
04    COP:   sitte on flaps on slo:w,
             then there is flaps are slo:w,

05           ((Cop shifts his gaze away from the notes;
              (1.0)))

06  → COP:   t[arkot]taa sitä että >ni ne< pitää (o-),
             m[ean  ]s that >they< must be (t-),

07    CDR:   ↓[Joo ]?
             ↓[Yeah ]?

08           (1.1)

09  → COP:   pitää ottaa,
             must be taken,

10           (0.6)

11  → COP:   nopeasti to[ta],
             quickly   e[r ],

12  → CDR:              [Hy]vissä a [join     ],
                        [We]ll in ad[vance    ],

13    COP:                           [eiku     ]hit-
                                     [no I mean]slo-
14    COP:   niin aikasin.
             yes early.
```

At lines 1-5, the COP's gaze is oriented to the notes based on the data transmitted by the Ecam; the COP reads one item aloud from the notes, 'flaps are slow' at line 4. During the succeeding (1.0)-second period of non-talk (line 5), the COP shifts his gaze from the notes, and starts to deliver the implications of the item from line 6 on. The CDR encourages the COP to continue talking with the overlapping 'yeah?' at lines 6-7. The COP's talk at lines 6, 9, and 11 indicates that the pilots need to take (i.e., extend) the flaps 'quickly'. The interrupted talk at line 6 ('must be t-'), the self-repair at line 9 ('must be taken'), and the pauses within the turn (1.1 sec. at line 8 and 0.6 sec. at line 10) imply that the COP has some problem in finding the proper description of how to operate the flaps; he ends up using 'nopeasti tota' [quickly er] at line 11. The CDR repairs the COP's description with overlapping 'hyvissä ajoin' [well in advance] at lines 11-12.

The CDR's repair replaces the COP's functional category of *how* to operate the flaps by the temporal category of *when* to operate them. The COP initiates (self-) repair with overlapping 'eiku' [no I mean] at lines 12-13; the interrupted self-repair 'hit-' may be intended as 'hitaasti' [slowly] and is produced in relation to the talk at line 11. After his discontinued self-repair, the COP acknowledges the CDR's repair with 'niin aikasin' [yes early] at line 14.

In the previous two cases, the Commanders corrected the Co-pilots' talk with un-modulated repairs. The Commanders' other-repairs were produced directly and 'early' relative to the trouble sources: in case 7, in overlap with the last turn constructional unit (or TCU) of the Co-pilot's multi-unit turn and, in case 8, overlapping with the increment 'er' following the transition relevance place (or TRP). In both cases, the activity of correcting was exposed, i.e., it became an interactive business in its own right by means of solo laughter (case 7) and acknowledgement (case 8). In the final cases (9-10), the troubles in understanding are repaired in the third position from the trouble-source turn.

4.2.4 Third position repairs

In case 9, the pilots are dealing with the problematic reference in conversation. The Commander engages in repair operation in the third position since the Co-pilot misrecognizes the referent of the Commander's preceding talk.

The crew is conducting an emergency landing at Arlanda Airport because of fire in a cabin lavatory. As a safety procedure, the pilots have checklists for normal, abnormal and emergency situations. The pilots have to execute the appropriate emergency checklist to restore the situation as quickly as possible during an emergency. At lines 8-9, the Co-pilot seems to misunderstand which checklist the CDR is requesting at line 6; at line 10, the Commander addresses the misunderstanding and engages in repair.

Transcription 9   CDR = PNF
Crew 5   COP = PF
Time 0:46

```
01          ((Cop is entering data onto the FMS))

02    COP:  Ils ((ILS)) zero one left,
            Ai el es ((ILS)) zero one left,

03          ((Cop is entering data onto the FMS; (10.5)))

04    CDR:  Ja<,
            And<,
```

```
05          (1.0)

06 → CDR:   annatko tsekkilistan sieltä. hh
            will you give me the checklist from there. hh

07          ((Cop completes entering data onto the FMS;
             (1.2)))

08 → COP:   Tsekkilista,hh
            The checklist,hh

09 →        ((Cop brings the normal checklist into view;
             (0.7)))

10 → CDR:   E:i↓ siis sen ↑imergensi<,
            N:o↓ I mean the ↑emergency<,

11          (1.5)

12 → CDR:   Quu är hoo,
            Q: R: H:,

13          (2.2)

14 → COP:   Quu Är Hoo,(.)[>Quu är hoo joo<,
            Q: R: H:,(.)  [>Q: R: H: yeah,<

15                        [((Cop moves the normal checklist
                             away))

16          ((Cop looks for the QRH; (3.4)))

17    ACC:  And Finnair:,(2.5)(six)(.)[six five one Romeo,

18                                    [((Cop gives the QRH
                                         to Cdr))
```

At lines 1-7, the COP is entering flight data specific to Arlanda Airport onto the FMS. Simultaneously, the CDR requests COP to 'give' him 'the checklist' at lines 4 and 6. The COP then responds to the CDR's request with an understanding check by repeating its referent at line

8. As soon as the COP hands up the checklist (line 9), the CDR launches a repair consisting of the initiation 'e:i' [n:o], the repair marker 'siis' [I mean] and the specification of the referent, 'sen imergensi' [the emergency] at line 10 (cf. Schegloff 1992a). Through his repair, the CDR distinguishes the emergency checklist from the normal checklist. The repair is designed to recast the COP's understanding to provide for another opportunity to fulfil the request. Despite the clarification of the referent, the COP does not meet the request, and a gap of (1.5) seconds ensues. After the pause in talk, the CDR reformulates his repair by revising the description of the referent using the acronym 'QRH' at line 12. 'QRH' stands for the Quick Reference Handbook containing checklists for various abnormal and emergency situations (see also Glossary). After a (2.2)-second pause, the COP produces a new understanding check, which he then repeats with the acknowledgement 'joo' [yeah] at line 14. The repetition of the understanding check followed by the acknowledgement seems to reveal his change of state in that the meaning of the request has now become clear to him. Simultaneously with his talk, the COP puts the normal checklist away (lines 14-15). During the succeeding (3.4)-second pause, he seeks the QRH, which he then gives to the CDR concurrently with the area controller's call (lines 16-18).

In this case, there appears to be an organizational reason for the emergence of the understanding problem between pilots. The terminologies for checklists vary between aircraft types. Within the Airbus family, the emergency checklists are called 'QRH', abbreviated from Quick Reference Handbook. The 'QRH' abbreviation is not used in other aircraft types, emergency checklists being called 'emergency checklists'. The crew in question differed in terms of flight experience[8] in various aircraft types. The COP had probably flown Airbus jets only, whereas the CDR had flown other types as well. The COP had no referent for 'emergency checklist' in his register, while the CDR for his part did not initially use Airbus terminology ('QRH') in his request; only after the COP had failed to respond to his first repair did the CDR seem to come back to using the terminology specific to Airbus.

In the final case (10), the pilots are dealing with problematic sequential implicativeness[9] in conversation. The Commander produces a repair in the third position as the Co-pilot displays misunderstanding about what the Commander's turn was doing.

The crew is performing an emergency landing at Turku Airport as a result of fire in a cabin lavatory. At lines 20-21, the Co-pilot is non-verbally displaying his understanding of what the Commander is asking him to do at lines 6-7; at line 22, the Co-pilot's misunderstanding emerges as the Commander engages in third position repair.

---

8   Total flight hours: COP (500 h), CDR (9000 h). Along with Airbus jets, the CDR had experience of flying with some if not all of the following aircraft: DC9, MD80, DC10 and MD11.

9   As mentioned, the 'sequential implicativeness' of talk takes place when the current turn projects a relevant next action/range of actions to be accomplished by another speaker in the next turn (Schegloff & Sacks 1973).

```
01    CDR:   Mä voin puhua radioon tässä kanssa,
             I can speak to the radio here also,

02           (.)

03    CDR:   [samalla          ],
             [at the same time],

04    COP:   [Okei             ],
             [Okay             ],

05           (0.7)

06 →  CDR:   Katoppas Quu är hoosta jos sieltä löytyy,?(.) ö::
             Look at the Q: R: H: if there are,? (.) uhm

07 →  CDR:   smoukki jut-[smoke juttuja tai jotaki samalla ni,
             smoke thin- [smoke things or something at the same
             time then,

08                       [((Cop brings the QRH into view and
                            starts to leaf through it))

09           ((Cop is leafing through the QRH; (4.0)))

10    CDR:   [Tampere Finnairi kuus viis ykköne,?
             [Tampere Finnair six five one,?

11           [((Cop is leafing through the QRH))

12           ((Cop is leafing through the QRH; (1.3)))

13    ACC:   [Joo? (.)  >Tampere<,?
             [Yeah? (.) >Tampere<,?
```

```
14          [((Cop stops leafing through the QHR;
               he starts to fold the QRH))

15          ((Cop completes folding the QRH; (1.4)))

16   CDR:   [Olik se Turun,
            [Was that Turku's,

17          [((Cop turns the QRH around))

18          ((Cop starts to shift the QRH left; (0.4)))

19   CDR:   [tuuli nolla viis nolla<,(.) hh
            [wind zero five zero<,(.) hh

20 → [((Cop shifts the QRH left and keeps it in front
               of Cdr))

21 →        ((Cop keeps the QRH in front of Cdr; (0.3)))

22 → CDR:   [°lue ittekses (se),°
            [°read (it) yourself,°

23 →        [((Cop shifts the QRH to his knees))

24          (0.5)

25   CDR:   nolla viis nolla ja viis solmua.
            zero five zero and five knots.
```

At lines 1-3, the CDR takes on the duty of communicating with air traffic control; the COP acknowledges the CDR's turn with 'okay' (line 4). After a pause in talk, the CDR orders the COP to search for the smoke checklists 'or something' from the Quick Reference Handbook, QRH (lines 5-7). Simultaneously with the CDR's talk, the COP lifts the QRH into view and starts to leaf through its pages (lines 7-8). From the succeeding (4.0)-second period of non-talk up to the outset of the pilot-controller communication, the COP leafs through the handbook (lines 9-14). Next, the COP folds the QRH (lines 14-15). As the CDR initiates the question to the area controller, the COP turns the QRH around (lines 16-17); he then starts to shift the QRH left, to the CDR's side (line 18). In his interrupted turn at lines 16 and 19, the CDR is

inquiring about the wind conditions at Turku Airport. During the CDR's talk and the following (0.3)-second period of non-talk, the COP keeps the handbook in front of the CDR (lines 19-21). So, by this time, the COP has brought the QRH out and leafed through its pages as if to find the proper checklist from there; finally, the COP has shifted the handbook with the checklist on view to in front of the CDR.

In this emergency situation, it is the COP's duty as a Pilot-not-flying to execute the appropriate checklists. Keeping the handbook left implies that the COP is showing it to the CDR as if to ensure that the current checklist is the one the CDR was asking for (see the CDR's ambiguous request for 'smoke things or something' at line 7). The CDR treats the COP's responsive conduct as problematic by reformulating the order as 'lue ittekses se' [read it yourself] at line 22. Therefore, from the CDR's point of view, it seems as if the COP is giving the checklist to him to read.[10] During the CDR's repair, the COP is putting the handbook to his knees (lines 22-23). After an (0.5)-second pause in talk, the CDR resumes the conversation with the controller (lines 24-25). The COP initiates the checklist reading later on, as the CDR has finished communicating with the controller and informed the passengers about the emergency descent.

In the extract, the COP did not understand what the CDR's turn at lines 6-7 was doing. The COP's interpretation was that the CDR ordered him to find the particular checklist from the Quick Reference Handbook and *show* it to the CDR. As the events in the extract reveal, the CDR is ordering the COP to find the proper checklist and *read* it through himself.

4.3   CONCLUSIONS

Airline pilots may have problems in their institutional talk-in-interaction, i.e., in speaking, hearing and understanding the cockpit talk. The flight crew members manage these problematic understandings by means of various types of repair procedure: self- and other-initiated self-repairs, (other-initiated) other-repairs and third position repairs. The conversational repair plays an important part in cockpit talk-in-interaction as it enables and facilitates the achievement of intersubjectivity between airline pilots. The current chapter was virtually based on a comparative analysis between (institutional) cockpit talk and ordinary conversation. The basic idea was to locate and exhibit similarities and differences in the properties of repair organization in these two settings. In terms of resemblances, the repair practices used in cockpit talk-in-interaction are formally similar to the organization of repair in everyday settings. The difference between the two settings is the preference organization of repair. In the airline cockpit, correcting the other crew member is not oriented to as normatively dispreferred activity, the result

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10   At this point, the CDR does not use the conventional form of third position repair "*I'm not asking you to give the checklist to me, I'm asking you to read it...*", but instead uses the concise turn "*Read it yourself*". This may be due to the specifics of the setting, i.e., the overlapping communication with the ATC and the general requirement to speak succinctly.

contrasting with ordinary conversation where this dispreferred status of other-corrections is frequently addressed through such things as mitigation, 'cushioning' and withholding.

Along with ordinary settings, the conversational repair is commonly used as a resource for locating and dealing with the problems of intersubjectivity in cockpit talk-in-interaction. More specifically, the airline pilots employ similar practices to participants in ordinary conversation in order to manage problems in speaking, hearing and understanding the talk – the practices such as self- and other-initiated self -repairs, (other-initiated) other-repairs and third position repairs. In the airline cockpit, the self-initiation techniques for self-repairs are the same as those in ordinary conversation: cut-offs, pauses within a turn, combinations of particles like 'eiku' [no I mean], etc. The other-initiation techniques for self-repairs in cockpit talk-in-interaction also resonate with those of ordinary conversation: repetition requests, partial repeats of the trouble source, open repair initiations, question forms, etc. Finally, the repair operations done in an airline cockpit – additions, replacements, repetitions, specifications and reformulations – are parallel to those used in everyday settings.

In the cases analyzed above, the 'miscommunication' or problematic talk occurs in institutional talk-in-interaction in and through which the airline pilots accomplish their formal tasks and activities. At this point, it is important to note that the processing of intersubjectivity is collaborative in nature, requiring some time and effort from the both flight crew members. Consequently, the repair procedures being used to recognize and resolve the problems of intersubjectivity momentarily interrupt or suspend – at least verbally – the actual task accomplishment on the flight.[11] The resumption of the interrupted task or activity provides the achievement of intersubjectivity between the airline pilots. In the cockpit interaction, the shared understanding necessary for the accomplishment of institutional tasks and goals and, in more general terms, for the safe and efficient conduct of the flight, is achieved and established through the practices of ordinary talk. In an ideal world, undoubtedly, interaction between airline pilots is smooth and fluent, without interruptions of any kind. In reality, the problems of intersubjectivity are also difficult to totally avoid between these highly skilled professionals. Even though the emergence of intersubjective problems in a cockpit setting is not favourable in terms of flight safety, the identification and management of these problematic understandings are, by definition, the significant safety-critical activities.

The notion of 'formal' similarity between the repair practices used in cockpit interaction and ordinary conversation has some important consequences for understanding the latter's role in institutional interaction in general and cockpit interaction in particular. To start with, the airline cockpit is a distinct socio-technical setting in which the particular flight tasks are carried out through the sequential coordination of verbal and kinetic activities (this kind of orchestration of activities appears especially clearly in cases 3 and 4). The cockpit talk-in-interaction in and through which the flight tasks and activities are completed is highly specialized and

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11   As an exception, see case 6 where the situation is (partly) vice versa: the processing of intersubjectivity is temporarily interrupted by institutional talk (i.e., pilot-controller communication).

standardized. Regardless of these particular features of cockpit interaction, the airline pilots may use generic forms of mundane conversation in task accomplishment. Thus, the practices of ordinary conversation provide the pilots with a functional way to perform particular tasks and activities in the cockpit setting.

More generally, any form of institutional interaction is embedded in the practices of everyday talk-in-interaction. In the cockpit and other institutional settings, the primordial role of mundane talk becomes obvious in situations where participants orient to the problems in maintaining intersubjectivity. Repairing the loss of shared understandings may momentarily over-ride the performance of institutional tasks and obligations. The establishment of intersubjectivity is an important prerequisite to resuming the actual task accomplishment. (Arminen 2000, 444-445.) The institutional tasks and activities are carried out not only through the practices of institutional talk but also through those of ordinary conversation. Since the basic forms of mundane conversation permeate each institutional practice, drawing the line between institutional and everyday interaction becomes difficult, sometimes even impossible (see also Drew & Heritage 1992a). Arminen however, points out that "even if there are similar kinds of interactional practices both in mundane and institutional settings, these 'similar' practices do gain distinct meanings through the reflexive tie to the context" (2000, 449). As mentioned, with regard to the preference organization of repair in ordinary conversation, self-repairs are preferable to other-repairs. When other-repairs occur, they are often (but not always, however) modulated in form, and preceded by a pause to prompt self-repair. In the following example taken from ordinary conversation, the other-correction is prefaced by *Y'mean*.

Lori:	But y'know <u>s</u>ingle <u>beds'r</u> <u>aw</u>fully <u>thin</u> tuh <u>sleep</u> on.
Sam:	What?
Lori:	Single beds. // They're-
Ellen: →	Y'mean narrow?
Lori:	They're awfully <u>n</u>arrow // yeah.

(Schegloff et al. 1977, 378.)

In an airline cockpit, however, the organization of preference has a meaning different from everyday settings. In correcting the other flight crew member, the airline pilot may produce *unmodulated* (other-) repairs *'early'* relative to the trouble source. Under the circumstances, the normative order of interaction in ordinary conversation is replaced by the institutional order of flight safety: the direct, un-modulated other-repairs are institutionally preferable in ensuring the flight crew will follow the appropriate departure route on take-off (see case 7) and the flaps are operated properly (see case 8). The 'procedural consequentiality' (Schegloff 1991; 1992b) of the context of the cockpit talk-in-interaction is embedded and demonstrated within this specific kind of preference organization of repair. In and through direct other-repair, essentially, the flight crew members display an orientation towards the normative order of flight safety, therefore utilizing the institutional norms of conduct as a constituent of action-in-progress.

Achievement of intersubjectivity in cockpit talk-and-action-in-interaction

In the previous chapter, the data analysis focused on the problems and breakdowns in inter-subjectivity in the airline pilots' talk-in-interaction. The scope of scrutiny encompassed the sequence structure, i.e., the relationship between turns at talk (Arminen 2005b; Schegloff 2007). The empirical analysis revealed the ways in which the pilots employed a range of repair practices to recognize and deal with the difficulties in speaking, hearing or understanding the cockpit talk. The main analytical outcomes were that the flight crew members were regularly using the practices of ordinary conversation in accomplishing their institutional tasks and activities. Further, the particular practices of ordinary conversation were used in an institution-specific way in cockpit talk-in-interaction, the pilots displaying their orientation to the institutional norms of flight safety, displacing the normative procedures of interaction in ordinary conversation in and through direct, un-modulated other-repair.

In Chapter 5, the analytical scope extends to the talk-and-action-in-interaction which concerns the 'sequential order', or, the relative positioning of move, utterance or action (Arminen 2005b; Schegloff 2007). The data analysis focuses on the intersubjective problems airline pilots have in establishing and maintaining the sequential order of action during the flight. In the analysis, the problem types emerging in the cockpit talk-and-action-in-interaction were identified and designated as 'false' and 'absent' actions. In doing false action, the airline pilot orients to the sequentially incorrect cockpit activity, whereas the absent action means the pilot fails to do the action or activity s/he is responsible for. False actions include the subcategories of premature, excessive and irrelevant actions. A premature action occurs when the pilot orients prematurely in sequential terms to some particular flight activity; in excessive action, the pilot orients to a flight activity that has already been done (e.g., initiating a checklist that has already been performed); when the pilot produces an irrelevant action, s/he orients to a flight activity that is not supposed to be done (e.g., changing a particular mode setting which would be relevant in normal conditions but not during emergencies).

The problem types under scrutiny encompass premature and absent actions only. This is because the former represent the empirical majority in my data and the latter differ from other (i.e., false) cases: as will be shown, the processing of absent actions deviates from the ways in which other sequential problems (premature, excessive, irrelevant actions) are resolved in the cockpit interaction. Table 5.1 shows the frequencies of various problem types in my data (n = 45); the majority (nearly 70%) of the cases are actions produced prematurely in cockpit talk-and-action-in-interaction.

Table 5.1
Problem type frequencies

Problem type	Frequency	
Premature actions	30	(66,7%)
Excessive actions	5	(11,1%)
Irrelevant actions	1	(2,2%)
Absent actions	9	(20,0%)
Total	45	(100%)

Like problems emerging in cockpit talk-in-interaction (see Chap. 4), pilots manage the false actions with a range of conversational repairs. The processing of absent actions, however, differs from that of false actions in that the actions undone by the flight crew members are resolved by the particular practice called 'reminder'. Similarly to the previous chapter, the approach in Chapter 5 is both descriptive and comparative. The purpose is 1) to describe and compare the uses of these two interactive practices, repairs and reminders, in processing sequential problems on the flight deck, 2) to describe the preference organization of repair in the course of cockpit talk-and-action-in-interaction and 3) to compare that with the organization of preference in cockpit talk-in-interaction (see Chap. 4). As will be shown, the pilots face different types of sequential problems in cockpit talk-and-action-in-interaction which require diverse practices for resolution. As distinct from Chapter 4, it is further revealed that the airline pilots display simultaneous orientation both to the normal procedures of interaction and to the normative order of flight safety using modulated other-repair.

At the beginning of the chapter, I describe and present an analytical framework developed by Charles Goodwin (2000) on 'action and embodiment within human interaction' (see 5.1).

In analyzing situated human action, therefore, the mix of a range of semiotic fields or resources has to be considered. The sequences of talk, the bodies of the participants and the material structure in the surroundings are specifically examined as integrated components for the social production of meaning and action. The empirical analysis includes ten (10) cases where airline pilots locate and deal with 'premature' and 'absent' actions in their cockpit talk-and-action-in-interaction (see 5.2). The former are handled with the various types of repair practice (self- and other-initiated self-repairs and other-initiated other-repairs; see 5.2.1-5.2.2), while the latter are resolved with the practice of reminding (see 5.2.3). Chapter 5 ends with the summary of the main findings, which are discussed in relation both to the normal procedures of interaction in ordinary conversation and to the major results and implications concerning cockpit talk-in-interaction (see Chap. 4).

5.1   INTERACTIVE ORGANIZATION OF SOCIAL ACTION

Goodwin argues "that a primordial site for the analysis of human language, cognition, and action consists of a situation in which multiple participants are attempting to carry out courses of action in concert with each other" (2000, 1489). The participants accomplish their actions through talk, while simultaneously attending to the larger activities that their actions are embedded within and to the relevant phenomena in their surroundings. Analyzing video recordings of young girls playing hopscotch and archaeologists doing their work, Goodwin (2000) shows how human action is built through the visible and public deployment of various sign phenomena instantiated in diverse media. These sign phenomena or semiotic fields are juxtaposed in a way that makes them possible to mutually elaborate each other. A particular subset of semiotic fields the participants demonstrably orient to as relevant for the organization of action is called *contextual configuration*. Within situated interaction, the participants may orient to new semiotic fields and treat some other fields as no longer relevant. In this sense, the contextual configurations are not fixed but in a constant process of change. (Goodwin 2000, 1490.)

In the analysis of the 'hopscotch' case, various semiotic fields have to be taken into account (see Goodwin 2000, 1492-1505). There is a brief dispute going on between the three girls playing the game, but the analysis focuses on the actions of two only.[1] The one whose actions are being challenged is called Diana and the other, who is doing the challenging, is called Carla. In hopscotch, the players jump through a grid of squares drawn on the ground. The objective is to land on the right squares as the player jumps from one end of the grid to the other. The player is not allowed to land on a square that is marked with an object on it, such as a beanbag or stone. If the player lands on an incorrect square, s/he is out of that round of play. The dispute begins as Diana throws her beanbag into a particular square and starts to jump through the grid from

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1   The third girl, Rosa, only has a peripheral role in the event.

the top (she has already navigated the grid from the bottom). What happens next is that Carla walks into the grid and physically stops Diana from moving. Carla further argues that Diana has made an illegal move by throwing the beanbag into the fifth square instead of the fourth.

The conversation between Carla and Diana is shown below. The original Spanish version is on the left and its English translation on the right (see also Figure 5.1).
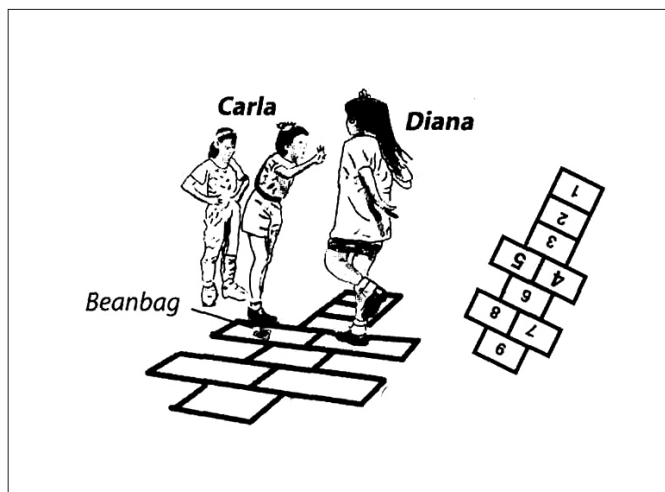
Figure 5.1
[Goodwin 2000, 1494]

1.	**Carla**:	Chiriona porgue-	*Cheater because-*
2.		Éste es el **cua:**tr[o	*This is the fo[ur*
3.	**Diana**:	[**Ai::**	*[**Hey::***
4.	**Carla**:	Y tú vas en el **CUA**TRO.	*And you go in the **FOUR**.*
5.		No vas en el **QUIN**TO.	*Don't go in the **FIFTH**.*

(Goodwin 2000, 1494)

Carla deploys many semiotic fields simultaneously in building her action here. First, she uses the lexical-semantic content of the talk as a resource for characterizing her playmate as a 'cheater' (line 1) and for specifying the squares on the grid as particular kinds of entities, 'the four' (lines 2, 4) and 'the fifth' (line 5). Second, these descriptions are embedded within a larger syntactic structure contrasting what Diana actually did with what she ought to have done. A re-use of the common syntactic frame 'And you go in the **FO**UR // Don't go in the **FI**FTH' clearly highlights the contrast, which is made even more salient by producing the disputable numbers in the same slot at the end of each unit. Third, Carla emphasizes the contrast through prosody, by stressing the first syllable of each number strongly. Fourth, the contrastive stress is produced within a larger framework of parallelism: both units in Carla's talk are delivered with the same pitch contour. Therefore, at lines 4 and 5, the pitch goes up after *vas* and down during *en el*; the pitch rises and falls over the first and second syllable of the numbers.[2] To sum up, Carla builds the central point of her argument through contrast. She employs a lexical-semantic content of talk, a particular syntactic frame and rhythmic pitch contours simultaneously to tell Diana why what she has done is wrong. (Goodwin 2000, 1494-1495.)

The previous exchange is, fifth, embedded within the larger activity represented by playing hopscotch (Goodwin 2000, 1496). In the dispute, Carla uses her own body to stop Diana moving and characterizes her as a cheater. The subsequent talk at lines 4-5 provides Carla with justification for her actions as she is arguing that Diana has just made an illegal move. The Spanish second person pronoun *tú* ('you' line 4), which could have been omitted in grammatical terms, seems to be doing some specific work. The use of the pronoun may help Carla to build her talk as an argument about how Diana's actual behaviour contrasts with what the rules of the game required: You [should] go in the Four. // Don't go in the fifth. Further, the *tú* is not referencing Diana as an individual person, but as a player who should act in a particular way in the game. Through the detailed structure of the talk, the game is constituted as a rule-governed institution with the normative consequences for making a distinction between legal and illegal behaviour. Sixth, the exchange takes place within a particular participation framework (see, e.g., Goodwin 1981; 1984) that is constantly built and sustained through the embodied actions of the participants. In the dispute, Carla and Diana are temporarily orienting towards each other with both their bodies and gaze. Within this participation framework, a variety of action is being built not only through talk, but also through gesture. (Goodwin 2000, 1496.)

Indeed, the framework of embodied mutual orientation enables the sign phenomena other than talk to function. Seventh, when Carla says *Cuatro* and *Quinto*, she provides a visual version of the numbers with the hand gestures: a four-fingered hand shape with *Cuatro* and a five-fingered hand shape with *Quinto*. These gestures are not only a visual mirror of the lexical content of the talk, but a semiotic modality in their own right. This means that Carla has to organize her gesture with reference to a specific embodied configuration including not only her

---

2   Goodwin demonstrates the variations in pitch contour with a picture resembling a stave used in composing (2000, 1495).

own body but Diana's as well. Carla thus positions her hand in Diana's line of sight to ensure that Diana will perceive it; actually, Carla's body is twisted so that her hand, arm and the upper part of the torso lean towards Diana (see Figure 1 above). The gestures are further framed by the contrastive movements of Carla's arm and hand. When Carla says '*Y tú vas en el **Cuatro**'*, she stretches her arm forward with the palm toward Diana; as Carla begins her next phrase '*No vas en el **Quinto**'*, she turns her hand around, and moves the arm closer to her own body. Carla uses the visual and rhythmic structure of her moving body not only to make the numbers produced in a stream of speech visible, but also to highlight the contrast between them. (Goodwin 2000, 1496-1499.)

Carla and Diana deploy numbers in different semiotic fields simultaneously in organizing their action. So far, the contextual configuration has consisted of the semiotic resources of spoken language (e.g., 'the four' and 'the fifth'), an iconic hand gesture and the participants' embodied orientation towards each other. What happens next amounts to a shift from one contextual configuration to another. When Carla says *Quinto*, Diana moves her gaze away from Carla's face and hand towards the grid on the ground (see Figure 5.2).
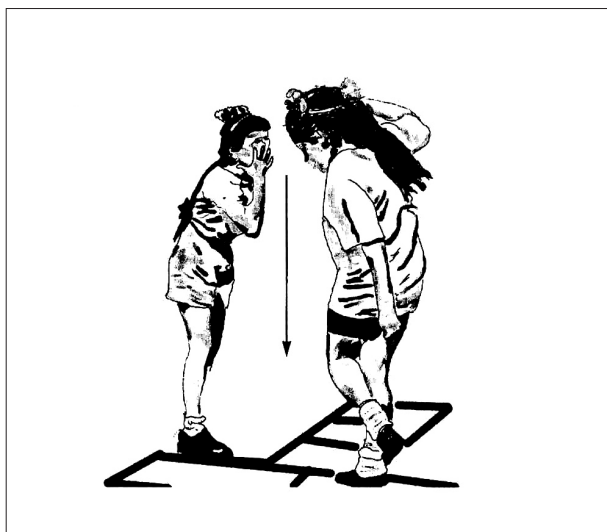
Figure 5.2
[Goodwin 2000, 1500]

At this point, Carla finds herself in the position of looking and gesturing toward someone who is no longer publicly orientated to her. Diana questions Carla's visual and vocal challenging by not acting as a visible recipient of it anymore. Carla treats what Diana has just done as undermining the challenge as she drops the gesturing hand and restates her argument in other words (see lines 6-7 in the next transcription).

4.	**Carla:**	Y tú vas en el **CUA**TRO.	*And you go in the **FO**UR.*
5.		No vas en el **QUIN**TO.	*Don′t go in the **FIF**TH.*
→ 6.		Este es el quinto	*This is the fifth*
→ 7.		y ese [es el **qua:**tro.	*And that [is the **fo**ur*
8.	**Diana:**	[No- (uhmm)	*[No-(uhmm)*
9.	**Diana:**	Pero éste es el **cua:tro**?	*But this is the **four**?*
10.	**Rosa:**	N [o. º Estás en el conco.	*N [o º This is the five*
11.	**Carla:**	[No. éste es el **cua**tro.	*[No this is the **fo**ur.*

(Goodwin 2000, 1502)

When Carla says: 'This is the fifth. // And that is the **fo**ur' she simultaneously uses her foot to do a deictic stomp at the particular squares on the hopscotch grid (see Figure 5.3).

Figure 5.3
[Goodwin 2000, 1502]

The entities being pointed to are located precisely in the grid that is the target of the Diana's gaze. Unlike a while ago, the grid as a focus of mutual orientation has now become a relevant semiotic field in the organization of the action. Consequently, the second contextual configuration consists of the semiotic resources of spoken language (e.g., 'this' and 'that'), an indexical gesture and the participants' embodied orientation towards the grid. (Goodwin 2000, 1500-1503.)

Analytical conclusions

The premise according to which human action is accomplished through the temporally unfolding juxtaposition of multiple semiotic fields has important analytical implications (see Goodwin 2000, 1517-1520). The participants use the public visibility of actions – performed by their bodies, the sequences of talk and the semiotic structure of setting – to build courses of action in collaboration with each other. Consequently, the scope of analysis is broadened from the interior life of a single actor into socially organized, interactively sustained configurations of multiple participants. (Goodwin 2000, 1517-1518.) The human body is considered as a locus for the display of meaning and action. Through the public visibility of bodies, the participants demonstrate their reflexive stance not only towards each other, but also towards unfolding talk and action. The same holds true for context. As the transformation from one contextual configuration to the other shows, the context is a dynamic, temporally unfolding process, accomplished through the ongoing re-arrangement of the structures in the talk, bodies, artefacts, spaces and features of the material environment to which the participants demonstrably orient within situated human interaction. (Goodwin 2000, 1519-1520.)

The activity of playing hopscotch has some fundamental similarities with flying the airplane. The hopscotch players and airline pilots are obliged to follow a set of procedures and rules that predefine the ideal or 'correct' courses of action. The rules of hopscotch require the players to jump through the grid in a numerical sequence, i.e., from square number one to square number two, etc. The standard operating procedures predetermine the sequence(s) in which the airline pilots are required to perform their tasks and activities while in flight. Thus, the activities to be conducted in hopscotch and flying the airplane are sequentially organized. Participants may both face similar kinds of problems in establishing and maintaining the sequential order of action. As shown in the hopscotch case, the problem, if only from Carla's point of view, was that Diana had skipped the fourth square on the grid, proceeding to the fifth 'too soon' in sequential terms. The airline pilot may also orient prematurely to some particular cockpit activity, therefore momentarily breaking down the sequential ordering of action (see case analysis sections 5.2.1-5.2.2).

The dispute between hopscotch players was processed with the coordinated actions of talk, gesture and posture.[3] Using the verbal 'And you go in the four…Don't go in the fifth', Carla was attempting to correct Diana's physical course of action in the game (i.e., repair in action-in-interaction). Being physically twisted towards Diana, directly facing her, Carla was simultaneously using iconic hand gestures to provide the visual equivalent of the numbers. Diana's gaze movement from Carla to the grid on the ground made new semiotic fields including spoken language, indexical gesture, and participants' bodily orientations to the grid relevant for the organization of action. In a similar vein, the airline pilots use talk, their bodily orientations, the gestures and the material surroundings as semiotic resources in building their action in the cockpit setting. These various vocal, visual and material resources are specifically employed and oriented to by the flight crew members in managing the problems of intersubjectivity while in flight.

5.2   REPAIR PRACTICES IN COCKPIT TALK-AND-ACTION-IN-INTERACTION

The data analysis concerns the intersubjective problems the airline pilots have in their talk-and-action-in-interaction or, more specifically, in positioning a move, utterance or action in the cockpit interaction. The analysis includes cases in which the pilot orients to the sequentially incorrect cockpit activity (premature actions) or fails to do the activity s/he is responsible for (absent actions). The analysis reveals how premature actions and absent actions are dealt with using divergent practices: the former with repairs and latter with what I call 'reminders'. The structural and functional differences between the two practices being used to deal with fundamentally dissimilar problems are addressed through comparative analysis. It will be further shown how the modulated form of other-repair displays the airline pilot's primary orientation to the normal procedures of interaction and secondary orientation to the normative order of flight safety.

The analysis includes ten (10) cases. Cases from 1 to 7 exemplify premature actions that are categorized according to repair type: 2 self-initiated self-repairs (n = 18), 2 other-initiated self-repairs (n = 8) and 3 other-initiated other-repairs (n = 4). The final three cases describe absent actions which are not managed with conversational repair but with reminder (n = 9). The actions under scrutiny are 'officially absent' (Schegloff 1972, 364) as their non-occurrence is noticed and explicitly oriented to by the flight crew members. Prior to each transcription, I will define the situation of action and specify the line numbers attracting my analytical interest. The analysis focuses on the lines where the airline pilots produce premature or absent actions (i.e., the problematic turns or 'moves') and where the repairs and reminders are accomplished.

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3   In all likelihood, the players were counting and labeling the squares on the grid in different ways – Diana from the top, Carla from the bottom (Goodwin 2000, 1503). In this sense, the disagreement between players was based on the mis-(or different) understandings.

The transcription numbers, the numerical crew 'identifiers', the starting times of episodes and the official roles of the airline pilots are also described above the transcriptions. In these cases, the dynamics of the setting play an important role. Where relevant for better understanding the situated cockpit talk-and-action-in-interaction, the airline pilots' bodily orientations towards the material surroundings (pointing gestures, gaze movements, etc.) are described verbally and, on occasion, visually using still pictures on the transcripts. The circles and arrows on the pictures highlight the participants' embodied orientations to and within the cockpit setting.

5.2.1 Self- and other-initiated self-repairs

In cases 1-4, the pilots produce self-repairs in cockpit talk. In cases 1 and 2, the repairs are initiated by the speaker of the trouble source turn, while in cases 3-4, the repair initiation is done by the other. In the first case, the Commander initiates a self-repair in the third turn from the trouble source.

   The crew is returning to Stockholm-Arlanda Airport owing to hydraulic failure in the aircraft's technical systems. While the aircraft is turning right to reach a heading of 270 degrees, the Commander orders the Co-pilot to extend the flaps on the wings (line 3). At this point, the Commander's orientation to the flaps extension seems premature in terms of the ongoing activity of turning in the required direction. At lines 7, 9 and 12, the Commander is not only (self-) repairing her order but also re-establishing the sequential order of action on the flight.

Transcription 1   **CDR = PF**
Crew 6   **COP = PNF**
Time 2:29

```
01     CDR:    Ja:,?
               And:,?

02             (0.8)

03  →  CDR:    <↑Flaps one>.

04             (0.6)

05     COP:    Speed checked,

06             (0.5)
```

```
07  →   CDR:    Ta[ikka] odota odota,(.) sen aikaa
                 O[r   ] wait wait,(.) until

08      COP:     [Fla-],

09  →   CDR:    et saadaan vielä:#(.)tota,
                we'll still:# get (.)er,

10               (.)

11      COP:    suun  [(ta)    ],
                direct[(ion)   ],

12  →   CDR:           [tohon   ] hedingille[nii↓ s-]
                       [into the] heading   [yes↓ s-]

13      COP:                              [Joo  ok]ei,=
                                          [Yeah ok]ay,=

14      CDR:    =ettei oo          kallis[tusta]< ( ),=
                =that there isn't any ba[nking]<( ),=

15      COP:                              [Joo  ].
                                          [Yeah ].

16      COP:    =Okei,
                =Okay,
```

At lines 1-3, the CDR orders the COP to set the 'flaps' to the position 'one'. The CDR uses the connector 'ja' [and] at line 1 to present the flaps extension as part of a larger course of action (Nevile 2006; see also Heritage & Sorjonen 1994). After a pause in talk, the COP responds to this order with the standard callout 'speed checked' (lines 4-5) which implies that the COP has checked that the current speed is appropriate for the flaps extension. Following an (0.5)-second pause in talk, the CDR initiates a repair with the connector 'taikka' [or] at lines 6-7. In overlap with the CDR's repair initiation, the COP continues the callout with interrupted 'fla-', which might be intended as 'flaps one' (lines 7-8).[4] At lines 7, 9 and 12, the CDR repairs her previous order by requesting the COP to refrain from flaps extension until the flight crew has reached

_____

4   The callout means that the COP is extending the flaps to position one by moving the flap lever on the pedestal.

the assigned heading. The COP acknowledges and accepts the CDR's (self-) repair with the overlapping 'yeah okay' at lines 12-13. The CDR's talk at line 9 includes word search markers: stretching the 'vielä:' [still:], a micro-second pause within the turn and the sound of hesitation 'tota' [er]. The COP proffers 'suunta' [direction] as a solution to the CDR's word search at line 11 (on collaborative completion, see Lerner 1991; Bolden 2003). The CDR accepts the word offered with 'nii↓' [yes↓] at line 12. The repair is accounted for by the CDR with 'ettei oo kallistusta' [that there isn't any banking] at line 14. The COP acknowledges and accepts this account with 'yeah' and 'okay' (lines 14-16).

In the second case, the initiation for self-repair also takes place in the third turn to the trouble source. The crew is returning to Stockholm-Arlanda Airport because of hydraulic failure in the aircraft's technical systems. At this point, it is the Commander's duty as a Pilot-flying to initiate the checklists; this is done by calling the name of the list. At lines 3-4, the Commander skips the 'approach' checklist and initiates the 'final' checklist prematurely. At line 14, the Commander not only corrects his initiation, but also restores the sequential order of checklist performance in the cockpit.

Transcription 2   **CDR = PF**
Crew 11   **COP = PNF**
Time 2:30

```
01      COP:    Lupa on,
                We have the clearance,

02              (1.0)

03  →   CDR:    Tch selvä juttu↓ rata edessä se on l:anding
                Tch right↓ the runway ahead it is l:anding

04  →   CDR:    miinus final check,?
                minus final check,?

05              (1.7)

06      CDR:    Cabin crew↑ please be seated for landing,

07              (0.8)

08      COP:    Cabin announcement,
```

```
09              (.)

10      CDR:    Given,?

11              (0.3)

12      COP:    Autothrus:t,?

13              (.)

14  →   CDR:    Siis >approutsii siit voi lukee äkkii välist pois
                I mean the >approach can be got out of the way
                quickly

15      CDR:    ettei unohettu sielt mitää<,
                so that we did't forget anything there<,

16              (0.7)

17      COP:    Joo↓ jos me ei sitä luettu vielä< BRIEfing
                Yeah↓ if we haven't read it yet< BRIEfing

18      COP:    (on) s[iinä ] ˚eka˚,=
                (is)  [there] ˚the first˚,=

19      CDR:          [O:n  ],?
                      [I:s  ],?

20      CDR:    =performed,
```

At line 1, the COP confirms to the CDR that the aircraft has received a clearance to land. Following a (1.0)-second pause in talk, the CDR acknowledges the COP's turn with 'right', notices that the 'the runway' is 'ahead' and initiates the final checklist with 'it is landing minus final check' (lines 2-4). The standard wording for checklist initiation would be 'final checklist;' the CDR frames his talk with 'it is landing minus'. After a pause in talk, the CDR performs the checklist action by asking the 'cabin crew' to 'be seated for landing' at lines 5-6. After that, the COP reads out the first item on the final checklist, 'cabin announcement' at lines 7-8. After a micro-second pause in talk, the CDR confirms that the announcement has been 'given' (lines 9-10). Next, the COP calls out 'auto thrust' (lines 11-12). After a micro-second pause in talk,

instead of responding, the CDR initiates a (self-) repair with 'siis' [I mean] at lines 13-14. The CDR's repair proper initiates the approach checklist: 'approutsii siit voi lukee äkkii välist pois' [the approach can be got out of the way quickly] at line 14. The repair is accounted for by the CDR at line 15: 'so that we didn't forget anything there'. As the CDR's talk indicates, skipping the approach checklist is explained by the forgetfulness of both pilots ('so that *we* didn't forget…'). After a pause in talk (line 16), the COP acknowledges the CDR's talk with 'yeah' and accounts for the skipping of the checklist with poor memory: it is as if the COP does not remember whether the pilots had performed the approach checklist or not ('*if* we haven't read it yet', line 17). The COP adheres to the normative order of checklist execution by reading out 'briefing' on the approach checklist – the prescribed wording, which is post-expanded with 'is there the first' (lines 17-18). The CDR's overlapping 'i:s' is preliminary to his standard response 'performed' with which the CDR confirms that the approach briefing has been done (lines 18-20).

This case concerned the problematic sequential order between different checklists. In the following cases, (3-4), the pilots are dealing with a problem in establishing the sequential order between checklist items. In case 3, the Co-pilot produces a (self-) repair initiated by the Commander.

The crew is going through the 'before engine start' checklist at Stockholm-Arlanda Airport. As the aircraft is on the ground, it is the Co-pilot's duty to read the checklist items aloud while the Commander responds to them. At line 4, the Co-pilot skips the 'altimeters' item and produces the 'take off data' item prematurely. At lines 8 and 10, the Commander initiates repair. With the repair proper at line 11, the Co-pilot corrects his talk and restores the sequential order of checklist execution.

Transcription 3   CDR = PNF
Crew 3   COP = PF
Time 1:17


```
01      COP:    Ö fjuuli, h=
                Uh fuel, h=

02      CDR:    =Viis yhdeksän kuuskymmentä, h
                =Five nine sixty, h

03              (0.6)

04  →   COP:    [↑Viis yhdeksän kuuskymmentä.(.)Take off deitta,?
                [↑Five nine sixty. (.) Take off data,?

05              [((Cop looks at the Secondary Engine Display))
```

```
                                    Still 1
                                    ((COP looks at the Sec-
                                    ondary Engine Display))
```

```
06               (.)

07      COP:     [h  ]hh

08 →    CDR:     [E- ]
                 [Is-]

09               (1.1)

10 →    CDR:     °Eiks se altimeter        tu[le ]°,
                 °Isn't it the altimeter com[ing]°,

11 →    COP:                              [A:l]timeter↓

12      COP:     sori( ),=
                 sorry( ),=

13      CDR:     =A- a- tuhatkolmeto:ista↓ satakymmene,=
                 =A- a- one thousand and thirte:en↓ one hundred
                 and ten,=

14      COP:     =Tuhat kolmeto:ista satakymmenen<,
                 =One thousand and thirte:en one hundred and
                 ten<,

15      COP:     ja (and) take off deitta,
                 and (and) take off data,
```

At line 1, the COP reads 'fuel' aloud from the 'before engine start' checklist. The CDR responds with the aircraft's fuel quantity of 5,960 kilos at line 2. Following an (0.6)-second pause in talk, the COP confirms the quantity with the repetition '5,960', simultaneously checking out the fuel quantity from the Secondary Engine Display (lines 3-5, Still 1). Next, the COP reads out the 'take-off data'[5] item on the checklist (line 4). After a micro-second pause in talk and in overlap with the COP's breathing out, the CDR takes the floor with the discontinuous 'E-' [Is-] at lines 6-8. Following a (1.1)-second pause in talk, the CDR starts his turn again with 'Eiks se altimeter tule' [Isn't it the altimeter coming] at lines 9-10. Instead of responding to the COP's checklist callout 'take-off data', the CDR initiates a repair by indicating that the 'altimeter' should be next on the current checklist. The COP (self-) repairs his previous talk in partial overlap with the CDR's turn by replacing 'take-off data' with 'altimeters' at lines 10-11. The COP displays an orientation to professional responsibility as he is 'sorry' for his mistake in checklist performance at line 12. The CDR responds to the 'altimeters' by announcing the standard atmospheric pressure of '1013' hectopascals and the height above sea level, '110' feet (line 13). The COP confirms the CDR's response with the repetition at line 14, and follows the sequential order of checklist execution by delivering 'take-off data' at line 15.

As above, the pilots now discuss the problematic sequential order between checklist items in the final example of self-repair, in which the Commander produces a repair that is initiated by the Co-pilot. The pilots are performing an emergency checklist procedure by using a complex computerized system called the ECAM. Because of its complexity, the current case (4) is presented at more length than the others to aid the readers' comprehension.

The crew is *en route* to Oslo from Stockholm. The ECAM system has just sent a computerized message to the pilots about a technical failure in one of the aircraft's hydraulic systems. The Commander is informing the Co-pilot about the nature of the failure by reading the data presented on the ECAM System Display aloud. The data consist of the list of inoperative systems in the aircraft and the effects the failure will have for later phases of the flight. According to the abnormal and emergency procedures, the Pilot-not-flying (i.e., the Commander) calls out 'Clear' + [system name] when s/he requests confirmation from the Pilot-flying (i.e., the Co-pilot) that the list has been read completely and the system screen may be cleared. The Pilot-flying will reply 'Clear' + [system name] to confirm that the clearing action can be taken.

For the sake of intelligibility, I will first show how the current instance would have proceeded if it had been in line with the emergency procedures (see the next, fictional transcription).

---

5   The item refers to the particular take-off speeds that are to be inserted into the Flight Management System (for further details, see Glossary for V1, Vr and V2).

```
06    CDR:   ei voida käyttää autobreikkiä.
             we aren´ t able to use the autobrake.

07           (1.5)

08    CDR:   Spoilerit ykkönen ja vitonen ( ) siivissä,
             Spoilers one and five on ( ) wings,

09           (1.2)

10  → CDR:   Clear wheel,

11  → COP:   Clear wheel,

12           ((Cdr pushes the key on the ECAM Panel;
               (1.0)))
```

The Commander asks for the Co-pilot's confirmation to clear the system screen after reading the electronic list completely. The request is made at line 10: CDR: 'Clear wheel'. At line 11, the Co-pilot replies 'Clear wheel' to confirm that the Commander may clear the screen. The clearance activity is physically done at line 12, where the Commander pushes the 'clearance' key on the ECAM panel.

In case 4 (see transcription below) the Commander prematurely requests the Co-pilot's confirmation for the screen clearance (line 8). At lines 11 and 16, the Co-pilot initiates a repair. The Commander uses the self-repair (lines 14, 18) not only to correct his previous talk but also to restore the sequential order of the emergency procedure on the flight.

Transcription 4   **CDR = PNF**
Crew 9   **COP = PF**
Time 1:27


```
01    CDR:   Steering, (.) ja autobreikki,
             Steering,(.) and autobrake,

02           (1.7)
```

```
03      CDR:    niihin vaikuttaa,  (.) jos mennään< laskuun
                those are affected,(.)if we go< to landing

04      CDR:    ni ei päästä radalta pois ja,
                then we won't get off the runway and,

05              (1.3)

06      CDR:    ei voida käyttää autobreikkiä.
                we aren't able to use the autobrake.

07              (1.5)

08 →    CDR:    Cl[ear wheel,

09              [((Cop points to the ECAM System Display))
```



```
                                      Still 2
                                      ((COP points to the
                                      ECAM System Display))
```

```
10              (.)

11 →    COP:    [Tch spoilereita puuttuu,?
                [Tch the spoilers are missing,?

12              [((Cop brings his pointing finger closer to the
                   display))
```

Still 3
COP: "Tch the spoil-
ers are missing,?" ((COP
brings his pointing
finger closer to the dis-
play))

```
13                  (.)

14 →    CDR:    [Spo[iler   ]it nii ykkönen ja vitonen,
                [Spo[iler   ]s right one and five,

15              [((Cdr moves his pointing finger onto the ECAM
                   System Display))

16 →    COP:        [(neljä)].
                    [(four) ].
```


Still 4
CDR: "Spoilers right one
and five," ((CDR moves
his pointing finger onto
the ECAM System Dis-
play))

```
17                  (1.2)

18 →    CDR:    (  )ssa siivissä,
                on (  ) wings,
```

```
19              ((Cdr pushes the key on the ECAM Panel; (3.6)))

20      CDR:    Flight controls,
```

At lines 1-6, the CDR is using the information on the ECAM System Display as a resource for his talk. The CDR's talk implies that the nose-wheel steering (see Glossary for 'landing gear') and automatic brake systems do not function because of a hydraulic failure. As a consequence of the steering malfunction, the flight crew will not be able to taxi 'off the runway' after landing (see Glossary for 'taxi'). Following a (1.5)-second pause in talk, the CDR asks for the COP's confirmation to clear the system screen (lines 7-8). Simultaneously with the CDR's request, the COP orients to the System Display with a pointing gesture (lines 8-9; Still 2). After a micro-second pause in talk and smacking his lips, the COP initiates a repair with 'spoilereita puuttuu' [the spoilers are missing] at lines 10-11. During the initiation, the COP brings his finger closer to the System Display (lines 11-12; Still 3). The COP's talk implies that the clearance activity is premature since the system screen is still displaying information the pilots should be aware of. The CDR produces a repair by reading 'spoilers' aloud from the System Display (lines 13-14). Simultaneously, the COP continues the repair-initiation with the quantitative specification 'four' at lines 14-16. The COP's initiation (lines 11, 16) amounts to the idea that four spoilers are malfunctioning because of the failure (see Glossary for 'spoilers'). The CDR acknowledges the COP's prior talk with the response token 'right' at line 14; the CDR continues his repair by specifying the inoperative spoilers 'one and five', simultaneously moving his finger onto the System Display (lines 14-15; Still 4). After a pause, the CDR locates the inoperative spoilers on the wings (lines 17-18). During the succeeding (3.6)-second period of non-talk, instead of asking for the COP's confirmation to clear the screen, the CDR actually does the clearance by pushing the key on the ECAM control panel; the next electronic page for the pilots to go through concerns 'flight controls' (lines 19-20).

In the previous cases, (1-4), the pilots produced either self- or other-initiated self-repairs in re-establishing the sequential order of action on the flight. Next, we will turn to cases in which the pilots use other-initiated other-repairs in dealing with the premature actions in cockpit talk-and-action-in-interaction. The analysis focuses specifically on the format of other-repair and the associated organization of preference. In the three cases shown, the (other-initiated) other-repairs are modulated in form; in and through these repair operations, the airline pilot's orientation is directed primarily to the normal procedures of interaction and secondarily to the normative order of flight safety.

5.2.2 Other-initiated other-repairs

Cases 5-7 describe other-initiated other-repairs produced in cockpit talk-and-action-in-inter-action. In the first two cases (5-6), the Commander corrects the Co-pilot's talk and action,

while in the final case of other-repair (7), the roles are reversed, the Co-pilot correcting the Commander's action.

In the next case (5), the problematic situation takes place in a sequential environment of action similar to the third case. Here, the other-repair is framed by the Commander inserting Finnish conversational elements into English standard terminology and giving an account of the repair.

The crew is performing the 'before engine start' checklist at Helsinki-Vantaa Airport. In line with case 3, the Co-pilot skips the 'altimeters' on the checklist and prematurely produces 'take-off data' (line 7). The Commander initiates a repair at lines 9 and 11. With his other-repair, the Commander corrects the Co-pilot's talk and re-establishes the sequential order of checklist execution in the cockpit (line 13).

```
Transcription 5            COP = PNF
Crew 9                     CDR = PF
Time 0:04


01      COP:     ↑Fu:el,

02               (1.2)

03      CDR:     Seven thousand four hundred sixty,=

04      COP:     [=seven four sixty.

05               [((Cop looks at the Secondary Engine Display))
```



```
Still 5
((COP looks at the
Secondary Engine Dis-
play))
```

```
06              (1.0)

07 →    COP:    Take off data,

08              (0.7)

09 →    CDR:    Inserted-

10              (1.9)

11 →    CDR:    Hetkinen<.
                Wait a minute<.

12              (1.6)

13 →    CDR:    Altimeters jäi välistä,
                Altimeters was skipped,

14              (0.7)

15      COP:    >(Aijaa sori) altimeters<,
                >(Oh yes sorry) altimeters<

                ((7 lines omitted: the Cdr laughs, the
                  Instructor calls the Cdr 'a fussy bloke',
                  the Cdr and Instructor laugh together))

23      COP:    >Altimeters<,

24              (1.1)

25      CDR:    Tu(h)hat kahe(h)ksantoista sata-(.)kaheksan(kyt)↓
                One tho(h)usand eigh(h)teen one hundred-
                (.) eigh(ty)↓

26      CDR:    (tuli) luupista kat(h)o,
                (came) out of the loop you se(h)e,

27              (0.6)

28      COP:    ↑Joo,
                ↑Yeah,
```

At line 1, the COP reads 'fuel' on the 'before engine start' checklist aloud. After a pause in talk, the CDR responds by delivering the fuel quantity of '7,460' kilos (lines 2-3). The COP confirms the CDR's talk with 'seven four sixty' while checking out the quantity on the Secondary Engine Display (lines 4-5, Still 5). Following a (1.0)-second pause, the COP launches 'take-off data' from the checklist (lines 6-7). Next, the CDR confirms that the take-off speeds are 'inserted-' into the system (lines 8-9). The CDR's cutting-off a word initiates a repair, after which a (1.9)-second pause follows (line 10). The CDR produces another repair initiation with 'hetkinen' [wait a minute] which suspends the ongoing execution of the 'before engine start' checklist (line 11). After a (1.6)-second pause, the CDR delivers his repair proper 'altimeters jäi välistä' [altimeters was skipped] at lines 12-13. In doing so, the CDR replaces the COP's 'take-off data' with 'altimeters'. The repair activity is framed by the CDR adding some conversational Finnish elements ('hetkinen…jäi välistä') to English official terminology ('altimeters'). Following an (0.7)-second pause in talk, the COP indicates with '(oh yes)' that he has undergone some change of state of awareness (Heritage 1984b), displays an orientation to professional responsibility with '(sorry)' and implicitly accepts the repair with 'altimeters' (lines 14-15). After the CDR's laughter, the Instructor's intervention and joint laughter between the two (omitted from the extract), the COP repeats the checklist item 'altimeters' at line 23. Next, the CDR responds to the previous item with the standard atmospheric pressure of '1018' hectopascals and the height above sea level, '180' feet (lines 24-25). The CDR continues his turn by giving a hilarious account of the repair at line 26: 'came out of the loop you se(h)e'.[6] After a pause in talk, the COP acknowledges the CDR's account with 'yeah' (lines 27-28).

In case 6, the Commander's repair operation is complicated: formally, the Commander makes a self-initiated self-repair, but functionally, an other-initiated other-repair. Despite its ambiguity, the case is treated as other-initiated other-repair by the Commander; the activity of correcting is framed by the Commander accounting for the repair.

The crew is conducting an emergency landing at Stockholm-Arlanda Airport, because of smoke in a cabin lavatory. The pilots are discussing the transfer of control and navigation duties in flight. The Co-pilot, who is in control of the aircraft, transfers the control and navigation duties to the Commander at line 5. The Commander first accepts the duties (line 6), but then gives them back to the Co-pilot (lines 8, 10).

---

6   The English expression 'being in the loop' means that one is part of the group who will get the information or hear about things. The CDR´s playful utterance 'came out of the loop you se(h)e', may refer to his cultural knowledge and competence in checklist execution. Having performed the (normal) checklists repeatedly during his career, the CDR knows automatically that 'altimeters' precedes 'take-off data' on the 'before engine start' checklist.

Transcription 6　　　**CDR = PNF**
Crew 4　　　　　　**COP = PF**
Time 0:47

```
01    STE:  Selvä no sitte me pannaan hösseliks, ((idiom))
            Right well then we start to work flat out,⁷

02          (0.5)

03    CDR:  Kyllä,
            Yes,

04          (3.2)

05 →  COP:  Se on your controls taas,=
            It's your controls again,=

06 →  CDR:  =My controls,

07          ((Cdr starts to shift his gaze and hand to the
             FMS; (0.5)))
```

Still 6
((CDR starts to shift
his gaze and hand to the
FMS))

Still 7
CDR: "Or wait a minute"
((CDR raises his index
finger))

---

7   To work "flat out", as hard and fast as you possibly can, is roughly the sense of "panna hösseliksi".

```
08 →  CDR:   Tai hetkine >otas vielä<,?
              Or wait a minute >take still<,?

09             (.)

10 →  CDR:   pidä[vielä jonkun              aika]a nii mä,
              keep[it still for          a whil]e so I'll

11    COP:        [(a:↑>minä pidän)     controls<],
                  [(a:↑>I'll keep)the controls< ]
```



```
Still 8
CDR: "keep it still for
a while" ((CDR points
toward COP))
```

```
12             (0.3)

13    CDR:   [paan valmiiks tota tän meijän↓>Tebin<jälkeen
              [finish up er this our↓ after >Tebby<

14             [((Cdr is bodily oriented to his FMS))

15             (0.3)

16    CDR:   nolla yks leftille,
              to zero one left,

17             (0.6)

18    CDR:   ja me saadaan radar vectors:,
              and we'll get radar vectors:,
```

To start with, the CDR and the Steward complete their conversation about the emergency on board (lines 1-3). The COP then hands the control and navigation duties to the CDR at lines 4-5. According to the standard operating procedures, the prescribed wording for the PF/PNF duties transfer is 'your controls'. The COP is framing English standard talk with Finnish non-standard talk: 'se on... taas' [it is...again]. The CDR accepts immediately, taking the control and navigation duties with the standardized 'my controls' at line 6. During the succeeding (0.5)-second period of non-talk, the CDR starts to shift his gaze and hand towards the FMS (line 7; Still 6). After his gaze and hand movement, the CDR initiates a repair with 'tai' [or] and suspends the ongoing activity of duties transfer with 'hetkine' [wait a minute] (line 8; Still 7). At his (other-) repair, the CDR asks the COP to first 'take' and then 'keep' the controls 'for a while', which the COP accepts in overlap (lines 8-11; Still 8). The CDR gives an account of the (other-) repair at lines 10 and 13: 'so I'll finish up er this our↓'; simultaneously with the talk, the CDR is bodily oriented to the FMS (lines 13-14). The CDR then orients to the data insertion, at the same time reading the approach data to the COP (lines 13-18).

In terms of sequence of talk, the CDR's repair at lines 8 and 10 focuses on his previous turn at line 6; formally, the CDR's turn is self-initiated self-repair produced in the turn next to the trouble source. In the sequential action, the CDR's turn is delivered in relation to the Co-pilot's previous turn at line 5. In functional terms, the CDR's turn is other-initiated other-repair as it reverses the task allocation suggested by the COP. Further, the turn is occasioned by the particulars of the socio-technical setting as a constraint on the action-in-progress, since the CDR moves his gaze and hand towards the FMS just before the repair (lines 7-8; Still 6). The CDR also mentions the task of data entry as his account for the repair (lines 10, 13, 16, 18). The visual glimpse of the FMS seems to have reminded the CDR of the task. At his other-repair, the CDR allocates the control and navigation duties back to the COP in order to ensure the proper data input into the system.

In the previous cases (5-6), the Commander corrected the Co-pilot's talk and action on the flight. In the last instance of other-initiated other-repair (7), it is the Co-pilot who corrects the Commander's conduct. The pilots are dealing with the problem of maintaining the sequential order between checklists – just as in case 2. The Co-pilot frames the activity of correcting the other by inserting Finnish conversational elements into English official talk.

The crew is at Helsinki-Vantaa Airport preparing for take-off. At this point, they need to perform an appropriate checklist. As the aircraft is still on the ground, it is the Commander's duty to initiate the checklist by calling its name. At line 4, the Commander is skipping the 'taxi' checklist and prematurely initiating the 'take-off' checklist. With his (other-) repair at line 7, the Co-pilot both corrects the Commander's talk and restores the sequential order of the checklist execution.

Transcription 7   CDR = PF
Crew 4   COP = PNF
Time 0:18

01   COP: Zulu Kilo (.)runway zero four↑ (.)cleared for

02   take off↓ Finnair six five one Romeo,

03   *((Cop starts writing the notes; (1.8)))*

04 → CDR: [↑**Ja** take off tsek**ki**.
            [↑**And** take off che*ck*.

05   [*((Cop is writing the notes))*

06   *((Cop is writing the notes*; *(0.7)))*

07 → COP: [°Zulu° Kilo **ja täs tulee** <u>taxi</u> tsek [**ki**],
            [°Zulu° Kilo **and here is** the <u>taxi</u> che[*ck*],

08   [*((Cop is writing the notes; he stops
               writing after saying "Kilo"))*

09   CDR: [**Ni**]
                                                  [**Ya**]

10   CDR: <u>taxi</u>i[ng tsek**ki**] **anteeks joo**,
             <u>taxi</u>i[ng che*ck*] **sorry yeah**,

11   COP: [**en:sin**],
                [**fi:rst**   ],

12   (0.7)

13   COP: **Ja** <u>**se**</u> **on:**, (.) >flight controls<,
            And <u>**it**</u> **is:**,(.) >flight controls<,

14   (0.5)

```
15      CDR:  Ja↑ se oli tsekattu,
              And↑ it was checked,
```

After acknowledging the take-off clearance from the tower, the COP starts to make notes (lines 1-3). While the COP writes, the CDR calls for the 'take-off' checklist (lines 4-5). The CDR prefaces the turn with 'and', thereby presenting the checklist as connected to other flight tasks and activities (Nevile 2006). The COP stops writing after saying 'Zulu Kilo', meaning the holding point via which the tower controller cleared the crew to taxi (lines 7-8). With 'ja täs tulee taxi tsekki' [and here is the taxi check], the COP repairs the CDR's turn by replacing 'take-off' checklist with 'taxi' checklist. The COP's repair is framed by Finnish conversational talk inserted into the English standard terminology: '*ja täs tulee* taxi tsek*ki*' (line 7). In his response at lines 7-10, the CDR confirms the repair with an overlapping 'ni' [ya]. With 'taxiing check', the CDR verifies that the pilots have a shared understanding about the appropriate checklist. The COP's temporal specification 'ensin' [first] produced in overlap with the CDR's turn (lines 10-11) can be heard as a complaint, as if the COP has to remind the CDR that the 'taxi' checklist will be performed prior to the 'take-off' checklist. An apology at line 10 shows the CDR's orientation to professional responsibility for skipping the checklist. The CDR further acknowledges the repair with 'yeah' (line 10). After a pause, the COP adheres to the sequential order of checklist execution by reading out the first item 'flight controls' on the 'taxi' checklist (lines 12-13). In his response, produced after a pause, the CDR confirms that the item 'was checked' (lines 14-15).

In the previous cases, (1-7), the pilots used self- and other initiated self-repairs and other-initiated other-repairs in dealing with particular sequential problems on the flight. The pilots were essentially using conversational repair not only to correct the talk but also to restore the sequential order of action. The activity of correcting the other flight crew member was framed in two ways, i.e., by accounting and using Finnish conversational talk together with English standard talk. These techniques were specifically used as a means of explicating and contextualizing the ongoing action in the cockpit interaction. In this way, then, the pilots oriented to achieving an intersubjective sense of cockpit activity in order to maximize flight safety.

In the cases analyzed above, the pilots handled 'premature' actions in which one crew member orients too early in sequential terms to some particular flight task or activity. In the remaining cases, (8-10), they deal with a different type of sequential problem called 'absent' actions, in which one pilot fails to accomplish the flight activity s/he is responsible for. As we will see, these tasks or activities conspicuously or officially not done in the cockpit setting are not dealt with by correcting, but with the practice of reminding (cf. Nevile 2007a).

5.2.3 Reminders by the other

The practice of reminding is used by pilots to detect and address some institutional task or activity as non-occurring in the course of cockpit talk-and-action-in-interaction. One flight crew member uses this interactive practice to remind the other about the latter's responsibility to perform a particular task or activity; the one who reminds is also simultaneously re-establishing the sequential order of action.

In the next two cases (8-9), the problem takes place in exactly the same sequential position of action. Just as in extracts (3-5), the pilots are discussing the problematic sequential order between checklist items.

The crew is going through the 'taxi' checklist before taking off at Helsinki-Vantaa Airport. At line 1, the Co-pilot reads out 'briefing' on the checklist, referring to the short confirmation of the thorough take-off briefing done earlier during the preparatory phase of the flight. The normal procedure is that it is the Pilot-flying's (i.e., the Co-pilot's) duty to deliver the take-off briefing in executing the 'taxi' checklist. At line 3, the Commander registers that the Co-pilot does not act according to his responsibility as a Pilot-flying as he fails to produce the take-off briefing at line 2.

Transcription 8   CDR = PNF
Crew 5   COP = PF
Time 0:21

```
01    COP:  Briefing,

02  →       (0.8)

03  → CDR:  Sul:la,
            Your:s,

04          (0.5)

05    COP:  Se on,
            It is,

06          (0.4)

07    COP:  Ru:nen four Delt:a departure four thousand
            blue,
```

```
08            (0.5)

09    COP:   Confir[med],

10    CDR:        [Con]firmed,
```

The COP reads out 'briefing' on the 'taxi' checklist at line 1. The item concerns the take-off briefing, consisting of the departure route to be used and the altitude assigned for the flight. At this point, it is the COP's responsibility as a PF to deliver the actual briefing. Instead of the COP producing the briefing, there is an (0.8)-second pause in talk at line 2. The CDR focuses his utterance 'sulla' [yours] at line 3 on the COP's previous move of not delivering the take-off briefing. The CDR's turn reminds directly and without mitigation that it is the COP's duty to deliver this briefing. After a pause in talk, the COP initiates the briefing with 'it is' (lines 4-5). Next, the COP produces the actual briefing, including the departure route 'Runen four Delta' and the altitude of 'four thousand' feet engaged in the aircraft's automatic systems (lines 6-7). By delivering the actual briefing, the COP acts according to his responsibility as a PF in executing the 'taxi' checklist. Following a pause, the airline pilots jointly confirm the take-off briefing (lines 8-10).

The following case (9) is sequentially congruent with example 8. The nature of the problem emerging in these two cases will be discussed afterwards.

Transcription 9   **CDR = PNF**
Crew 2   **COP = PF**
Time 0:13

```
01    COP:   Br:iefing,?

02  →          (1.5)

03    COP:   .h[hh  ]

04  →  CDR:    [Se ] oli sun hei[niä    ],
               [That] was your ba[by     ],

05    COP:                       [Ru:nen] four Delt:a

06    COP:   four thousand blue no changes. hh[hh ]

07    CDR:                                     ↑[Con]firmed,
```

At line 1, the COP reads 'briefing' on the 'taxi' checklist aloud. Following a (1.5)-second pause in talk, the COP may be taking the floor by inhaling deeply (lines 2-3). In overlap with the COP's in-breath, the CDR utters 'se oli sun heiniä' [that was your baby] at lines 3-4. The format of the CDR's turn is pronouncedly informal, since the Finnish utterance used is a popular idiom. The CDR's turn focuses on the COP's previous move of not delivering the take-off briefing at line 2. In talk, the CDR reminds the COP that it is his duty as a PF to deliver the actual briefing. The COP initiates the briefing delivery simultaneously with the CDR's reminder (lines 4-5). The briefing consists of the departure route 'Runen four Delta' and the altitude of 'four thousand' feet engaged in the aircraft automatics. The COP employs 'no changes' to indicate that the current briefing is consistent with the clearance delivery (lines 5-6). The CDR confirms the take-off briefing in overlap with the COP's strong exhalation at lines 6-7.

In cases 8-9, the COP failed to deliver the short take-off briefing although it was his responsibility as a Pilot-flying to do so. Why did this happen? To begin with, the 'challenge – response' method used in conducting the normal checklists adheres to the sequence of an adjacency pair. One flight crew member produces a first pair part (FPP) by calling an item on a particular list to be checked. The other crew member delivers a second pair part (SPP) by giving a response to this call after having checked the configuration. However, the 'taxi' checklist includes the adjacency pair of 'briefing – confirmed' which is structured in the previous cases like the following three-part sequence (see transcription 1a):

Transcription 1(a)

01	**COP/PF**:	"Briefing"

02	**COP/PF**:	"Runen four Delta, Four thousand blue"

03	**CDR/PNF**:	"Confirmed"

Before analyzing the sequential coordination of interaction between pilots in detail, I will briefly introduce the concept of the 'pre-sequence' (see Levinson 1983, 345-364; Heritage 1984a, 277-280; Schegloff 2007, 28-57). In conversation analytic terms, the pre-sequences that are themselves constructed of adjacency pairs (i.e., a pair of turns by two different speakers) commonly prefigure the specified base sequence, with the base first pair part (FPP) and the base second pair part (SPP). The following phone call example, which includes a type-specific 'pre-invitation' pre-sequence (lines 4-5), is taken from ordinary conversation (see transcription 2 on page 128):

Transcription 2
(Nelson is the caller; Clara is called to the phone)

```
01    Cla:                    Hello
02    Nel:                    Hi.
03    Cla:                    Hi.
04    Nel:  FPP pre    →      Whatcha doin'.
05    Cla:  SPP pre    →      Not much.
06    Nel:  FPP base   →      Y'wanna drink?
07    Cla:  SPP base   →      Yeah.
08    Nel:                    Okay.
```

(Schegloff 2007, 30)

At line 4, Nelson produces the pre-invitation question which is preliminary to a possible invitation. The type of response Clara delivers is the 'go-ahead' (line 5) as it encourages Nelson to continue with the base FPP which the pre-invitation was projecting. At line 6, Nelson actually issues the invitation, and Clara accepts it (line 7), which her go-ahead response to the pre-sequence had foreshadowed. The pre-invitations and many other pre-sequences (such as pre-offers, pre-announcements, etc.) are used as a conversational device to check whether there are grounds for initiating some yet-to-come base action; the responses to the pre-sequences are designed to serve either to encourage or to discourage the subsequent production of that action. (Schegloff 2007, 29-30, 41; see also 1980.)

On closer examination, the previous cockpit cases prove to be sequentially organized into the 'pre-sequence' and 'base sequence' in the following way (see transcription 1b):

Transcription 1(b)

```
01    COP/PF:     FPP pre    →    "Briefing"

02    CDR/PNF:    SPP pre     →    (--------)

03    COP/PF:     FPP base   →    "Runen four Delta,
                                   Four thousand blue"

04    CDR/PNF:    SPP base   →    "Confirmed"
```

The two turns at lines 3-4 form the base sequence in the sequential course of interaction: what is 'confirmed' here is the actual briefing 'Runen four Delta, four thousand blue', the actions taking place before (lines 1-2) preparing the way for the base sequence. The problem the pilots face may arise because the flight procedure lacks the SPP of the pre-sequence. Based on the turn-taking system of ordinary conversation (see Sacks et al. 1974), the relevant next action to the FPP of the pre-sequence (COP/PF: 'briefing') would be a response by the other speaker (CDR/PNF; e.g., 'go-ahead'). Instead of using some standardized wording, the CDR/PNF must rely on the practices of ordinary conversation (i.e., reminders) in order to display his understanding of unfolding action and proceed with the interaction. The checklist practice according to which it is the COP/PF's duty to deliver 'FPP pre' and 'FPP base' consecutively, without the CDR/PNF's response ('SPP pre') in between, contradicts both with the initial logic of checklist use and the normative procedures of interaction in ordinary conversation.

In the final case (10), as in the previous two, the Commander needs to remind the Co-pilot about the latter's responsibility to perform a particular activity.

The crew is returning to Stockholm-Arlanda Airport as a result of hydraulic failure in the aircraft's technical systems. At lines 1-2, the Stockholm control instructs the crew to descend to 2,500 feet. Following the abnormal and emergency procedures, it is the Pilot-flying's (i.e., the Co-pilot's) responsibility to respond to the message from air traffic control without delay. At line 6, the Commander registers that the Co-pilot has not acted according to this responsibility as he is failing to respond to the controller's instruction at line 3.

Transcription 10   **CDR = PNF**
Crew 10   **COP = PF**
Time 0:57

```
01    STO:  Finnair, hhh six five one Romeo descent to

02          two thousand five hundred,

03          (2.7)

04    COP:  S̲e̲t two thousand five hundred and p̲u̲ll,

05          (1.2)

06 →  CDR:  Puhuksä n̲y̲t ku↓ s- sulla on kontr̲o̲lli,
            Will you talk n̲o̲w as↓y-you have the controls,
```

```
07              (1.3)

08      COP:    Ai >kun mulla on< kontrolli,=
                Oh >as I have< the controls,=

09      CDR:    [=Nii,=
                [=Yes,=

10              [((Cdr starts to rotate the altitude knob))

11      INS:    =°#Joo,°
                =°#Yeah,°

12              (1.7)

13      COP:    O:kei voin mä puhua,
                O:kay I can talk,

                ((Instructor's intervention for 6.0 seconds))

14      COP:    Ää leaving five thousand feet ää (.)
                Erm                           erm

15              descending to two thousand five hundred feet

16              Finnair six five one Romeo,
```

The Stockholm Control instructs the flight crew to descend to 2,500 feet at lines 1-2. At this point, it is the COP's responsibility as a PF to respond to the message from air traffic control immediately. Following a (2.7)-second pause in talk, the COP orders the CDR to set and engage the 2,500 value by rotating and pulling the altitude knob on the Flight Control Unit (lines 3-4). After a (1.2)-second pause, the CDR asks the COP to 'talk' to the Stockholm control since it is the COP who is in control of the aircraft (lines 5-6). The CDR's turn at line 6 focuses on the COP's earlier move of not responding to the air traffic controller's instruction at line 3. In talk, the CDR is reminding the COP about the responsibility to communicate with the controller. After a pause, the COP responds to the CDR's reminder with 'oh as I have the controls' (lines 7-8). The response token 'oh' indicates that the COP has undergone some change of knowledge or awareness (Heritage 1984b). It seems to come as a surprise to the COP that it is his responsibility as a PF to communicate with the air traffic control. The CDR

confirms that it is the COP's duty to respond with 'yes'; simultaneously with his talk, the CDR starts to rotate the altitude knob on the Flight Control Unit (lines 9-10). The Instructor aligns himself with the CDR at line 11. After a (1.7)-second pause in talk, the COP acknowledges the CDR's reminder with 'okay' and notifies his acceptance with 'I can talk' (lines 12-13). Following the Instructor's intervention, the COP acts according to his responsibility as a PF by responding to the Stockholm control (lines 14-16).

5.3   CONCLUSIONS

The activity of flying the airplane is organized in sequences of action. The particular task in the cockpit becomes sequentially the relevant 'next' only after some other tasks or activities have been accomplished. In organizing the collaborative courses of action with each other, it is important that the pilots have an intersubjective sense of what tasks and activities are a) completed, b) in progress and c) to be done next and by whom. The flight crew members use a range of verbal, visual and material means or resources not only to establish and maintain the sequential order of action, but also to display to one another (and the analyst as well) their understandings of where they are in terms of task accomplishment. The pilots may have troubles of various kinds in sequential positioning of move, utterance or action in cockpit talk-and-action-in-interaction. The current chapter described and analyzed two different problem types: first, false actions, in which the pilot orients prematurely in sequential terms to some cockpit activity; and second, absent actions, in which the pilot fails to carry out the activity s/he is responsible for 'here and now', i.e., in a particular sequential phase of action.

The problem types mentioned above are dealt with using the different kinds of practices in cockpit interaction. The pilots' premature orientations to particular flight task or activity are regularly managed with conversational repair. The identification and management of activities left undone by the flight crew member takes place, by contrast, with the practice called reminder. The use of these different interactive practices project and bring about the rather divergent sequentially organized trajectories of action in the cockpit. Through the use of repair practice, to begin with, the pilot indicates the action or activity *done* during the previous turn as sequentially problematic. The crew member uses self- and other-initiations specifically to address the preceding talk or action as 'being in need of repair'. The activity of correcting is subsequently completed either by the speaker of the problematic talk (see cases 1-4: self- and other-initiated self-repairs) or by the other participant (see cases 5-7: other-initiated other-repairs).

In relation to the regular correction practices, the use of a reminder describes and conveys an atypical or 'deviant' course of action. As distinct from the repairs, the reminders are employed by the pilots to point out that the action or activity *not done* in the previous turn or slot is problematic in sequential terms. The activity of reminding (e.g., '*yours*' / '*that was your baby*') not only prods the other crew member about particular cockpit responsibility or

assignment, but also implicitly addresses the non-occurring talk or action as 'being in need of realization' by the other. The participant being reminded then carries out the requested task or activity, thus meeting the demands and obligations of his official role as a Pilot-flying (see cases 8-10).[8] Despite the differences in structure and function, the uses of repairs and reminders have convergent, safety-relevant implications for cockpit talk-and-action-in-interaction: in and through these practices, the sequential order of action is re-established and, the intersubjective sense of action-in-progress is simultaneously achieved.

In the cockpit setting, the practice of reminding stems from the misuse or non-use of standard operating procedures. The formal procedures say, for example, that it is the Pilot-flying's responsibility to communicate with air traffic control during abnormal and emergency situations. As shown in the final case, when the Pilot-flying (i.e., the Co-pilot) failed to respond to the air traffic controller's clearance, the Pilot-not-flying (i.e., the Commander) reminded him about his duty to communicate. Along with airline cockpit interaction, the reminders are used – and usable – in ordinary conversation where the practice reflects non-adherence to the normative rules and procedures of interaction. While the intrinsic orientation in ordinary conversation is towards diminishing the opportunities for disagreement or conflict (see Heritage 1984a, 265-280), the processing of absent actions can threaten the maintenance of social solidarity between the participants in interaction. To illustrate, two people make an agreement to meet at a specific place and time, such as in a coffee house at 6 p.m. Based on the normative order of interaction, these persons are now socially expected to show up by the appointed time, or, in case they cannot make it on time or at all, to announce the delay or cancellation in advance. Failing to arrive at the meeting place without advance notice may entail some kind of negative sanction or punishment. The person waiting, for example, can use a form of verbal abuse by cell-phoning the other, indignantly reminding him or her about the meeting, demanding an explanation for not coming, and at the same time complaining about the other being 'scatty' or 'careless'. Meanwhile, the flight crew member failing to accomplish an action or activity under his responsibility does not seem to engender complaints or accusations in cockpit interaction (see also Nevile 2007a). This kind of 'neutral' or 'professional' stance in the course of reminding is certainly consequential in establishing and maintaining a pleasant, safety-oriented atmosphere.

In addition to the usages and meanings of different interactive practices of correcting and reminding, the second theme of the chapter concerned the relationship between two distinct normative orders oriented to by the pilots. Firstly, according to the normative order of interaction, self-repairs are preferable to other-repairs. The activity of correcting the other speaker is marked as normatively dispreferred in a variety of ways, such as mitigation, 'cushioning', withholding, etc. Secondly, following the normative order of flight safety, it is important not only

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8   As mentioned, Nevile (2007a) has analyzed the instances where some cockpit action is due but not yet begun. His study shows how one pilot 'prompts' the other to initiate the action with *and*-prefaced talk; the action is then initiated by the pilot responsible for doing so. The *and*-prefaced talk is considered here as an activity repairing the problematic timing of action. (Nevile 2007a, 239-245, 247-248.)

that the pilots constantly maintain and update the intersubjective sense of ongoing action, but also that they actively bring the potential problems or breakdowns in intersubjectivity to the conversational surface. Using any kind of corrective action is consequently better than not correcting at all. Given the high stakes and the time-critical nature of the airline pilots' work, direct, explicit other-repairs are preferable to indirect, implicit other-repairs. In interactive terms, to summarize, correcting the other crew member is a dispreferred activity since the use of a self-repair would be preferable. However, in terms of flight safety, other-corrections can be seen as the preferred activity, because the achievement of intersubjectivity necessary for safe conduct of the flight is enabled and realized through them.

As shown above, the interactive techniques or means the airline pilots use to modulate other-corrections include 1) accountings and 2) the insertions of Finnish non-standard talk into English standard talk. By providing tools to explicate the action, these strategies display the pilots' orientation to the maintenance of intersubjectivity that is a precondition for the time-critical coordination of flight safety. The first strategy is used, not only in the cockpit interaction (and probably some other institutional settings), but also in ordinary conversation where the accountings produced in company with dispreferred seconds serve to support social solidarity (see Heritage 1984a, 269-273). The second modulation technique appears to have meanings characteristic of the cockpit interaction. In case 5, for example, the Commander uses Finnish conversational elements together with English official talk in correcting the Co-pilot who had skipped one item on the 'before engine start' checklist (CDR: '...**hetkinen**... altimeters **jäi välistä**'). As the standard operating procedures state, it is the Co-pilot's duty to read out the items, while the Commander is obliged to respond to them. In the course of correcting, the Commander as it were steps into the Co-pilot's territory by launching the item ('altimeters') himself. The Finnish non-standard talk inserted into English standard talk not only frames the corrective action, but also demonstrates the Commander's orientation to, and understanding of, the particular roles and responsibilities (i.e., who does what and when) in the accomplishment of flight tasks. In line with case 5, the form of modulation in case 7 indicates that the talk-in-progress 'deviates' from the official agenda. At his other-correction, the Co-pilot accomplishes an activity coming under the Commander's responsibility, i.e., he (re-) initiates the checklist with '**ja täs tulee** taxi chek**ki ensin**'. At that point, the Co-pilot eschews delivering direct other-repair ('taxi check/-list') and instead contextualizes the talk by adding Finnish conversational elements to it; he simultaneously demonstrates implicit orientation to and respect for the formal cockpit procedures and task allocation.

In ordinary conversation, the dispreferred status of (other-initiated) other-correction is addressed not only with mitigation or 'cushioning', but also with pauses, gaps or delays preceding the (initiation of) corrective action. In cases 5-7, similarly, the activity of correcting the other crew member is produced after a pause in talk, or rather, after a 'period of non-talk'. During that time, the pilots are not specifically engaged in talking but in some 'silent', physical activity. The delays occurring prior to other-corrections do not thus necessarily or automatically indicate the pilot's orientation to the normative order of interaction. The production of

other-repair may be delayed because of the pilot's prevailing orientation to, or within, the cockpit environment. For example, the Commander pays attention to the particular material object prior to correcting the other crew member (see case 6, lines 7-8). In a similar vein, the Co-pilot delivers other-correction only after completing writing the notes (see case 7, lines 3-8). In the airline cockpit, then, the pauses preceding the other-corrections do not inevitably indicate the dispreferred nature of upcoming activity, but may be due to the pilot's current engagement in some physical action or activity. The idea that the delays may have meanings and implications distinct from ordinary conversation projects the complexity and specificity of the cockpit as an institutional setting.

To repeat, the dispreferred actions, such as other-initiated other-repairs, are commonly accompanied by delays, prefaces (e.g., the use of markers like '*uh*' or '*well*', apologies, etc.), accounts and the related 'modulators' of ordinary conversation (Levinson 1983, 334-335). Through these interactive resources, the participants mainly orient to maintaining social solidarity and avoiding conflict or disagreement (Heritage 1984a, 265-280). In addition, however, the use of modulators may at least partly display the participants' orientation to achieving and maintaining intersubjectivity. For example, the accounts specifically explain and make the reason for the dispreferred action understandable. Along with functioning as a 'face-preserving' strategy, the accounts can thus also serve to establish an intersubjective sense of action-in-progress.

In terms of cockpit interaction, the modulation techniques used provide important means of framing and explicating the ongoing action. By modulating the activity of correcting the other, therefore, the flight crew members' primary orientation is not towards preserving face, as in ordinary conversation (see especially case 7: the COP's other-repair including a complaining element); instead, the pilots rather orient to establish intersubjectivity in order to ensure flight safety through accountings and insertions of Finnish non-standard talk into English standard talk. To conclude, the safe conduct of the flight requires the achievement of intersubjectivity which is also oriented to in ordinary conversation (see discussion on accounts above). In this sense, the pilots use modulated other-repairs to display an orientation to two normative orders simultaneously, the primary orientation being directed to the order of interaction and secondary orientation to that of flight safety.

As compared to this twofold normative orientation, the crew members established and maintained a different orientation in Chapter 4, where the normative order of interaction was replaced by the norms of flight safety. The replacement or 'omission' of the normative procedures of interaction occurred with such practices and forms of correction as are favourable in terms of the safe and efficient conduct of flight, i.e., through direct, un-modulated other-repair (see Chap. 4, cases 7-8). In general terms, then, the pilots employ the normative order of interaction and that of flight safety as resources in organizing their action and activities in the cockpit. Depending on the form of other-correction, the two normative orders are oriented to either simultaneously (see Chap. 5: modulated other-repairs) or separately (see Chap. 4: un-modulated other-repairs). The issue of whether the differences in the form of other-correction,

and thus in the normative orientations in cockpit talk-in-interaction (Chap. 4) and talk-and-action-in-interaction (Chap. 5) are systematic, is discussed in the final chapter (see 7.1.2).

Regardless of the various normative orientations demonstrated by the pilots, the activity of correcting the other flight crew member is 'exposed', i.e., made the interactional business of the exchange on both problem dimensions. In lieu of being an 'embedded' correction, i.e., an incidental occurrence in the ongoing course of action, the corrections of one speaker by another are frequently produced with attendant activities, like 'solo laughing' (Chap. 4, case 7), 'acknowledging' (Chap. 4, case 8), 'explaining' (Chap. 5, cases 5-6) and 'apologizing' (Chap. 5, cases 5 and 7). In this way, by bringing corrections and errors to the conversational surface, the airline pilots display their orientation to, and comprehension of, flying the airplane as a collaborative accomplishment they are jointly responsible for. (On exposed and embedded corrections, see Jefferson 1987.)

Gestures in the achievement of intersubjectivity in cockpit interaction

In Chapters 4 and 5, the airline pilots demonstrated their orientation to the problems of intersubjectivity in cockpit talk-(and-action)-in-interaction. In and through the use of various kinds of repair practice, the flight crew members made visible and manageable the difficulties in speaking, hearing or understanding the talk (Chap. 4) and in maintaining the sequential order of action and activities on flight (Chap. 5). The pilots specifically used the talk, their bodies and the material surroundings as a resource in the courses of processing intersubjectivity collaboratively with each other. The data segments encompassed descriptions of a range of different types of embodied activity by the pilots, such as non-verbal actions (entering data, rotating the knob, etc.) and gestural movements (pointing gestures, gaze movement, etc.). The descriptions were selective in the sense that the particular visual activity was marked on the transcripts where that was considered to enhance the intelligibility and accessibility of the analysis of situated (inter-) action. In Chapter 6, the focus of analysis is turned to the embodied conduct of participants in the cockpit setting. The scope of analysis is confined to the role and meanings of gestures in processing intersubjectivity in cockpit interaction. The interactive episodes used here are the same as those in the previous chapters. The premise is that by analyzing not only the talk but gesture as well will result in a deeper understanding of how various verbal, visual and material resources are used by the pilots in achieving intersubjectivity.

In this chapter, the gestures chosen for detailed analysis include the pilot's 1) pointing gesture directed either to a) the other flight crew member or b) a particular material object in the cockpit and 2) gaze movement directed to the other flight crew member. What is common to these gestural activities is that they all fall outside the pilots' formal protocol, i.e., they are not learned or standard practices, such as pushing a knob or pulling a lever, but improvised, spontaneous practices used intuitively in cockpit interaction. The physical working position of the airline pilots is characteristically relatively static and motionless as they are seated in a limited space. The cockpit ergonomics and design constricts the pilots' gesticulation so that the repertoire of gestures consists mainly of upper body orientations and hand/arm and gaze move-

ments. The material constraints of the setting frame and configure the ways in which cockpit (inter-)action is organized and accomplished by the pilots. The range of gestures available for analysis is also constrained by these practical ergonomic reasons. Along with these, however, there are also other (related) reasons for choosing the two gestures for analysis. The pointing gestures were chosen because of their prevalence in repair sequences (Chap. 4-5), my observations suggesting that gestural pointing is an often-used practice, specifically in the processing of intersubjectivity in cockpit interaction.

The gaze movement towards the other flight crew member became the subject of the study due to its particularity in the cockpit setting. To begin with, the flight crew consists of the two pilots sitting side by side in the cockpit. Both are obliged to visually monitor displays and instruments positioned in front of them, as well as the environment outside the cockpit; simultaneously the pilots are able to (over-)see each other's conduct on the flight peripherally by focusing their visual attention somewhere ahead. Fundamentally, then, the performance of flight tasks and activities does not provide, or even suggest, the use of direct eye contact between them. Further, in terms of the two-party team of Commander and Co-pilot, the speaking pilot would not have to address talk to the other through a gaze, as is common practice in ordinary conversations (see, e.g., Goodwin 1981). In other words, because the group consists of two participants, the pilots do manage to become aware of their role as the recipients of the talk without the speaking pilots needing to visibly display their attention to them. Thus, in taking the social and technical aspects of the setting into account, the speaking pilot moving his/her gaze to the other crew member is seen to have a specific significance in cockpit interaction – a significance which this study aims to address relative to the activity of processing problematic understandings between pilots.

Based on a glance at some literature compilations (see, e.g., Kendon 1981; 2004; McNeill 2000), there seems to be no universal way to study gesture. Each researcher has thus to establish and develop his/her own means of analysis depending on research background, interests, and goals. In Chapter 6, specifically, the pilots' pointing gestures and gaze movement are analyzed and described within the following, ethnomethodologically informed dimensions:

1) The interactive function of gesture in the relationship between Commander and Co-pilot, i.e., what is done through gesture in cockpit interaction
2) The temporal relation of gesture to talk, i.e., whether the gesture is produced prior to repair or reminder ('asynchronous gesture') or simultaneously with repair or reminder ('synchronous gesture')
3) The relation of gesture to the material environment

Nevile has analyzed the airline pilots' use of gestures in the performance of routine flight tasks and activities, such as engaging the autopilot (AP) with particular selections on the Flight Mode Panel (FMP) (2004a, 81-144). Once turned on, the autopilot makes the inputs necessary for the aircraft to fly according to the selections made for heading, altitude and speed. The

successful and acceptable accomplishment of this task provides that both pilots see and know the AP has been engaged and the required mode selections have been made. Nevile (2004a, 113-119) shows how this 'seeing' is specifically facilitated by the pilot pointing with an index finger to the Altitude Alert Selector window while verbalizing the set altitude 'one three zero' (i.e., 13 000 feet).[1] In this way, through precise coordination of talk and gesture, the pilots are able to develop the focus and timing of this 'seeing' on a moment-to-moment basis; simultaneously, a socially shared understanding of the selections made on the FMP is established (Nevile 2004a, 119; see also 2007b).

Another example of the gestural pointing of airline pilots occurs during the task of monitoring the altitude (Nevile 2004a, 127-133). In an airline cockpit, there are two altimeters displaying the aircraft's altitude, located on each side of the main instrument panel so that both pilots can see the altitude easily. In this case, the Captain is saying to the First Officer 'one thousand to altitude' meaning the plane is one thousand feet from the target altitude (i.e., from 25,000 feet); in the meantime, the 'altitude alert' lights located above each altimeter are illuminated. Simultaneously with talk, the Captain raises his right hand, with index finger extended to point to the main instrument panel, and moves his hand from left to right. During the word 'altitude', the movement stops and his hand is held still with the finger pointing towards the First Officer's side of the panel. As Nevile (2004a, 132) suggests, the Captain's hand movement and pointing to the right side of the panel links the two sides of the cockpit where information about the altitude is available. The hand movement produced concurrently with talk supports the content of that talk – the plane is 'one thousand to altitude'. It also makes it clear that what the Captain is saying is of significance to both pilots. The Captain's gesture is thus seen as a visual prompt for a joint monitoring activity, i.e., a prompt for the First Officer to monitor his own altimeter.

While Nevile (2004a, 81-144; 2007b) analyzes airline pilots' gestures as part of the accomplishment of routine flight tasks, this study focuses distinctively on gestures relevant for processing the problems of intersubjectivity in the course of cockpit interaction. At the beginning of this chapter, I define a set of conversation analytic principles and guidelines for studying gesture in a social interaction and briefly describe earlier research on the relation between repair and gesture (see 6.1). The empirical part covers five (5) extracts that include six (6) gestures in all under scrutiny: two pointing gestures towards the other pilot (see 6.2.1), three pointing gestures towards the technical artefact or tool (see 6.2.2) and one gaze movement towards the other pilot in the cockpit setting (see 6.2.3). At the end of chapter, I recapitulate the interactive functions and features of gestures in cockpit interaction and discuss the use and meaning of gestural practices in the airline cockpit and other socio-technical settings (see 6.3).

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1   The Altitude Alert Selector (AAS) window displays the selected altitude for aircraft automated systems.

6.1. STUDY OF VISUAL PHENOMENA

The bodies of participants provide various displays of relevant action and orientation in inter-action. In studying visual phenomena within conversation analysis, the research interest is not the visual events as such, but the part they play in the social production of meaningful action. This study aims to demonstrate the ways in which participants actively orient to particular visual events, therefore employing them as the constitutive features of the activities they are engaged in. (Goodwin 2001, 157, 160.) The visual phenomena ought thus to be analyzed by considering a mixture of semiotic resources and meaning-making practices the participants use in interaction to achieve collaborative courses of action with each other. The intelligibility and relevance of visual events, such as gaze movement and pointing gestures, is established and maintained through the mutual juxtaposition of a range of semiotic fields, including the body, talk, and the physical surroundings. (Goodwin 2001; 2003a.)

In face-to-face interaction, visual orientation toward the other party is frequently displayed through gaze. One principal rule about the organization of gaze between speaker and hearer is as that when the speaker is gazing at the recipient, the recipient should be gazing at the speaker (Goodwin 1980, 287; 1984, 230). If the recipient is not gazing at the speaker but elsewhere, the speaker may utilize different means or devices, including restarts, pauses and self-repairs, to secure the recipient's gaze (Goodwin 1980; 1981; see also 1984). Other techniques used by the speaker to attract the eyes and attention of a non-gazing recipient include body movements of various kinds. In analyzing medical encounters, for example, Heath has demonstrated how a patient employs a particular postural shift to summon the gaze of a doctor (1984; see also 1989; 1992b; 2002; 2004). Goodwin (1986), who has studied the ways in which a noticeable handclap is used by the speaker to secure the gaze of a recipient provides another example from everyday settings.

A strip of talk is not produced through the speaker's actions only, but is the product of the interaction between speaker and hearer. The hearers use their bodies, and gaze in particular, to display the focus of their orientation to the co-participants. The speakers, for their part, use their own gaze to see relevant action in the bodies of the hearers, and actively modify the structure of their talk according to what they see. (Goodwin 2001, 159.) The participants use each other's bodies as the specific sources of information about the talk-in-progress. When, for example, a speaker makes a pointing gesture while saying '*this*', a recipient needs to shift gaze toward the speaker to understand and recognize the referent of the talk. There are also particular body movements which call for systematic inattention from a recipient. The actions which have no visible relevance for the ongoing talk are not gestures but self-grooms (e.g., rubbing one's face). Both types of movement are interactively used to realign orientation – gestures for attracting a recipient's gaze and self-grooms for driving the gaze away. These various body movements consequently function as communicative acts with visible implications for the organization of interaction. (Goodwin 1986; see also Heath 1992b.)

The hand gestures in general are mainly performed by the speakers in interaction. The idea or notion of hand gesturing as a speaker's phenomenon implies that such gestures are organ-

ized at least partly by reference to the strip of talk in which they are produced. With regard to the temporal relationship between gesture and talk, the particular place/space related gestures, like pointing with an index finger or a thumb, are commonly pre-positioned relative to their lexical affiliates. In other words, the various pointing gestures are often produced before the lexical components to which they are tied. (Schegloff 1984a; see also Streeck & Hartge 1992; Mondada 2007.) The activity of pointing is essentially a 'situated practice' constituted in and through the simultaneous deployment of multiple semiotic resources, such as the body performing an act of pointing, the talk which both elaborates and is elaborated by the act of pointing, the space that is the target of the point, and the larger activity within which the act of pointing is embedded. In analytical terms, then, the study of pointing encompasses the synchronized analysis of the details of language use and the body as an unfolding locus for the production of meaning and action as well as the material structure in the surroundings. (Goodwin 2003a.)

As mentioned, the hand gestures are strongly affiliated to the talk in the course of which they are produced. The hand gestures may be organized – and therefore analyzable – in relation to the 'stress' organization of the talk, the lexical component of the talk, the type of turn in which they occur or to repair operations in the talk, and so on. (Schegloff 1984a, 273.) In doing conversation analytic study on gesture, the analyst aims to uncover the specific ways in which gestures are consequential for recipients in interaction (Goodwin 1986, 47, footnote 2). This goal may be challenging, because the implications and consequences the gesture has for the organization of recipient's action are frequently difficult to assess. For example, the recipients of the talk accompanied by a pointing gesture do not necessarily direct their gaze to the gesticulating speaker; at the same time, however, these recipients do display their understanding of the talk by producing an appropriate responsive action. Despite the analytical difficulties, it is important to reveal the main principles of the ways in which gestures are treated and attended to by recipients as distinct events in their own right and therefore as interactively significant for action-in-progress. (Goodwin 1986, 29-30.)

Research on gesture and repair

To my knowledge there has been no systematic research about the relationship between (hand) gesture and repair so far. Greiffenhagen and Watson (2009), Martin (2004), McHoul (1990) and Streeck (1984) have touched upon the issue in studies conducted in various institutional settings. To start with, Greiffenhagen and Watson (2009) have analyzed how pairs of pupils used storyboarding software during English lessons in a British secondary school. The software was designed and implemented for the visualization of scenes from Shakespeare's *Macbeth* as a series of storyboard frames. One of the pupils, Shawn, describes the events shown on the computer screen by typing in the caption box: "*Macbeth is guilty and he knows it. Lady Macbeth is reflecting on her poor past*". After typing "*poor past*" and pressing the space bar, Shawn moved his hand away from the keyboard, therefore marking the typing activity as completed. The other of the pair, Bob, shifted his hand to above the backspace key, and let it hover there briefly

before slightly withdrawing it. Shawn then brought his hand back to the keyboard, toward the backspace key. At this point, Bob retracted his hand completely from the keyboard and asked: '*Is that it?*' Shawn responded '*Yeah*' and pressed the backspace and full stop keys. (Greiffenhagen & Watson 2009, 76-77.)

This case demonstrates the phenomenon of visual repair in which participants locate and remedy things that visibly 'go wrong' on the computer screen. More specifically, the case exemplifies other-initiated self-repair in which Bob initiates a repair both verbally and gesturally. Bob's hand movement toward the backspace key is seen as other-initiation of repair, since it transforms Shawn's sentence on the computer screen into a repairable. The gestural initiation is produced indirectly: while the actual trouble-source is on the screen, the initiation is done on the keyboard. Bob's verbal initiation '*Is that it*?' gains its meaning through his hand movement. As Bob's gesture implies, the difficulty with the typed sentence is its incompleteness, i.e., it is formulated without the full stop ('.'). Shawn's affirmative '*Yeah*' indicates that the pupils have a shared understanding about the upcoming course of action. Shawn then presses the backspace and full stop keys, therefore self-repairing the sentence on the screen. (Greiffenhagen & Watson 2009, 77-78.)

In the 'Macbeth' case, one of the repair-initiations was done with the hand movement directed to the space above the keyboard. A particular hand gesture is also used to initiate a repair in the next case. Martin (2004) has studied learning and the longitudinal development of verbal and non-verbal repair in physiotherapy encounters. The physiotherapist was checking the patient's shoulder movement when she noticed that the shoulder was incorrectly drawn up. As the patient did not correct the movement himself, the physiotherapist initiated repair non-verbally by tapping him on the shoulder. In his response, the patient pulled his shoulder down, simultaneously displaying his understanding of the 'tapping' activity as an initiation of repair. (Martin 2004, 52-54.) Further, the study by Streeck (1984) includes a repair initiation done with hand movement. His research concerns the ways in which talk is contextualized through 'embodiments' or 'postural configurations' in interaction in a combined first-to-third grade classroom in a Black and Mexican-American neighborhood in San Diego, California. The pupil called Wallace acted as a peer-teacher, who was supposed to teach his peers a given language-arts task. There was something of a dispute between Wallace and two other pupils, Ernesto and Carolyn, when they joined each other at the table where the teaching took place.[2] When a quarrel arose, the teacher came to the table and repeatedly requested that Wallace '*tell the children what to do*'. Whenever the teacher initiated her request, she was physically bending down, simultaneously looking at Wallace. Once, as the teacher stooped down towards Wallace, Ernesto made a wide, sweeping hand gesture across the table and made an alternative proposal about what to do. As a consequence of the hand movement, the teacher partially withdrew from the table. (Streeck 1984, 124-128.)

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2   The fourth pupil, Leola, came to the table a little later. The pupil called Greg, who was not the member of the group, was also standing by as an onlooker to the interaction.

Ernesto's hand gesture displays an orientation to the teacher's verbal and bodily conduct (request + bending of upper body) as an intrusion into the interactive territory of the group of children. In this sense, then, his hand movement can be seen as a 'corrective action' (Streeck 1984, 131) or, more specifically, as (other-) initiation of (self-) repair completed by the teacher withdrawing from the table. The final case, described only briefly here, differs from the previous three: the hand gesture here is not used as a repair initiation but as a repairable entailing a distinctive gestural repair. McHoul (1990) has analyzed the organization of repair in geography lessons in an Australian high school classroom. The teacher asked the pupil called Peter to indicate the geographical region of the Coastal Plains on the screen. In his response, Peter made a sweeping hand gesture around large area on the screen and said: '*Round here*'. The teacher initiated a repair by requesting Peter to show the exact territorial boundaries of the region ('*Whereabouts...*' '*W'll where's the border...*'). Since the teacher's repair initiation focused on a large-scale hand gesture made by Peter, the gesture was oriented to as a trouble-source in the course of interaction. Peter then indicated the borders of the Coastal Plains one by one, thereby correcting his initial gesture. (McHoul 1990, 371-372.)

6.2. GESTURES AND REPAIR SEQUENCES IN COCKPIT INTERACTION

The present empirical analysis concerns two kinds of gesture, pointing gestures and gaze movement, produced by speaking pilots while processing intersubjectivity. These gestures embedded in repair sequences are not scripted but are spontaneous and unconscious in the cockpit interaction. The investigation of pointing gestures is limited to the pointing done with an extended index finger only; under the circumstances, the activity of pointing done, for example, with an 'open' hand, an extended thumb or a head/eye movement are left without analytic attention. Furthermore, the pointing gestures chosen for analysis are directed either to the other flight crew member or to a specific material object in the cockpit; the pointing gestures directed outside the cockpit are not within the present scope of analysis. With respect to gaze movement, the research focuses only on those instances in which the pilot shifted his gaze toward the other crew member. The analysis consists of five (5) extracts including six (6) gestures of interest in all. The extracts are familiar from Chapters 4-5 and are categorized in the following way: Extracts 1 and 2 (see 6.2.1.) concern two pointing gestures directed towards the other flight crew member in the cockpit environment (n = 4). Extracts 3 and 4 (see 6.2.2.) describe three pointing gestures in total directed toward a particular material object or device (n = 7). The last extract, 5 (see 6.2.3.), includes just one gaze movement directed towards the other crew member (n = 5).

In analyzing these gestures, I have applied the description of the sequence of gestural phases by Kendon (1980; 1983; 2004). In forelimb gesturing, as a simplified example, the limb is moved away from the position of rest or relaxation, or 'home position' (see Sacks & Schegloff 2002) toward some region of space and is subsequently moved back to the position of rest or relaxation. In the cases studied here, the home positions are on the pilot's knees and on the

throttle lever on the pedestal. The phase in which the limb is moving away from its home position is called the 'preparation'; that in which the particular meaning of gesture is most clearly expressed and accomplished is called the 'stroke' (the nucleus of the movement); and finally, the phase of limb movement that follows as the hand is relaxed or withdrawn to its home position, is referred to as the 'recovery' or 'return'. (Kendon 1980, 212; 1983, 18; 2004, 111-112.) In transcribing the visible, embodied practices of the pilots, I have relied on the notation conventions used by Nevile (2004a; see also Appendix 2). The case example below will demonstrate how the timing of gesture is marked in relation to the talk and to the period of non-talk in the transcripts (see also 6.2.1, extract 2).

```
01    (1.2)  =  (0 > 0.6 > 1.2)

02                         ↑_____>

                  ((Cdr points towards Cop))

03    CDR:   Puhuksä nyt ku↓  s- sulla on kontrolli,
            Will you talk now as↓  y- you have the controls,

04         >_____↑

             ((Cdr withdraws his hand))
```

As lines 1-2 illustrate, (0.6) seconds into the (1.2) seconds of non-talk, the Commander starts pointing towards the Co-pilot (see the upwards-pointing arrow (↑) that indicates the beginning of the gesture). The Commander's pointing gesture ends with his verbal activity of reminding; more specifically, the activity of pointing is completed by the end of Commander's wording '*puhuksä*' (lines 3-4, see upwards-pointing arrow (↑) marking the end of gesture). The notation mark (↑_____>) and the description of embodied activity (*Cdr points towards Cop*), to use Kendon's terms, demonstrate that the 'preparation' and 'stroke' phases of pointing are achieved within a (1.2) second period of non-talk and, more importantly, previous to the verbal reminder by the Commander (see lines 1-3); as the marking (>_____↑) together with the description of hand movement (*Cdr withdraws his hand*) reveal, the 'recovery' phase of gesture occurs concurrently with the Commander's verbal reminder (see lines 3-4).

The various phases of gestures – preparation, stroke and recovery – are selectively shown in still pictures. In cockpit interaction, the preparatory phase or the exact beginning of the pointing activity may be hard to see and demonstrate for at least two reasons. Firstly, the pilot's

pointing gesture does not always or necessarily begin from the position of rest or relaxation (e.g., from one's knees), but may be a kind of a continuation of some other type of hand movement. For example, the Commander's pointing gesture in extract 1 proceeds from his kinetic activity of wiggling his hand; in extract 4, correspondingly, the Commander's non-verbal activity of operating the particular knob on the Flight Control Panel is followed by him lowering his hand to the Flight Management System and pointing towards it; in extract 3, further, the Co-pilot's larger-scale pointing gesture is a continuation of his smaller-scale pointing. Secondly, even though the pilot may start to move his hand from the home position (e.g., from his/her knees), the onset of the movement can be difficult to specify for practical technical reasons, i.e., the video-tapes are recorded entirely from behind the flight crew, which may hinder the perception of the exact beginning of the movement (see extract 3, the onset of the COP's first pointing gesture). In the light of these complications, the still pictures include only one example of the actual preparatory phase of pointing activity (see 6.2.1, Extract 2, Still 3).

The stroke phase of the gesture is of special importance in examining the temporal relationship between talk and bodily action. When the stroke of the gesture (and the preparation phase as well) occurs prior to verbal repair or reminder, the gesture is considered 'asynchronic' in relation to talk; when it takes place during verbal repair or reminder, the gesture is 'synchronic' relative to talk, irrespective of the timing of preparation phase of gesture. In other words, in cases where the gestural preparation occurs prior to talk but the stroke phase takes place simultaneously with it, the gesture is considered as 'synchronic'. The stroke phase is seen as especially important and critical in analyzing the temporal relationship between talk and gesture because the meaning of the gesture becomes most plainly expressed and semantically interpretable in the action-in-progress during that time. Consequently, the stroke phases of all six gestures under scrutiny are shown here in still pictures. In the recovery or return phase, the pilot either moves his hand to the home position (i.e., to his knees or to the throttle lever) or withdraws the hand only slightly, therefore projecting and 'preparing the ground for' the continuation of some other kind of hand movement. For example, in the segment shown above, after withdrawing his pointing hand a little, the CDR continues with the non-verbal activity of rotating the altitude knob on the Flight Control Panel. The final phases of hand gestures are illustrated in still pictures, providing these returning movements can be clearly shown in the data.

As Goodwin points out, "the task of translating the situated, embodied practices used by participants in interaction to organize phenomena relevant to vision poses enormous theoretical and methodological problems" (2001, 160). Basically, the transcription system used here encompasses descriptions of the kind of gesture the pilot is performing (pointing gesture or gaze movement), the target of the gesture (human or material object) and the ways in which the gesture is received (the recipient's visible orientation or non-orientation to gesture). This way of transcribing gesture provides only a partial description of the entirety constituted by the pilots' bodies interacting in the cockpit setting. The gestures are fundamentally contextualized by 'participation frameworks' constructed in and through the embodied mutual orientation of speaker/gesturer and addressee (Goodwin 2003b). In order to keep the descriptions

understandable and accessible to the readers, the larger postural configurations (in which the pointing gesture and gaze movement are embedded) are not extensively described in the transcripts. Although selective rather than comprehensive, the still pictures are used to demonstrate the complex participation frameworks, including the pilots' posture and alignment and the phenomena in the surroundings (the pilot's bodily orientations to and within the setting are also highlighted with arrows and circles on the pictures). The final point to be made on the transcription difficulties concerns the description of the target of the gesture. For example, in extract 3, it is suggested that the COP points towards the ECAM *System Display*, even though the pointing gesture does not actually reach this target (see Stills 6-7). In such cases, essentially, the target defined on the transcriptions is not the 'pure description' of the participant's bodily conduct, but an analytical interpretation.

6.2.1 Pointing gestures directed to the other crew member

In cases 1 and 2, the Commander is pointing to the Co-pilot. In the first case, the Commander performs the pointing gesture prior to repairing the Co-pilot's non-verbal activity; in the second case, the gesture is done before the Commander reminds the Co-pilot about a particular cockpit responsibility.

The pilots are performing an emergency landing at Turku Airport because of fire in a cabin lavatory. At lines 19-20, the Commander points towards the Co-pilot prior to the production of repair.

Transcription 1   **CDR = PF**
Crew 7   **COP = PNF**
Time 0:48

```
            ((five lines of talk between Cdr and Cop
              omitted))

06    CDR:   Katoppas Quu är hoosta jos sieltä löytyy,?(.) ö::
            Look at the Q: R: H: if there are,? (.)uhm

07    CDR:   smoukki jut- smoke juttuja tai jotaki samalla ni,
            smoke thin- smoke things or something at the
            same time then,

08           (4.0)

09    CDR:   Tampere Finnairi kuus viis ykköne,?
            Tampere Finnair six five one,?
```

```
10          (1.3)

11   ACC:   Joo? (.) >Tampere<,?
            Yeah? (.) >Tampere<,?

12          (1.4)

13   CDR:   Olik se Turun,
            Was that Turku's,

14          (0.4)

15   CDR:   tuuli nolla viis nolla<,? (.) hh
            wind zero   five zero<,? (.) hh

16                            >_____>

                      ((Cop, gazing leftward, keeps
                        the QRH in front of Cdr))

17          (0.3) = (0 > 0.3)

18                      >_____>

                      ((Cop, gazing leftward, keeps
                        the QRH in front of Cdr))

19                      ?_____>

                      ((Cdr points towards Cop))
```



```
Still 1
((CDR points towards
COP; COP keeps the QRH
in front of CDR))
```

```
20 → CDR:    ˚lue ittekses (se),˚
             ˚read (it) yourself,˚

21           >_____↑

             ((Cdr puts his hand on
               the throttle lever))

22           >_____↑

             ((Cop shifts the QRH to his knees))
```



```
Still 2
CDR: "˚Read (it) your-
self,˚" ((CDR puts his
hand on the throttle
lever; COP shifts the
QRH to his knees))
```

```
23           (0.5)

24    CDR:   nolla viis nolla ja viis solmua.
             zero five zero and five knots.
```

At lines 6-7, the CDR orders the COP to find the relevant checklist from the Quick Reference Handbook. In the midst of the pilot-controller talk, the COP keeps the manual, with the checklist on view, in front of the CDR (lines 8-18). The COP's visual conduct implies that the COP is showing the particular checklist to the CDR to ensure that it is the one he requested. Instead of confirming the checklist, the CDR points towards the COP (line 19; Still 1).[3] Next,

---

3   A little earlier, at line 15, the CDR lifts his hand from the throttle lever and wiggles his fingers hurriedly; the hand movement then proceeds into the pointing gesture.

the CDR delivers third position repair by ordering the Co-pilot to 'read' the checklist himself. Simultaneously with the talk, the CDR puts his hand on the throttle lever and the COP shifts the QRH to his knees (lines 20-22; Still 2). After a pause, the CDR continues talking with the controller (lines 23-24).

From the CDR's perspective, the pointing gesture functions proactively by prefacing his verbal repair (see, e.g., Schegloff 1984a). The CDR's gesture not only visibly displays his orientation in interaction, but also (pre-) allocates the activity of checklist execution to the other flight crew member. In all likelihood, the COP receiving the gesture interprets its interactive function rather differently. From his point of view, the CDR is probably producing a sequentially inappropriate next action: instead of confirming the checklist shown to him, the CDR points towards the COP, a gesture which may thus suspend the ongoing course of action and interaction. From the COP's perspective, then, the pointing gesture can function both proactively and retroactively: on the one hand, it may be a kind of initiation of an imminent repair operation; on the other hand, it may mark the previous turn or 'move' as problematic.

In the second case, the crew is returning to Stockholm-Arlanda Airport because of the hydraulic failure in the aircraft's technical systems. At lines 6-7, the Commander points to the Co-pilot prior to remind him about the communication duties on the flight.

Transcription 2   CDR = PNF
Crew 10   COP = PF
Time 0:57


```
01    STO:  Finnair, hhh six five one Romeo descent to

02          two thousand five hundred,

03          (2.7)

04    COP:  Set two thousand five hundred and pull,

05          (1.2) = (0 > 0.6 > 1.2)

06 →                      ↑_____>

                   ((Cdr points towards Cop))
```

Still 3
((CDR points towards COP
– preparatory phase))

Still 4
((CDR point towards COP
– stroke phase))

```
07 →  CDR:   Puhuksä nyt ku↓ s- sulla on kontrolli,
             Will you talk now as↓ y- you have the controls,

08                >_____↑

             ((Cdr withdraws his hand))

09                ↑_____>

             ((Cop shifts his gaze towards Cdr))
```


Still 5
CDR: "Will you talk now"
((CDR withdraws his
hand; COP shifts his
gaze towards CDR))

```
10          (1.3)

11    COP:  Ai >kun mulla on< kontrolli,
            Oh >as I have< the controls,
```

At lines 1-2, Stockholm Control instructs the flight crew to descent to 2,500 feet. The COP fails to respond as a PF to the controller's message, and a (2.7)-second pause ensues (line 3). Next, the COP orders the CDR to set and engage the altitude value into the computerized systems (line 4). Instead of setting the altitude, the CDR points to the COP (lines 5-6; Stills 3-4), after which the CDR reminds the COP about his responsibility to communicate with the air traffic control, and simultaneously withdraws his hand (lines 7-8; Still 5). The COP displays recipiency in the conversation by shifting gaze towards the CDR at the outset of the verbal reminder (Heath 1984; see Still 5). After a pause, the COP responds to the reminder (lines 10-11), and the CDR starts setting the altitude (visual conduct not shown on transcript).

Similarly to the previous case, the CDR's pointing gesture prefaces his talk, thus acting proactively in ongoing interaction. The CDR's hand gesture (pre-) allocates a particular communication task to the COP. From the COP's point of view, however, the CDR's bodily conduct may appear sequentially inappropriate: instead of lifting his hand to the altitude knob, he points towards the COP. In this sense, the CDR's hand gesture interrupts the action-in-progress. For the COP, once again, the gesture may function both proactively and retroactively, perhaps initiating a repair (or, in this case, a reminder) or indicating some trouble that has already taken place in talk-and-action.

In cases 1-2, the pilot was allocating the particular cockpit activity to the other crew member. The task allocation was done not only through talk but also through a pointing gesture directed to the other pilot. In both of these cases, the gesture was performed prior to talk. In other words, the pointing reached its 'stroke' phase, and thus became expressive, before the talk associated with it was produced. As the data analysis implies, the pointing gesture may have various interactive functions depending on the organization of participation in the course of interaction, i.e., whether one is the producing or receiving party of the gesture. In this light, by pointing towards the other flight crew member, the pilot may not only be allocating relevant cockpit activities, but also suspending the sequential course of (inter-) action.

6.2.2 Pointing gestures directed to the material object

In the next cases, (3-4), the pilot points towards a particular material object in a cockpit. Case 3 includes two pointing gestures accomplished by the Co-pilot successively: the first is performed prior to initiation of repair, whereas the second gesture is done simultaneously with it. In case 4, the Commander points towards the material object while producing a repair.

The flight crew is returning to Stockholm-Arlanda Airport because of technical failure in the aircraft's hydraulic systems. The Commander, who has the Pilot-not-flying role is reading out the data on the ECAM System Display. The data concerns the aircraft systems that have now become inoperative, and the effects of failure for the progress of the flight. At lines 9-12, the Co-pilot points towards the System Display prior to initiating a repair; the Co-pilot's second pointing gesture directed to the same display occurs simultaneously with the repair initiation at lines 12-13.

Transcription 3   **CDR = PNF**
Crew 9   **COP = PF**
Time 1:27

```
01    CDR:   Steering, (.) ja autobreikki,
             Steering,(.) and autobrake,

02           (1.7)

03    CDR:   niihin vaikuttaa, (.) jos mennään< laskuun
             those are affected,(.)if we go< to landing

04           ni ei päästä radalta pois ja,
             then we won't get off the runway and,

05           (1.3)

06    CDR:   ei voida käyttää autobreikkiä.
             we aren't able to use the autobrake.

07           (1.5)

08    CDR:   Clear wheel,

09 →             ?_____>

                 ((Cop points towards the System
                   Display and slightly withdraws his hand))
```

Still 6
((COP points towards the
ECAM System Display))

```
10          (.)

11 →        >__>

            ((Cop keeps his hand slightly withdrawn))

12 → COP:   Tch spoilereita puuttuu,?
            Tch the spoilers are missing,?

13 →        >_____↑

            ((Cop points closer to the System Display
              and brings his hand back to his knees))
```


Still 7
COP: "Tch the spoil-
ers are missing,?" ((COP
points closer to the
System Display))

Still 8
((COP brings his hand
back to his knees))

```
14              (.)

15      CDR:    Sp [oile   ]rit nii ykkönen ja vitonen,
                Spo[iler   ]s right one and five,

16      COP:       [(neljä)].
                   [(four) ].
```

Using the ECAM System Display as a source of his knowledge, the CDR specifies the inopera-
tive aircraft systems and the consequences of failure for the ongoing flight (lines 1-6). After
a pause, the CDR asks for confirmation to clear the screen page with 'clear wheel' (lines 7-8).
This talk indicates that the pilots have gone right through the current page and they may now
proceed to the next one. Instead of confirming the clear action,[4] the COP points to the System
Display and withdraws his hand slightly (line 9; Still 6). After a pause in talk, the COP initiates
a repair with 'tch the spoilers are missing' (lines 10-12). As the COP's talk implies, the screen
clearance is not a sequentially relevant 'next' action, since the electronic page still includes
some information about the spoiler malfunction. Simultaneously with his repair initiation,
the COP performs another, more expansive pointing gesture towards the display, and returns
his hand to his knees (lines 12-13; Stills 7-8). Next, the CDR produces a self-repair 'spoilers
right one and five' (lines 14-15); in overlap with this, the COP specifies that 'four' spoilers are
inoperative (lines 15-16).

    The COP's first pointing gesture at lines 9-11 functions proactively by projecting his ver-
bal repair initiation at line 12. By pointing towards the display, the COP directs the CDR's
attention to the semiotic field relevant for the action-in-progress. Through hand gesture, the
COP further (pre-) specifies the source of knowledge for his upcoming talk. From the CDR's
perspective, the COP's gesture may have somewhat different interactive functions. The gesture
presumably directs the CDR's attention, but it may also interrupt the ongoing course of action,
i.e., instead of verbally confirming the CDR's request, the COP makes a pointing gesture
towards the display. For the CDR as its recipient, the gesture may function both proactively
and retroactively: it may initiate repair and/or mark some trouble that has already occurred in
conversation (see also cases 1-2).

    The COP's latter hand gesture is accomplished simultaneously with his verbal repair ini-
tiation at lines 12-13. This time, the pointing gesture is directed closer to the display and the
hand is then returned to the home position. In terms of its interactive functions, this second
gesture is also used to specify the source of knowledge, and to direct the other's attention in
space and time, but in a more visible and "witnessable" (Nevile 2007b) way than with the first
gesture. The CDR responds to the COP's talk and gesture, with self-repair being produced

----

4   The confirmation is formally done by the response repetition: 'Clear wheel'.

simultaneously with some pointing gestures towards the System Display (line 15; the CDR's pointing activity not shown on the transcript).

In case 4, the flight crew is performing an emergency landing at Arlanda Airport, Stockholm, because of fire in the cabin. At lines 17-18, the Commander points towards the physical object simultaneously with a repair.

Transcription 4   CDR = PF
Crew 2   COP = PNF
Time 0:50

```
              ((three lines of talk omitted))

04    CDR:  Mites se sanoo se sun< ö ↑briiffaus homma siellä.
            How is it that your< uh  ↑briefing job there.

05          (0.5)

06    COP:  Mitä,?
            What,?

            ((six lines of talk between approach control
              and Cdr omitted))

13    CDR:  ä:: se ↑briiffaus (.) homma.
            e:: the ↑briefing (.) job.

14          (1.2)

15    COP:  M:::: mikä briiffaus homma,=
            M:::: what briefing job,=

16          >_____>

            ((Cdr keeps his right hand on the
              heading/track knob; after "what" he starts to
              move his hand right, sloping downwards))
```

```
                                         Still 9
                                         ((CDR moves his hand
                                         right, sloping down-
                                         wards))
```

```
17 →  CDR:  =ä: tämä,(.)o:nks[(se valmis jo),   ]
            =e: this,(.) i:s [(it done already),]

18 →        >_____↑

            ((Cdr's hand reaches Cop's FMS; during
              "this", Cdr points with his forefinger
              towards the FMS screen; Cdr then moves
              his hand to the throttle lever))

19          >_____>

            ((During "e:", Cop shifts his gaze from
              Cdr to the FMS and looks at it))

20    COP:                 [Siin on se >mato  ]laatikko
                           [There's the >worm ]box

21    COP:  eikö vaa<, (.) se on valmis,
            right<, (.) it's done,
```



```
                                         Still 10
                                         CDR: "This,"
                                         ((CDR points to the FMS))
```

Still 11
((CDR moves his hand to
the throttle lever))

At line 4, the CDR seeks information on the 'briefing job there'. After an (0.5)-second pause, the COP responds with the open repair initiation 'what' (lines 5-6). After finishing the radio talk with the controller, the CDR produces a repair with the repetition of 'briefing job' at line 13. The COP then delivers another repair initiation by launching 'm:::: what briefing job' at lines 14-15; as the COP's talk implies, he does not recognize the referent of the CDR's turn. Simultaneously with a repair initiation, the CDR starts to shift his right hand from the heading/track knob right, sloping downwards (lines 15-16; Still 9). While the CDR produces the repair 'this', he points towards the FMS screen with his forefinger (lines 17-18; Still 10); during the ensuing inquiry, 'is it done already', the CDR moves his hand to the throttle lever (lines 17-18; Still 11). The COP pays visual attention to the CDR's hand movement by shifting his gaze towards the FMS (lines 17-19; Still 10); in the course of responding, while saying 'it's done', the COP points towards his FMS (lines 20-21; see Still 11).

At lines 17-18, the CDR points towards a particular object in the cockpit while producing the deictic term 'this'. Through the pointing hand movement, the CDR visually specifies the referent of his talk, i.e., the FMS (Flight Management System). The CDR employs the gesture to display his bodily orientation to that object in the immediate surroundings, as well as direct the COP's attention towards it. The CDR's gesture is of obvious interactive significance as the COP follows the CDR's hand movement with his gaze.

In the previous cases (1-4), the pilots were using pointing gestures in processing the loss of intersubjectivity in cockpit interaction. The hand gestures were directed either to the other crew member (cases 1-2) or particular objects (cases 3-4). The interactive functions of gestures may differ, not only in terms of the target of activity (i.e., whether gesture is directed to a human or a material object) but also in terms of participant organization in interaction (i.e., whether one produces or receives the gesture). The temporal relationship between talk and gesture (i.e., whether gesture is produced prior to or simultaneously with talk) also contributes to the functional interpretations the participants give to the gesture. By pointing to the display screen, for example, the pilot directs the other's attention to that particular object in the local surroundings. In so far as the gesture is produced prior to talk, it may also amount to the inter-

ruption of the course of ongoing (inter-) action. By directing the pointing gesture to the physical object in the cockpit, the pilots may further specify the source of their knowledge (case 3) or the referent of the talk (case 4).

The deictic expressions like '*this*' or '*here*' cannot be properly understood without the speaker binding them to their situated contexts of use, as the Commander does in case 4, in which he points his forefinger towards the Flight Management System while uttering '*this*' in conversation. In this case, by significantly contributing to the Co-pilot's referential understanding of the Commander's verbal action, the pointing gesture is a necessary condition for the achievement of intersubjectivity. Overall, the pilots rely on a range of various verbal, physical and visual resources in dealing with the intersubjective problems. In this process, the activity of pointing is seen to smooth the pilots' way into the establishment and maintenance of shared understandings. Through pointing hand movement, the pilots may complement or clarify their verbal and material activities in the cockpit setting, strengthening the achievement of intersubjectivity.

The final case (see 6.2.3.) concerns the pilot's gaze movement toward the other crew member. The movement of gaze directly to the other seems to have some special significance for pilots who are dealing with the problem of intersubjectivity in cockpit interaction.

6.2.3 Gaze movement directed to the other crew member

The episode in case 5 is the same as in case 4. To recapitulate, the crew is performing an emergency landing at Arlanda because of fire. At lines 15-16, the Co-pilot shifts his gaze towards the Commander while initiating a repair.

Transcription 5   **CDR = PF**
Crew 2   **COP = PNF**
Time 0:50


```
          ((three lines of talk omitted))

04    CDR:  Mites se sanoo se sun< ö ↑briiffaus homma siellä.
            How is it that your< uh ↑briefing thing there.

05          (0.5)

06    COP:  Mitä,?=
            What,?=
```

```
              ((six lines talk between approach control and Cdr
                omitted))
13    CDR:    ä:: se ↑briiffaus (.) homma.
              e:: the ↑briefing (.) thing.

14            (1.2)

15 →  COP:    M:::: mikä briiffaus homma,=
              M:::: what briefing thing,=

16 →                    ↑_____>

                    ((Cop shifts his gaze to Cdr
                      and looks at him))

17                 >_____>

              ((Cdr's gaze and right hand is oriented to the
                heading/track knob; after "what", Cdr starts to
                shift his gaze and hand down to Cop's FMS))
```


Still 12
COP: "what briefing
thing,"((COP glances at
CDR))

```
18    CDR:    =ä: tämä,(.) o:nks (se valmis jo),
              =e: this,(.) i:s (it done already),
```

The COP shifts his gaze towards the CDR while initiating a repair at lines 15-16. In considering the onset of gesture, the COP starts to move his gaze left after the sound 'm:::'. This sound, with which the COP keeps the floor in the conversation, indicates to the COP's self-musing or his engagement in some mental process. Simultaneously with 'm:::', the COP faces forwards, away from the CDR (gaze direction not shown on the transcript). The situation is kinetically analogous to the word search in which the speaker seeking a word often looks away from the recipient (see Goodwin & Goodwin 1986).[5] The COP visibly directs the lexical initiation ('what briefing thing') to the CDR by shifting gaze towards him at the same time (lines 15-16; Still 12). This gaze movement allows the COP not only to display his visible orientation in interaction but also to catch the CDR's eye. The CDR does not, however, respond to the COP's gaze but is bodily oriented elsewhere (lines 15-17; see Still 12).

6.3   CONCLUSIONS

In the cases analyzed above, the pilot's pointing gestures and gaze movement were organized in relation to repair and reminder operations in cockpit interaction. The analysis of gesture was basically done in three dimensions: 1) the interactive function of gesture, 2) the temporal relationship between talk and gesture and 3) the relation of gesture to the material surroundings. What is done or accomplished through gesture in the processing of problematic understandings between pilots is at least partly dependent on the following conditions or aspects: the target of gesture (human vs. material), the timing of gesture relative to talk (asynchronous vs. synchronous gesture) and the organization of participation in a situated cockpit interaction (receiver vs. producer of gesture). As an example, the pilot may allocate particular cockpit activity to the other flight crew member with a pointing gesture directed toward the other. But, when the gesture is asynchronic, i.e., produced prior to talk, it may serve a rather different function for the recipient, from whose perspective the hand movement may specifically be an inappropriate next action that visibly interrupts or suspends the ongoing course of (inter-) action. In this way, then, the gesture may function both retroactively, by marking out some previous turn or move as problematic, and proactively, by being a kind of gestural initiation of the upcoming verbal repair or reminder.

The spatial relationship between the speaker/gesturer, the recipient and material artefact is established and made visible through the activity of pointing. The embodied pointing toward, for example, the 'System Display' or 'Flight Management System' allows the pilot to direct the other flight crew member's attention to that object and therefore to establish 'mutual orientation' in interaction (see, e.g., Goodwin 1986; 1995: 2003b; Hindmarsh & Heath 2000). The hand movement can also be used as a resource in organizing talk; i.e., the pilots may specify and demonstrate the source of their knowledge or the referent of the talk-in-progress through

---

5   The current event differs from the word search in the sense that what is 'lost' here is not the word as such, but its meaning.

visual pointing. Finally, the airline cockpit as a socio-technical setting neither provides nor supports mutual eye contact between Commander and Co-pilot. In this light, the pilot moving his gaze to the other flight crew member in processing intersubjectivity seems to have a specific significance in cockpit interaction. During the loss of shared understandings, in other words, the pilot may be pursuing complete, direct eye contact with the other crew member by shifting gaze towards the other.[6] Simultaneously, the 'gazing' pilot may display an orientation to the management of the problem as a joint activity which is accomplished through the collaborative effort of both flight crew members. These main results and findings of Chapter 6 are summarized in Table 6.1.

Table 6.1
Three-dimensional analysis of gestures

Dimensions → Gestures ↓	The gesture's function in the relationship between participants:	The gesture's temporal relation to the speech:	The gesture's relation to the material environment:
(1 & 2) pointing towards the other	– allocates the activity to the other – suspends the ongoing course of action	asynchronic	-----
(3) pointing towards the physical object	– directs the other's attention to the object – suspends the ongoing course of action	asynchronic	– specifies the source of knowledge, i.e., the System Display
(4) pointing towards the physical object	– directs the other's attention to the object	synchronic	– specifies the source of knowledge, i.e., the System Display
(5) pointing towards the physical object	– directs the other's attention to the object	synchronic	– specifies the referent of talk, i.e., the Flight Management System
(6) moving one's gaze towards the other	– addresses the talk to the other – catches the other's eye	synchronic	-----

---

6   Bolden (2003) has analyzed the multimodal resources used by participants in interaction to complete each others' utterances. The study shows how the shift in the speaker's gaze from the surroundings to the recipient is a visual way to invite the recipient to produce a completion of the turn (ibid., 203-208).

In general terms, talk and gesture are seen to complement each other in communication. As McNeill suggests: "Together speech and gesture present a more complete version of the meaning than either accomplishes on its own" (2000, 7). Under some circumstances, the speaker's gestures can contribute significantly to the recipient's semantic and pragmatic understanding of the talk (Kendon 1994, 193). In case 4, for example, the Commander makes a pointing gesture towards a particular object (the Flight Management System) while saying '*this*'. At that point, the Commander's hand gesture is a necessary condition for the Co-pilot's understanding of the referent of the talk.

In the cases analyzed, gestures and talk are coordinated temporally such that the gestures precede or occur simultaneously with talk – asynchronic and synchronic gestures respectively. The temporal priority of gesture over speech (see 'asynchronic' gestures) is partly because the production of gesture can be more readily and quickly accomplished than the production of speech (Kendon 1980). In case 3, for example, the Co-pilot's first pointing gesture occurs previous to his verbal repair initiation. Here, the use and timing of gesture may stem from the 'limiting' standard operating procedures being restricted to affirmative responses in terms of callouts, such as '*Clear wheel*' (the standardized response would be a confirmatory '*Clear wheel*'; see also Chap. 5, case 6: '*Your controls*' – '*My controls*'). In this case, therefore, the flight procedures do not include a callout with which the Co-pilot could formally deny the Commander's request to clear the screen. In the production of his negative response, the Co-pilot first leans on a quick and easily accomplished way of gestural pointing; only secondly does he use a conversational repair that is a more elaborate and time-consuming method than a single hand movement.

The use of the 'asynchronic' gestures may also be related to the processes of maintaining and preserving face in the cockpit interaction (on 'face work', see Goffman 1967). In interactive terms, it may be preferable to deal with the losses of intersubjectivity through indirect non-verbal means than by using direct verbal communication. By using a-synchronic gestures, as in case 3 (see the COP's first pointing activity), the pilots are able to delay the production of other-initiation of repair. This period of non-talk during which the gesture is performed offers an opportunity for the recipient of the gesture to initiate a self-repair. Providing such an opportunity is not taken, the 'gesturer' takes the floor with other-initiation (case 3: COP: '*...spoilers are missing...*'). To conclude, the pilots may use asynchronic gestures as a visible trigger for the initiation of self-repair (cf. Nevile 2004a). By providing sequential space for self-initiation through gesture, the pilots simultaneously display an orientation to the normative procedures of interaction in ordinary conversation.

Goodwin (1986) and Heath (1992b) have shown how participants in interaction regulate each others' visual attention through various kinetic activities, such as gestures and self-grooming. In terms of my data examples, the following questions and discussions about the interactive implications of gesture arise: how do pointing gestures and gaze movement contribute to the unfolding cockpit interaction? What are the ways in which gestures are meaningful for the recipients in interaction? How are gestures demonstrably consequential for the recipient's

understanding of ongoing action and interaction? Is the recipient's visual attention regulated by gesture, talk or both? One way to start to get to grips with at least some of these issues is to look at the recipients' orientation to gesture with, for example, their gaze. To begin with case 5, the Co-pilot's gaze movement toward the Commander is 'non-consequential' or 'non-communicative' in the sense that the Commander is not gazing back. With regard to cases 1-4, the recipient's visual attention to the pointing gesture is relatively difficult to address. This is principally due to the technical, practical constraints; since the video-recordings used in this study are taken only from behind the pilots, which to a large extent hinders detailed inspection and recognition of the recipients' gaze direction. However, in considering the limited physical space of the cockpit, the pilots can easily become peripherally aware of each others' kinetic activities, such as gaze and hand movements. In the cases of visual pointing, the recipient's head, and therefore gaze, is specifically oriented in the direction of gesture, rather than away from it. It is assumed, then, that the gestures in question do reach, if not the direct line of their vision, then at least the periphery of the recipients' visual field. In this fashion, the pointing gestures and gaze movement are consequential for the ways in which pilots interpret and make sense of what is going on 'here and now' and where they are up to in building their situated action.

To summarize, the pointing gesture and gaze movement have specific implications for the organization of action and activity in an airline cockpit. These gestural practices are used as a resource not only for displaying the pilots' orientation and alignment in interaction, but also for recognizing and resolving the problems of intersubjectivity on the flight. In addition to gestures, importantly, the pilots also use other semiotic modalities in processing the losses of shared understanding, including talk, bodily orientations, the ongoing activity, as well as the physical features of the setting. The intersubjective sense of ongoing action that is necessary for the safe conduct of the flight is achieved through the mutual juxtaposition of verbal, visual and material resources in the cockpit. In this way, then, the simultaneous deployment of a range of multimodal practices is critical in terms of achieving intersubjectivity as well as of maximizing flight safety. A theoretical implication is that the multiple meaning-making practices and the interconnections among them must be taken into account in analyzing the establishment of intersubjectivity, not only in an airline cockpit, but also in other socio-technical settings.

Summing up and conclusions

This study is a story about a range of social and work practices airline pilots use, not only in accomplishing flight tasks and activities, but also in demonstrating their situated and moment-to-moment understandings of the ongoing course of action in the cockpit. The flight crew members employ multiple semiotic resources or 'modalities' concurrently in producing, making sense of and coordinating their activities with each other. The interactive resources salient for the production and organization of cockpit activities include talk, the bodies of the pilots, the unfolding activity they are engaged in, and the physical features of the setting. The particular sub-set of the semiotic resources the pilots noticeably orient to as relevant in building their situated action is called the 'contextual configuration', which changes constantly (Goodwin 2000). As a practical example, the transition from an electronic checklist (the ECAM system) to a paper checklist in the emergency situation (the QRH handbook) entails a change of contextual configuration by redirecting their orientation from one material artifact to another. The demonstrable orientation to the paper checklist procedure opens up new semiotic resources for the pilots to use in the recognition and production of a sequentially organized action on a flight.

In more specific terms, this research is a story about the Finnish airline pilots who actively and collaboratively manage the various problems of intersubjectivity in their cockpit interaction, therefore contributing to the elimination of flight incidents and accidents (see also Arminen et al. 2009). A loss of shared awareness between flight crew members increases the risk of aviation mishaps or hazards. The pilots employ several modalities simultaneously in locating and managing problematic understandings in the course of the cockpit interaction, including verbal repair and reminder, pointing gestures, gaze movements, upper body orientations and object manipulations in their local environments. The mutual juxtaposition of these various meaning-making practices is considered here as an activity critical to safety, preventing potentially hazardous incidents and accidents. Flight safety is thus seen to be created and maintained in/through the evolving processes of interaction and collaboration; the safe conduct of flight is understood and treated as an 'interactive achievement' between participants.

7.1 PROBLEM DIMENSIONS

The establishment of intersubjectivity between the airline pilots was described and analyzed along two interrelated problem dimensions. The first dimension is the organization of cockpit 'talk-in-interaction', which concerns the relationship between turns at talk. The following example, taken from Chapter 4, illustrates the intersubjective problem the airline pilots have within this particular dimension.

Transcription 1 (simplified)

```
01   CDR:   And will you give me the checklist from there.
02   COP:   The checklist, ((Cop brings the normal checklist
                           into view))
03   CDR:   No I mean the emergency, Q: R: H:
04   COP:   Q: R: H: yeah, ((Cop moves the normal checklist away
                           and gives the QRH to Cdr))
```

In the case above, the loss of intersubjectivity between pilots occurs at the level of sequence structure. The problem lies in understanding or making sense of cockpit talk as the Co-pilot misrecognizes the 'checklist' the Commander is referring to in his original request (see lines 1-2). The intersubjective sense of the referent of the talk – the emergency checklist instead of the normal checklist – is achieved through the practices of talk and embodied conduct (see lines 3-4). It is important to note here that the pilots simultaneously demonstrate their orientation to, and understanding of, the broader sequential organization of action in the cockpit through the precise coordination of verbal and visual action. The Commander's request ('... *will you give me the checklist...*') indicates that the performance of the checklist is a relevant next thing to do at that particular sequential phase of the flight tasks; the Co-pilot initially orients to the execution of the normal checklist, and, following the reparative operation by the Commander, re-orients to the performance of the (intended) emergency checklist.

The last point leads us to the second problem dimension, namely, the organization of cockpit 'talk-and-action-in-interaction'. This dimension concerns the sequential positioning of move, utterance or action. In the example below, familiar from Chapter 5, the airline pilots locate and deal with the problem emerging within this dimension.

Transcription 2 (simplified)

```
01   CDR:   And take-off check.
02   COP:   And here is the taxi check first,
03   CDR:   Yeah taxiing check sorry yeah,
04   COP:   And it is flight controls,
```

In this case, the loss of intersubjective sense of action affects the sequential order as the Commander skips the 'taxi' checklist and orients prematurely to the execution of the 'take-off' checklist (lines 1-2). The flight crew members thus have different interpretations of the sequential phase of task accomplishment, i.e., what tasks and activities have been done and what to do next. The next point is important here as it brings us back to the features of the first dimension, i.e., the pilots employ the practices of ordinary talk-in-interaction (conversational repair or reminder) as an interactive resource both in restoring the sequential order and in achieving the intersubjective sense of the ongoing course of action in interaction (see lines 2-4). These two examples highlight the close relationship between talk and action; it is misleading to treat the language system as distinct from action. As these and the rest of the cases analyzed show, language and action are not separated but are juxtaposed in ways which mutually elaborate each other. (Goodwin 1994; 1996; 2000; 2003a.)

7.1.1 Comparative analysis of cockpit talk-in-interaction

The comparative analysis of repair organization in cockpit talk-in-interaction and everyday conversation produced two key findings. Firstly, the repair procedures in the airline cockpit are formally similar to those used in ordinary talk. The flight crew members employ, and orient to, the practices of self- and other-initiated self-repairs, other-initiated other repairs and third position repairs in dealing with the problems in speaking, hearing or understanding the cockpit talk. The loss of shared understanding between Commander and Co-pilot may momentarily interrupt the current flight task performance; the resumption of the suspended activity requires the achievement of a mutually shared interpretation of ongoing action in cockpit talk-in-interaction. The conversational repairs are used by the pilots as an interactive resource in recognizing and resolving problematic understandings during the flight. These practices of ordinary conversation can provide participants with a functional way to accomplish their tasks and goals not only in the airline cockpit, but also in other institutional settings.

Secondly, the preference organization of repair in cockpit talk-in-interaction differs from that of ordinary conversation. Based on the normative order of interaction, the participants tend to avoid any potential for conflict or disagreement by specifically mitigating the dispreferred second actions in talk (see Levinson 1983, 332-345; Heritage 1984a, 265-280; Schegloff 2007, 58-96). Accordingly, as shown in the 'hopscotch' case (Chap. 5), the straightforwardly argumentative turns may lead to disagreement and dispute between participants in interaction. The use of overt, un-modulated other-repairs in cockpit talk-in-interaction contrasts with the preference structure of everyday conversation, i.e., the direct other-repairs can be accomplished without conflict. In considering the cockpit environment, both flight crew members are jointly responsible for the safe conduct of flight; it is also critical that they have a shared awareness of the ongoing events in and outside the cockpit. Therefore, the normative order of flight safety requires that any type of corrective action contributing to the achievement of intersubjectivity

is preferable to not interrupting or correcting at all. Taking into account the stringent flying time limits as well, immediate, explicit other-repairs are preferred to delayed, implicit other-repairs. Unlike ordinary talk, the pilots' main orientation is not to preserving 'face' in the production of other-initiated other-repairs in cockpit talk-in-interaction. Through the activity of correcting one another, the pilots rather orient to achieving intersubjective understanding of the unfolding action to ensure the safety of the flight.

The orientation to maximizing flight safety is but one of the reasons impinging on the pilots' use of the direct other-corrections in the course of their cockpit talk-in-interaction. Another reason arises from the aforesaid time-criticality of flying the airplane in that the identification and management of the intersubjective problem may momentarily suspend the current task performance in the cockpit. With regard to the safe conduct of flight, it is crucial to solve the understanding problem and continue the interrupted activity as soon as possible; the rapid resumption of flight activity is best enabled through direct rather than delayed corrective action. The formally standardized nature of the setting can also prepare the ground for the use of outright other-correction in cockpit talk-in-interaction. As compared to other forms of institutional interaction and ordinary conversation, the airline cockpit operations are highly scripted. The flight crew members are obliged to follow the formal procedures that prescribe in detail how the aircraft is to be operated, who is to do what, and in what sequence. In the case of deviations from the standard (e.g., the pilot saying the wrong departure route, etc.), the use of direct other-repair makes it possible for the pilots to fluently and effectively return to the institutional standards and norms of flight operation.

In institutional terms, therefore, the activity of directly correcting the other speaker in cockpit talk-in-interaction serves to achieve three interrelated goals or tasks: (1) maximizing flight safety, (2) sticking to the strict time limits and (3) adhering to the standard airline operating procedures. It is thus institutionally 'favorable' and 'acceptable' to use the form of direct other-correction in solving the problems of intersubjectivity in the course of cockpit talk-in-interaction. Along with the airline cockpit, there are also other settings favoring direct corrections by the second speaker. Norrick (1991), for example, presents empirical data from environments conducive to using un-modulated other-corrections, including interactions between parents and children, teachers and students, and native speakers (NS) and non-native speakers (NNS). Common to all these interactions is a perceived imbalance in background information and/or language ability towards a knowing participant. These more competent speakers (i.e., parents, teachers, NSs) other-correct the not-yet-competent speakers (i.e., children, students and NNSs) in order to help them achieve equal status; the latter usually go along with this organization of repair in their own interests. In these settings, the use of the straightforward other-corrections characteristically exhibits the participants' orientation to the particular learning and pedagogical goals. (Norrick 1991, 78.)

7.1.2 Comparative analysis of cockpit talk-and-action-in-interaction

In addition to the problems in speaking, hearing or understanding the cockpit talk, the pilots may encounter troubles in positioning of move, utterance or action. The data analysis revealed two types of problem: false actions (including the subcategories of premature, excessive and irrelevant actions), and absent actions. The premature and absent actions were selected for the final analysis because the former are the most common problem in my data and because the processing of the latter deviates from that of false actions. In line with the troubles in cockpit talk-in-interaction, the various problems in maintaining the sequential order of action are regularly located and managed with the practices of ordinary talk-in-interaction. The pilots employ self- and other-initiated self-repairs and other-initiated other-repairs (but not third position repairs) in dealing with premature, excessive and irrelevant actions; meanwhile, absent actions are resolved by the practice of reminding. Table 7.1 shows the repair type frequencies of premature, excessive and irrelevant actions in cockpit talk-and-action-interaction (n = 36).

Table 7.1
Repair type frequencies according to problem type

	Premature Actions	Excessive Actions	Irrelevant Actions	Total	
Self-initiated self-repair	18	3	0	21	(58,3%)
Other-initiated self-repair	8	0	0	8	(22,2%)
Other-initiated other-repair	4	2	1	7	(19,4%)
Third position repair	0	0	0	0	(0,0%)
Total	30	5	1	36	(100%)

There is an empirical preponderance of self- over other-correction in cockpit talk-and-action-in-interaction: the great majority (81%) of the cases is self-repaired by the producer of the 'mistimed' action. In other words, then, the airline pilots initially breaking down the sequential order of action usually also restore that order by themselves. This finding is equivalent to the organization of repair in ordinary conversation, where self-correction is preferred over other-correction (Schegloff et al. 1977).

More specifically, the airline pilots may lean on the practices of ordinary talk in situations where the range of responses ('second pair parts') to standard callouts is limited to affirma-

tive ones only. The first example, the transfer of control and navigation duties between pilots, occurs with the scripted wording: Pilot-flying (PF): '*Your controls*' – Pilot-not-flying (PNF): '*My controls*'. Consequently, the standard terminology does not include a callout that would enable the pilot to formally refuse to take on these duties. In the second example, the PNF asks to clear a particular ECAM screen page with the callout '*Clear wheel*'; officially, the PF is only able to confirm the clear action by repeating '*Clear wheel*'. In these cases, then, there is no formal way for the pilots to produce negative responses to the previous turns or moves ('first pair parts'). When the standardized responses to the standard callouts are inappropriate or not usable, the pilots may use practices from ordinary talk, such as repairs, as a resource in the production and recognition of intelligible courses of action (see Chap. 5, cases 4 and 6).

The analysis of cockpit talk-and-action-in-interaction also showed that the other-initiated other-repairs used in connection with premature actions were regularly modulated in form. The particular modulation means or techniques employed by the pilots included 1) accountings and 2) the insertions of Finnish non-standard talk into English standard talk. Through the use of these marked forms of other-repair specifically, the airline pilots frame and explicate the ongoing action in the complex setting of the cockpit. In this way, they noticeably orient to the achievement of intersubjectivity in order to ensure the safe conduct of the flight, simultaneously making their 'dual' orientation to the normative order of interaction and that of flight safety visible. Meanwhile, as the analysis of the cockpit talk-in-interaction showed, the problems in speaking, hearing and understanding the talk were resolved with direct un-modulated other-repairs. In that case, then, the normative procedures of interaction in ordinary conversation were overridden by the institutional norms of flight safety. Are the differences in the normative orientations between the two problem dimensions systematic? Is it that the other-repairs used in dealing with the problems of cockpit talk-in-interaction are commonly done directly, without any marking of their dispreferred status? What about the other-repairs related to premature actions or other sequential problems in cockpit talk-and-action-in-interaction? Do they occur only in a marked format?

In the light of my data, the pilots employ not only un-modulated but also modulated other-repairs in managing the problems of cockpit talk-in-interaction. In the twenty-three flight segments analyzed, there are in total five (5) cases in which the activity of correcting the other speaker is accompanied by such things as the indicators of hesitation ('*Uhm...*') and mitigating prefaces ('*Yes, but...*'). None of these cases, however, were included in the present analysis mainly because of their technical complexity[1] (on case selection criteria, see Section 3.6). The distribution of various forms of other-repair in the cockpit talk-and-action-in-interaction is more strongly biased towards the modulated form of correction. The premature and excessive actions to be found in my data are recurrently resolved with modulated other-repairs. The

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1   It is also possible that the pilots themselves display an orientation to this complexity with prefaces and hesitation markers.

processing of one (and only) irrelevant action makes an exception to this practice: the flight activity the pilot should not be doing 'at all' is dealt with by direct other-repair.[2]

Taken together, in contrast to ordinary talk, the pilots' main orientation is not towards 'face work' (Goffman 1967) in the activity of correcting one another. Deviating from the normal procedures of interaction, the use of direct other-repairs does not engender disagreement or conflict between the pilots. The flight crew members rather use other-repairs un-modulated in form to orient to the rapid achievement of intersubjectivity in order to maximize safety. In a similar vein, the pilots do not seem to display their orientation to the avoidance of conflict with the modulated other-repairs either. In ordinary conversation, the modulation techniques such as accounts used in company with dispreferred seconds serve at least two functions: first, maintaining social solidarity and second, explaining and making the ongoing action understandable. By framing the repair operations with accountings and insertions of Finnish non-standard talk into English standard talk, the pilots primarily orient to the second task – the achievement of intersubjectivity – as a pre-condition for flight safety, thus bringing the norms of interaction and that of flight safety into play simultaneously.

Premature and absent actions

The 'premature' and 'absent' actions represent two different problem types that are resolved by diverse practices in cockpit talk-and-action-in-interaction: the cases in which the pilot orients prematurely to a particular flight task or activity are dealt with by repairs, while the cases in which s/he fails to carry out the activity within his/her responsibility are managed with reminders. These two practices of interaction differ from each other both structurally and functionally. The use of repair addresses the action or activity *done* in the preceding turn or slot as sequentially problematic. The repair initiation by oneself or another indicates that the previous talk and action is in need of correction in the course of interaction; the repair operation is completed either by the speaker (doer) of the problematic talk (action) or by the other speaker. Through the practices of reminding, however, the action or activity *undone* in the prior turn or slot is marked as sequentially problematic. The reminders specifically imply that the non-occurring talk and action is in need of accomplishment by the other; the pilots being reminded then perform the 'missing' activity, simultaneously adhering to the responsibilities of their official role as, for example, a Pilot-flying or Pilot-not-flying. Regardless of the structural and functional differences, the repairs and reminders have similar consequences for cockpit

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2   The flight crew (2) is conducting an emergency landing at Stockholm-Arlanda Airport.
      01   CDR: And then I'll choose that <u>three</u> from there<, ((CDR is choosing 'slats/flaps position 3' from FMS))
      02   (.)
→ 03   COP: No,=It'll stay on full position,? ((COP other-corrects that the slats/flaps position must be FULL))
      04   (0.5)
      05   CDR: <u>Really</u>,=
      06   COP: =Yes,
                    ((Continues...))

talk-and-action-in-interaction, since the sequential order of action is restored and intersubjectivity between pilots is achieved through them.

As mentioned elsewhere, premature actions are clearly the most common problem type in my data (see Chap. 5, Table 5.1). One reason for this may be related to the importance of being proactive and anticipatory in flying the airplane. In an airline cockpit, the flight crew members control the situation by taking an initiative and predicting events and their consequences for the flight. The sort of anticipatory orientation inherent in the work of the pilots may contribute to the high incidence of actions that are oriented to prematurely or 'too soon' in the cockpit talk-and-action-in-interaction. More specifically, as shown in Table 7.2 below, the occurrence of premature actions is more typical in the abnormal and emergency situations than in normal conditions.

Table 7.2
Problem type frequencies according to flight conditions

	Normal conditions	Abnormal/emergency conditions	Total
Premature actions	10	20	30
Excessive actions	2	3	5
Irrelevant actions	0	1	1
Absent actions	6	3	9
Total	18	27	45

The great majority (67%) of premature actions occur during abnormal or emergency situations, while about every third case (33%) occurs in normal flight conditions (n = 30). This distribution may be explained at least partly by the diversity and unpredictability of emergencies: as compared to normal circumstances, it is much more difficult for pilots to anticipate activities and events in abnormal and emergency situations very different from one another. Consequently, then, the unpredictable and time-critical nature of emergency operations can create the circumstances for the breakdown of sequential order in cockpit talk-and-action-in-interaction.

The small number of cases (n = 9) makes it impossible to draw conclusions about the distribution of the absent actions between different flight conditions. It would be interesting

to use a statistically significant sample of cases to determine whether the absent actions are distributed differently than premature actions in my cockpit data. The question is whether the lapses of memory and the activity of reminding occur more under normal, routine circumstances than under emergency situations in the flight simulator environment (see Table 7.2). In addition, the occurrence of various problem types on real operational flights would be a relevant topic for future research for comparison purposes. Do the premature actions by the pilots regularly take place during actual operational conditions, or only during simulated flights with a range of abnormal and emergency situations? Do the absent actions and reminders go hand in hand with the routine flight activities on both actual and simulated flights? These questions and concerns about the frequencies of problem types in and between real and simulated flight conditions have been left for further work.

7.1.3 The role of gestures in cockpit interaction

The analysis of gestures in the cockpit interaction had two related goals: first, it aimed to investigate the function of pointing gestures and gaze movement in the processing of intersubjective problems between pilots. The second goal was to provide tools to refine and systematize the analysis of gestural conduct in the airline cockpit and other socio-technical settings. It was suggested, therefore, that what is done or achieved through gesture in interaction depends on at least the following conditions: a) the target of the gesture; i.e., whether the gesture is directed toward the co-participant or a particular object in the local surroundings, b) the temporal relationship between talk and gesture; i.e., whether the gesture is produced prior to or simultaneously with talk, and c) the organization of participation in the production of gesture; i.e., whether one produces or receives the gesture. As an example, the airline pilot uses the pointing gesture towards the cockpit display not only to direct the other's attention to that object, but also to specify the source of knowledge (see case 3: second gesture). When produced prior to talk, the gesture may suspend the ongoing course of interaction from the recipient's perspective (see case 3: first gesture); seen from recipient's point of view, therefore, the gesture can initiate a repair and/or address the trouble that has taken place earlier in the conversation.

In general, the gestural movement and speech are coordinated temporally such that gestures precede their lexical affiliates (Schegloff 1984a).[3] The use of these 'asynchronous' gestures has at least two implications in cockpit interaction: firstly, the gestures may sometimes provide a more efficient and quicker way to convey meanings than speech. In cockpit interaction, the 'asynchronous' gesture may be specifically mobilized as a multimodal resource to accomplish the strict time-critical goals of flying the airplane (see also discussion on the use and function of direct other-correction in Section 7.1.1). Secondly, indirect, non-verbal communication may be socially preferable to direct verbal communication in the processing of intersubjective

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3   On verbal turn prefaces, see Schegloff 1980; 2007.

problems between airline pilots. The pointing gestures preceding a conversational repair or reminder provide pilots with suitable interactive means for maintaining social order by opening up sequential space for the initiation of self-repair or absent task/activity.

The pilots use pointing gestures and gaze movement as an interactive tool to address and make their orientation and engagement in processing of intersubjective understandings on the flight visible. In analytic terms, these gestures get their meaning and organization from the close relationship with other meaning-making practices and sign systems, including talk, bodily orientations, the unfolding activity the pilots are engaged in and the features of the surrounding environment (Goodwin 1994; 2000; 2003a & b). Since the recognition and resolution of problems of intersubjectivity is not a verbal phenomenon alone but an action embedded within the complex network of multiple semiotic resources, it is important to take into account all relevant modalities and interconnections among them in analyzing the achievement of intersubjectivity in the airline cockpit and other technologically saturated settings.

7.2   RESEARCH CONTRIBUTION

The traditional research on the organization of repair has been concerned with problems in speaking, hearing and understanding talk (Schegloff et al. 1977; Schegloff 1979; 1987; 1992a; Drew 1997; McHoul 1990; Kurhila 2001; Macbeth 2004; Egbert 2004; Hosoda 2006). The current study broadens the scope of conversation analysis by pointing out that the practices of repair are used to manage not only the linguistic problems of participants, but also their problems in positioning a move, utterance or action in interaction. Together with more conventional conversation analytic research, this study also follows in the footsteps of other research that shows how corrective actions target the participants' physical courses of action, their interactions with the physical environment and their uses of multimodal semiotic facilities (Suchman 1987; C. Goodwin 1994; 2000; 2001; Spagnolli, Gamberini & Gasparini 2002; see also Nevile 2004a; Nevile & Walker 2005).

In terms of my data, the problems of sequential positioning of talk and action are particularly prevalent in the routine task of executing the normal checklists. Out of one hundred and twenty-two (122) normal checklists analyzed, the pilots had eleven (11) sequential problems[4] and one (1) linguistic problem[5] in the performance of this critical safety procedure.[6] There are at least three potential reasons for the emergence of sequential problems in the performance

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4   Includes (6) premature actions, (1) excessive action, (0) irrelevant action and (4) absent actions.
5   In this case, the CDR first responded to the 'briefing' item on the taxi checklist with 'checked' and then self-repaired his talk with 'confirmed I mean'.
6   It is worth noticing that the twelve (12) cases under scrutiny concern only those situations which the pilots themselves treat as problematic in the course of cockpit interaction. My data also includes some further cases where the 'error' takes place in the normal checklist performance (e.g., the pilot fails to complete the checklist with 'checklist X completed'). These instances were omitted since the pilots did not demonstrably orient to the situations as troublesome, i.e., they did not bring the errors to the conversational surface with repairs or reminders.

of normal checklists. Firstly, the coordination of simultaneous tasks and activities may have caused the Co-pilot to skip of an item on the 'before engine start' checklist (see Chap. 5, cases 3 and 5). Prior to the Co-pilot leaving the 'altimeter' item out, the pilots went through the 'fuel' item on the checklist. At that point, both flight crew members were required to check the fuel quantity from the Secondary Engine Display. In practice, then, the Co-pilot must momentarily move his gaze from the list to the display (see Chap. 5; Stills 1 and 5). This management of concurrent task demands, in which the pilot is responsible for reading the checklist and verifying the fuel quantity, may have distracted the Co-pilot's attention so that he inadvertently skipped one item, and proceeded prematurely to the next one. Secondly, as shown and discussed in Chapter 5 (cases 8-9), the checklist practice can be contrary to the initial logic of checklist use and the normative procedures of interaction in ordinary conversation. Thirdly, the pilots were using the normal checklists in a simulated environment in which the accomplishment of routine everyday tasks may be characteristically prone to errors. Finding out whether the setting has an effect on the occurrence of sequential problems in the execution of normal checklist procedure, however, requires comparison with data gathered from actual flights.

Based on this research, the pilots generally speak, hear and understand the normal 'checklist' talk properly and without trouble. The standardization of checklists is thus well-designed and successful in linguistic terms. The sequential ordering of action appears to be more problematic in the execution of the normal checklists. In order to improve the 'human-centered' point of view in airliner checklist design, we need to carefully analyze a) what kinds of problems the pilots have in their situated use of checklists, b) how common or frequent the problems are and c) what causes these problems to occur in the course of cockpit interaction. As with the troublesome understandings in any other cockpit activity, the pilots manage the various checklist problems with conversational repairs and reminders. The fact that the practices of ordinary talk-in-interaction are used as an interactive resource in the accomplishment of tasks highlights the close relationship between talk and action, not only in cockpit interaction but also in other socio-technical settings.

7.2.1 The importance of intervention in cockpit interaction

The airline cockpit is an inherently complex, technologically mediated environment in which the pilots produce and coordinate their actions with regard to standardized practices and procedures. In addition, the research data used in this study is characterized by the fact that it includes not only normal flight conditions but also mentally and physically stressful conditions due to a fire in a cabin, severe hydraulic failure in the aircraft's technology, and so on. However, notwithstanding the complexity of the setting and the highly loaded situations encountered during flying, the pilots still can actively communicate and listen to one another, monitor each other's verbal and non-verbal conduct and negotiate shared meanings for their actions. Thus, in the light of this research, the co-operative and communicatively skillful airline pilots say and do

'the right things, at the right time, in the right way' to ensure not only an intersubjective sense of unfolding action but also the safe and efficient conduct of the flight. The pilot may occasionally say the wrong word or orient to the flight activity in a sequentially inappropriate place. In these and related problematic situations, the interactively competent flight crew members have the ability and guts to bring the problems to the conversational surface and deal with them collaboratively, thereby improving flight safety.

The interactive excellence in the cockpit setting amounts to both the effective and fluent communication and the skill and courage to intervene in situations of problematic understandings through the conversational repair or reminder. Consequently, the use of these social practices has at least the following meanings or implications in cockpit interaction: firstly, the repairs and reminders are used as an interactive tool to identify and address episodes of problematic understandings between the pilots. For example, the practice of reminding brings out the deficiencies ('absences') in the pilot's performance of a given cockpit duty. In some contrast to ordinary conversation, the reminders are produced sensitively, without judgment or blame, in order to assure professionalism and a good team spirit among flight crew members. Basically, neither pilot can be complacent or imagine the other will always know the current status of the flight, etc. Both flight crew members must be vigilant and ready to intervene when necessary. Secondly, then, the interventions carried out through the repairs and reminders can be seen as evidence of a well-functioning interactive 'back-up system' eliminating risks to flight safety (see also Arminen, Auvinen & Palukka 2008). Thirdly, the pilots simultaneously produce and make visible their professional competence and know-how in action through the activities of repairing and reminding. In this process, to cite Goodwin, "there is a growth in intersubjectivity as domains of ignorance that prevent the successful accomplishment of collaborative action are revealed and transformed into practical knowledge" (1994, 614).

7.2.2 Who is doing the intervention?

The flight crew consists of the Commander and the Co-pilot, of which the former is usually the most senior, experienced pilot. Does the authority gradient or command hierarchy (CDR as a leader — COP as a subordinate) contribute to the processing of intersubjectivity between pilots? Is it so that the Commander regularly corrects the Co-pilot's talk and action, and not vice versa? Is it only the Co-pilot who has to be reminded about particular flight duties? Is the Commander immune or safe from (other-) corrections and reminders in the course of cockpit interaction? My data suggests that the 'authoritative' thinking embedded in these questions is fairly old-fashioned and passé: as revealed in Table 7.3, *both* the Commander *and* the Co-pilot

Table 7.3
Frequencies of interventions according to cockpit roles

Intervention	Commander	Co-pilot	Total
Other-initiated other repair (sequential problems)	2	5	7
Reminder	7	2	9
Total	9	7	16

can and are socially allowed to intervene in each other's conduct through the conversational repairs and reminders.[7]

One reason why the lower status person (the Co-pilot) corrects and reminds the higher status person (the Commander) may relate to organizational and cultural factors. At Finnair, as in many other western airline companies, the authority gradient can be described as relatively 'flat': the Co-pilots are willing and ready to question or challenge their superiors in order to eliminate a threat to safety, and the Commanders specifically encourage their subordinates to speak up when a problem arises. By contrast, Co-pilots working with a domineering or over-bearing Commander can experience a 'steep' authority gradient. At Singapore Airlines, for example, the Co-pilots are not expected to criticize the persons in charge; giving 'negative' feedback may indeed be perceived as a confrontation that causes a loss of face.[8] The second potential reason for the interventions carried out by the Co-pilot includes the number of flight hours in the Airbus 320, which allows the Co-pilot to 'be able' to (other-) correct and remind the Commander as a result of having more experience and skill in flying the A320 (for the flight hours of pilots in this study, see Appendix 1). Thirdly, the formal roles of pilots can contribute to who is doing the intervention. The Pilot-not-flying (PNF) is responsible not only for navigation and communication but also monitoring the performance of the Pilot-flying (PF). For example, the Co-pilot in the role of PNF may thus be more inclined to intervene than the Commander who has the PF duty (i.e., the control of the aircraft).

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7   The comparative analysis of the distribution of intervention practices between pilots would require a much larger sample of cases.
8   The presentation held by Finnair Chief Pilot, Mr. Heikki Saloheimo who has worked as a pilot at Singapore Airlines. Human Factors and Safety III – seminar organized by the VTT Technical Research Centre of Finland, Espoo, Finland, 15 May, 2008.

7.2.3 A glimpse of the future and the 'LISA' model

To keep the data analysis within limits, the current study does not cover all relevant issues concerning the complex organization of airline cockpit action and interaction. Along with those mentioned above (i.e., the comparisons of practices between simulated and real flights), there are also other topics left for future research. To start with, this research work provides scientific and systematic knowledge about the different kinds of intersubjective problems in cockpit interaction and how pilots deal with these problematic understandings by coordinating their talk and embodied conduct. However, in order to gain a deeper appreciation of this phenomenon, the various reasons or causes contributing to the emergence of the problematic understandings between them would be worth extra analysis (see Arminen et al. 2009). By thoroughly examining both 'what' the problems are and 'why' they happened, we may discover new ways to avoid them through, for example, Crew Resource Management (CRM) training and cockpit design.

Secondly, the airline operational communication conducted in English (i.e., standard operating procedures and callouts through which flight tasks and activities are accomplished) does not include the conversational practices of repair and reminder. Consequently, it is natural and expected that the airline pilots participating in this research recognize and resolve the problems of intersubjectivity with their mother language – that is, Finnish. This kind of code-switching or language alternation (see Auer 1984; 1998) from English to Finnish is an aspect of the processing of intersubjective problems between pilots on a flight deck (see Chap. 4, case 3; Chap. 5, cases 1-10). Finnish thus functions as a 'meta-language' to the official English, allowing the achievement of intersubjectivity in the cockpit environment. Importantly, the code-switching occurs not only during the episodes of problematic understandings but also during routine sequential action in cockpit interaction (see, e.g., Chap 5., case 7: COP: '**Ja se on** flight controls', '**And it is** flight controls'). Therefore, it would be interesting to investigate more carefully what functions the alternations between two languages serve in both problematic and non-problematic sequences of cockpit talk and action. The comparative analysis of the use of code-switching in cockpit interaction and in other institutional settings, such as foreign language classrooms (see Üstünel & Seedhouse 2005), will also be one of the potential topics to be discussed later.

As a final word, the possibility for the losses or breakdowns of intersubjectivity is constantly present when two or more people communicate and interact with one another. It is thus impossible to entirely avoid the problems occurring in cockpit interaction between the Commander and Co-pilot either. When problems will inevitably occur, the pilots must be willing and able to detect and resolve them to ensure flight safety. The management of intersubjective problems is also a collaborative process, taking time and effort from both flight crew members. This can have some adverse effects on the safe conduct of the flight, especially under emergency conditions, since the pilots are engaged in dealing with the problem of shared understanding in a situation in which it would be more appropriate to fully concentrate on controlling the

airplane. As a partial answer to these contradictory concerns, I have developed the interaction model called 'LISA' (see below).[9] The general guidelines provided by the model can be used as a starting point in helping the maintenance and achievement of intersubjectivity, not only in cockpit interaction but also in other safety-critical environments.

Listen to what the other is saying.

Intervene in action when necessary.

State your intentions.

Ask if you do not hear or understand.

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9   I designed the model originally in Finnish (see Palukka & Auvinen 2005). In that case, the model consist of the following '4 Ks': **K**uuntele (listen) – **K**erro (state) – **K**ysy (ask) – **K**orjaa (intervene).

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APPENDIX 1

Flight Hours of Pilots

Flight crew members	Total flight hours	Flight hours in Airbus A320
Crew 01: Commander	14,500	2,000
Crew 01: Co-pilot	2,100	2,100
Crew 02: Commander	10,500	1,500
Crew 02: Co-pilot	3,500	2,700
Crew 03: Commander	9,000	1,600
Crew 03: Co-pilot	2,300	2,300
Crew 04: Commander	11,000	1,200
Crew 04: Co-pilot	2,400	2,000
Crew 05: Commander	9,000	---
Crew 05: Co-pilot	500	---
Crew 06: Commander	10,000	---
Crew 06: Co-pilot	2,000	---
Crew 07: Commander	5,000	600
Crew 07: Co-pilot	1,500	300
Crew 08: Commander	6,500	---
Crew 08: Co-pilot	3,000	---
Crew 09: Commander	5,000	700
Crew 09: Co-pilot	3,800	2,500
Crew 10: Commander	8,000	---
Crew 10: Co-pilot	1,000	---
Crew 11: Commander	8,000	600
Crew 11: Co-pilot	2,100	600
Crew 12: Commander	7,000	900
Crew 12: Co-pilot	5,000	300

APPENDIX 2

Transcription Conventions

[ ]   Interlocking left-brackets indicate where overlapping talk begins; interlocking
               right-brackets indicate where overlapping talk ends.

=   Equals signs, one at the end of one line and one at the beginning of the next,
               indicate no 'gap' between the two lines.

(1.5)   Silence measured in seconds and tenths of seconds.

(.)   Silence of less than a fifth of a second, i.e., less than (0.2).

<u>He</u> says   Underscoring indicates some form of stress, via pitch and/or amplitude.

: :   Colons indicate prolongation of the immediately prior sound.
               The length of the colon row indicates length of the prolongation.

↑ ↓   Arrows indicate shifts into higher or lower pitch.

. , ? ,?   Punctuation markers are used to indicate intonation.

WORD   Upper case indicates especially loud sounds relative to the surrounding talk.

° °   The degree sign is used as a 'softener'. Utterances or utterance parts bracketed by
               degree signs are relatively quieter than the surrounding talk.

<   A pre-positioned left carat indicates a 'hurried start'. A post-positioned left carat
               indicates a 'sudden stop'.

-              A dash indicates a cut-off.

> <   Right/left carats bracketing an utterance or utterance-part indicate speeding
               up.

.hhh   A dot-prefixed row of hs indicates an in-breath. Without the dot the hs indicate
               an out-breath.

wohhrd	A row of hs within the word indicates breathiness.
hu, ha, he	Laugh particles. If enclosed in round brackets, e.g. (h), then it occurs while talking.
#	An asterisk indicates 'creaky voice'.
( )	Empty parentheses indicate the transcriber's inability to hear what was said. The extent of the parenthesized space indicates the length of the un-transcribed talk. In the speaker-designation column, the empty parentheses indicate inability to identify a speaker.
(word)	Parenthesized words are particularly dubious hearings or speaker-identifications.
(( ))	Doubled parentheses contain transcriber's comments.
[*(( ))*	Doubled parentheses (italic) contain the description of non-talk activity. Interlocking left-bracket indicates the initiation of non-talk activity relative to talk.
↑___↑	Beginning, duration and end of non-talk activity. Arrows point upwards to the precise point in talk or silence where non-talk activity begins or ends.
>___↑	Non-talk activity is continued from the previous line.
↑___>	Non-talk activity continues to the following line.
>___>	Non-talk activity is continued from the previous line, and continues to the following line.