

A conversation analysis model for examining aviation communication in context: part II – processes for analysing data

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Abstract

This paper is the second of two, which together present a model for representing and analysing aviation communication in detail, as it occurs in context. Effective verbal communication is an important aspect of human performance, and is necessary for operations in a safe and efficient aviation system. The model draws on methods, insights, and findings of conversation analysis, an academic field within sociology which has developed over four decades. The model can be used whenever it is possible to make detailed transcriptions from audio or video recordings of naturally occurring interaction. It will be valuable for accident investigators, human factors researchers, or operations and training personnel. The previous paper presented part I of the model, and focussed on representing recorded communication data. It outlined a rationale and processes for transcribing communication in micro-detail. This paper presents part II of the model, and focuses on analysing micro-detailed transcriptions of recorded communication data. It also includes a select bibliography of key texts to support use of the model.

Introduction

This paper is the second of two, which together present a model for representing and analysing in detail *aviation communication as it occurs in context*. The first paper presented part I of the model. It outlined the models' development and introduced the origins and principles of conversation analysis (CA) as the academic field on which the model is based. CA originated within sociology (e.g., Hutchby and Wooffitt, 1998; ten Have, 1999; Wooffitt, 2005). Part I then focused on a rationale and processes for *representing* aviation communication in micro-detailed transcriptions, using methods and notation of conversation analysis (Neville, 2007). As part II of the model, this paper focuses on processes for *analysing* transcribed communication data. It shows five possible *approaches* to data, or ways of looking at data. Each approach is introduced and developed through explanations and sample questions to guide analysis. Part II also offers a select bibliography of key texts in CA, to support use of the model.

The model is premised on the view that effective communication is an important aspect of human performance, and is necessary for operations in a safe and efficient aviation system. It is therefore valuable to have a method for examining and understanding communication closely, as it occurs in context in authentic aviation settings. The model aims to allow communication analysts to show and see much more of the actual rich detail potentially available in communication data. Analysts can therefore have access to more of the details that were available to and used by the operators, or *participants*, themselves, as they constructed their own communication, and interpreted and understood others' communication, in context and moment-to-moment. In short, analysts can be better placed to know what is in the data that can inform their examination of what participants understood and did, and what happened and why.

A fundamental notion in conversation analysis, underlying this model, is that *people exhibit in the design and timing of their own talk and conduct their understanding and treatment of others' prior talk and conduct*. For this reason, conversation analysis focuses on the *sequential development of interaction*, on seeing what happens and what happens *next*. So, the basic guiding question for anyone analysing the details of recorded naturally occurring interaction, becomes *why that now?* (Schegloff and Sacks, 1973). To summarise points made in part I of the model, the following are key principles and strengths of conversation analysis (CA): CA is primarily a *qualitative* approach; CA focuses on *micro-detailed transcriptions* of verbal and non-verbal communication; CA uses *naturally occurring data* (communication recordings that are not set up and occurring for the benefit of the analyst); CA claims and findings are *data driven and reliant*, they must be supported by the evidence of what participants actually say and do; CA *does not rely on predetermined abstract theories, constructs or categories*; CA emphasises analysis of the *sequential organisation* and order of communication;

CA analyses *communication in context*, as it occurs and emerges in real time interaction. The model, as illustrated in part I, is reproduced in figure 1.

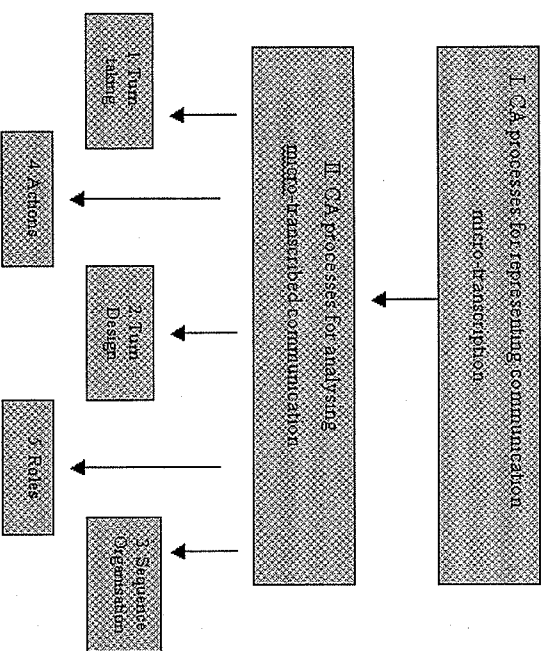


Figure 1 A conversation analysis model for examining aviation communication in context

This paper presents part II of the model. It focuses on processes for analysing aviation communication data, as represented in micro-detailed transcriptions made according to processes presented in part I. Part II outlines five possible approaches to transcription data, or ways of interpreting data. Each approach is introduced and developed through explanations and sample questions to guide analysis. Lastly, the paper offers a select bibliography of key texts in CA, to support use of the model.

CA processes for analysing micro-transcribed communication

Motivated or unmotivated looking?

A first way to deal with transcribed data is to consider whether to apply *unmotivated* or *motivated* looking (Sacks, 1984). Approaching the data by *unmotivated* looking can be a first go through the transcription of the data in its own terms, to identify possibly significant indicators of the participants' actions

and understandings. The analyst looks at the data with no particular focus or intention, just to see what is there, what emerges and stands out early on as significant or interesting. The analyst approaches the data with no particular interest or view, but is open to what the data can reveal about the role of participants' communication for developing moment-to-moment the world in which they are acting. Or, the analyst can look at the data while *motivated* by prior interests, targeting specific research questions, or informed and guided by information from other sources, such as technical and performance data, interviews etc. In either form of looking, analysts can do the following:

- Identify any communication phenomena of special interest, for example that stand out for some reason, or that recur in the recording;
- Identify key moments, events, actions, or periods of communication for close analysis.

Five approaches to transcribed data

The following are five approaches to transcribed data, constituting possible ways of interpreting data. How the approaches are used will depend on the nature of the data and the interests of the analyst in examining the data. Therefore, it is not necessary for an analyst always to use all approaches, and it is not necessary for the analyst to use approaches in the order in which they are given here. Using these approaches does not exclude other possible ways of examining the same transcription data, either informed by conversation analysis or guided by some other form of communication analysis.

1. Turn-taking The notion of *turn-taking* at the core of conversation analysis accounts for the observation that, overwhelmingly, one party talks at a time (Sacks, Schegloff and Jefferson, 1974:699). While periods of talk occur when more than one party talks at the same time (*overlapping* talk), and may occur frequently, these do not make problematic the basic systematics of turn-taking, such that mostly one party speaks at a time with no gap and no overlapping talk. A fundamental task for participants in interaction, in any setting, is to determine moment-to-moment who is speaking to whom, and who is listening to whom. This is the case even when communication is scripted or directed, such as in aviation settings. Examining aspects of turn-taking is essential for understanding how the participants created and understood what was going on moment-to-moment. In aviation settings the following can be considered.

- *Who takes communicative turns*, and how do different participants get to be speaker or recipient?
- How do turns relate to *scripted wordings* for formal standard procedures?

- *When do the turns occur* in the ongoing interaction, and what are the turn boundaries? How is the communication created by the participants, as turns?
- How do turns *begin*? Turn beginnings are important because they show how someone connects their new communication to immediately prior communication (or to silence, or some non-verbal activity, or an event). Connecting communication appropriately can be evidence of understanding (Sacks, 1992, VI:717).
- How do turns *end*? Turn endings are important because they are the point to which the next speaker must connect their new communication.
- How are turns timed relative to one another, what happens at turn *transition relevance places* (TRPs)? This is a technical term from CA and is based on a phenomenon seen in naturally occurring interaction data. TRPs are places where speaker transition could occur unproblematically (unremarkably). That is, at a TRP the current speaker could reasonably be heard to be ending a turn, and speaker change could occur acceptably, without being a problem or somehow remarkable to the participants. This doesn't mean that speaker change will occur at this point, or has to occur, just that if it did occur it is likely to be treated by the participants as nothing out of the ordinary. So what actually happens at these places? Does speaker change occur unproblematically? Are there signs of problem in turn-taking, in changing speakership?
- How do *recipients* of communication act while the speaker is talking? Do they offer response tokens? (e.g. 'right', 'yeah', 'mm', 'mhm', 'uhuh' etc.). If so, when do they do so relative to the speaker's emerging talk, and how?
- When does *overlapping* talk occur, where more than one person talks at the same time? Note precisely any points of overlapping talk. Where exactly in the flow of communication does overlap begin and end? Such moments can reveal something about the communicative actions that participants undertake, and how they understand and act upon one another's talk. Such moments cannot be equated with simple conceptions of conversational interruption. See how overlap is treated by the participants, what happens during the period of overlap? What do the participants do? Who initiates overlap? What happens to the talk? Do the participants treat the overlap as a problem and do something to resolve it? Why might it be treated as a problem (or not)?
- When/where do *silences* occur relative to the development of the sequence of turns at communication? Silence is not necessarily a problem at all, and it is a routine feature of aviation communication. However, silence can also be interpreted by participants as significant, as meaning something, and can have an impact on talk. For example, it may prompt a reminder when action for a flight task is overdue, when someone by now to have said or done something (Neville, in press a). Does silence occur within one

participant's turn, or between the turns of different participants? Does the silence between sequences of communication, say occurring between talk for different flight tasks, or does it occur within a sequence, say during performance of one task? Is there evidence that the presence or length of the silence is treated as noticeable or significant to the participants? What happened just before the silence, and what happens just after the silence? Is there evidence that something else is happening during the silence e.g. a non-verbal activity (e.g., at instrument panel) or a flight/aircraft event (e.g., landing gear lowering)?

- Who is *responsible* for the silence? If a silence occurs within someone's turn, it could be understood as that speaker's responsibility. If silence occurs between turns, between speaker change, it might be the recipient's responsibility. That is, is it the case that someone does not talk when they might have done so by now, when they might have been entitled or expected to talk, for example as a relevant or required response to another's prior talk, or in response to some flight event or circumstance (a possibly absent or delayed response)? Conversation analysis studies have consistently found that participants in ordinary conversation can notice and act on silences between the turns of a sequence, from as little as 0.3 or 0.4 of a second. For example, the silence is treated as possibly signalling a problem with the first turn, perhaps that it was not heard, or was not understood, or was unexpected, or will be disagreed with or declined. In aviation settings, communication silences are common, but any particular silence may still be examined for its possible significance.

2. *Turn design* Conversation analysis research has shown that people pay close attention to exactly how one another's communicative turns are *designed*, or put together. People do not just attend to the words or content of communication. That is, participants in interaction take note of and treat as significant, in the instant of the developing moment, numerous details of *exactly how* another person says what it is they say. These details include not just the choice and grammatical order of the words in an utterance, but the manner in which the talk was uttered. It had been claimed in some branches of linguistics that such details are merely superficial, messy and irrelevant aspects of communication that get in the way when focusing on the important content of what people say. Such details could therefore be ignored. However, such claims were made by researchers who were not trying to engage with data of actual language use in real communicative contexts, by real people, in real time, for real purposes. Four decades of research in CA have shown clearly, and repeatedly, that these claims are utterly false.

When people communicate in real naturally occurring interaction they do not treat the content of communication separately from how it is produced. People attend very closely to exactly others design their communication, and especially as it follows and coordinates with other (e.g. prior) communication. People attend to

content as it is presented in an organised *sequence of communicative turns*, and relates to the sequential moment, to that particular point in that interaction.

For doing conversation analysis it is not necessary for these details of talk to be captured and analysed with specialist technical audio-analysis equipment, because such equipment was not available to the participants at the time. In conversation analysis the aim is to see *how the participants* heard and treated such details of communication. Instead it can be informative to see what happens immediately before and after a particular moment of communication. The following details can be considered.

- *In-breaths and out-breaths* Are there audible in-breaths and out-breaths? Where do they occur in a speaker's turn, or relative to the developing sequence of turns? How do they impact the organisation or direction of the communication? For example, an audible in-breath can be treated as a sign that someone is preparing to talk.
- *Hesitation markers* Are there hesitation markers, such as 'uh', 'uhm', 'um', 'er' etc.? Where do they occur in a speaker's turn, or relative to the developing sequence of turns? Do they impact the direction of the talk? How are they treated by the participants? Speakers can use such markers to hold the turn as they prepare further talk, or to claim speakership for next talk. Such markers might also signal something problematic in developing the communication, for example that it will be a *dispreferred* response, such as disagreeing or declining or rejecting etc. (see below).
- *Silence* Why might a speaker have stopped talking, or not talked, at just that point? What comes just before and just after the silence? How long is the silence, relative to other silences? How is the silence placed relative to the speaker's turn, or within a sequence of turns? Are there silences mid-utterance, or between turns? What do the participants do next in response? Do the participants treat the silence as a sign of a problem of some kind, either in producing the talk or in what it refers to and is doing?
- *Cutoffs and restarts* Are there cut-offs and restarts? Why might the speaker have cutoff or restarted talk? What immediately precedes and follows the cutoff or restart, and how does it relate to the rest of the turn? How might the cutoff or restart relate to what the other participant is doing/saying, or what else is going on?
- *Repetition* Is any communication repeated, either by the current speaker or by the recipient participant? Aviation communication is of course full of repetition, but this does not mean it is unimportant. Not all repetition is part of talk standard operating procedures. What is repeated? Is repetition expected? Is repetition in full or in part? Do speakers repeat their own or other's talk? Exactly what is repeated and what is not repeated? Where does repetition occur in a speaker's turn, or in a subsequent turn by same or

- other speaker? Is some talk not repeated when maybe it could or should have been?
- *Prosody* Are there any noticeable prosodic features, such as marked shifts or in voice pitch contours (rise/fall), or pitch contours that seem different to what might typically be expected, either generally or relative to the rest of the recorded data? Pitch can be used to signal communication as complete or incomplete (Neville, 2005b, or to signal how it can be attended to in particular ways (for example to make communication salient). Pitch change might be evidence of affective states such as doubt.
 - *Emphasis* Are there any noticeable instances or changes or patterns of stress and emphasis, such as speech volume or rate of speech? Does talk get noticeably louder or quieter? Exactly where does it occur in the talk, when does it start and when does it stop? Where does it occur relative to the developing sequence of turns? How is it treated by the other participant?
 - *Sound stretches* Where do sound stretches occur, in what words, and where in those words? Why might a sound be stretched? How does the stretch relate to the talk in the rest of the turn, or the developing sequence of turns? What occurs before and after talk that has a stretched sound?
 - *Voice quality* Are there other forms of marked pronunciation, such as details of voice quality like breathiness or creaky voice? Exactly where does it occur in the developing turn? When does it start and when does it stop? Where does it occur relative to the developing sequence of turns? How is it treated by the other participant?
 - *Rate of talk* Does any talk get noticeably faster or slower? Why might this be? What is the speaker doing with the talk? What details of communication are said faster or slower? What is happening just before and just after the faster or slower talk? What is the significance or impact of this? How does the other participant treat such talk?
 - *Laughter* Are there moments of laughter? Why might someone be laughing? Who laughs? Exactly when does laughter occur, relative to a current turn at talk or to a sequence of turns? When does laughter begin and end? What do participants treat as worthy of laughter? Does only one or both participants laugh? Who laughs first? Who laughs last? It seems obvious to say that laughter is evidence that a participant treats something as laughable, however it can be significant if only one participant does so. Shared and closely coordinated laughter can be sign of collaboration or affiliation, or a form of joint understanding of something. Laughter that is not shared or well coordinated might be a sign of different participant interpretations of what is meant or what is going on.

3. *Sequence organisation* A great deal of research in conversation analysis has shown how people speak in *sequences* of turns at communication, and orient to (act according to) the *sequential nature of interaction*. This means that,

overwhelmingly, turns occur in close relationship to one another. When one person in an interaction produces a turn, the first of a pair of utterances (or 'first pair part'), the other person produces talk that is appropriate as a response type to that first turn ('second pair part'). These *adjacency pairs* of turns are strongly *projective*. By producing the first of a pair, a speaker projects a place for the expected second of the pair type to be produced. Participants interpret turns at talk for how they do or do not fit into the places that are continually created in the progression of the talk (see ten Have 1999:113). Participants are always, inevitably, filling the *next* created place, in ways that can be interpreted as more or less relevant, acceptable, and intelligible. More than this, particular types of turns at talk are associated with particular types of response. For example, a greeting can be responded to with a greeting, a telling can be acknowledged, an offer can be accepted or rejected, a question can be answered, an invitation can be accepted or declined. Sequences can also be expanded by preliminary sequences, inserted sequences, or post sequences.

It is not always the case that someone will in fact produce the expected response type, but not doing so can be noticed by others and be accountable. It can be attended to and interpreted as somehow significant. Also, the initiating turn of a particular sequence can be thought of, treated as, expecting (or *preferring*) particular forms of response. Such a response is *preferred*. The word *prefer* here just means that particular forms of response are interactionally easier, in that they do not require any kind of extra interactional work. Other forms of sequential response are interactionally difficult, or *dispreferred*. For example, in a team environment where one member acts with control or authority, for an instruction the preferred response is to accept and follow it. Declining an instruction is more difficult to do on its own. It is very difficult just to say 'no'. Mostly, declining an instruction involves offering some form of reasoning or account of inability, maybe an apology, etc. When some form of extra work is not forthcoming, the inviter might pursue it, 'why not?'. On the other hand, typically it is possible just to say expected wording to follow an instruction, or simply to carry it out. Think of how easy it is to accept an invitation, and how difficult it is to decline one. A dispreferred response is often signalled in various ways in the manner of talk. For example, it may be delayed, it may be prefaced by signs of hesitation ('um', 'ah'), or there may be perturbations in the production of the talk (such as cut-off words, silences, restarted or repeated words, sound lengthening etc.).

In aviation settings, sequences of talk are very often formalised as standard *scripted* wordings for operating procedures and other required or common practices. However in real life, pilots and other participants in aviation settings might vary the talk in these sequences in subtle ways by adding to or embellishing them somehow (see Neville, 2001, 2004a, 2004b, 2005a, 2006, in press). These non-standard variations may serve useful communicative purposes. Also, non-routine situations may lead pilots and others to improvise or depart from standard and formal wordings. The following can be considered.

- *What is the sequence of talk underway? What is the evidence for this?*
- How does the sequence relate to specific tasks or actions (see below)?
- How does the sequence relate to scripted wording for *standard operating procedures*? How might any variations be significant?
- How does the sequence *begin*? What is the initiating turn for the sequence?
- How does the sequence *develop*, and how is the sequence *organised*? Who produces what turn in the sequence, and when? How does each turn do its part to develop the sequence?
- How does the sequence *end*?
- How do the participants *show their understanding* that the sequence has ended?
- Are any turns presented or treated as *dispreferred*?
- Are there instances of *repair*? Conversation analysts have identified systematic processes of a general conversational practice, repair, as a social action that participants can undertake, and orient to, in naturally occurring interaction. Repair refers to sequences of talk in spoken interaction where participants deal with communicative problems of some sort, where they fix some *trouble in talk*. Repair may be of particular relevance to understanding error in aviation and how it is managed. Conversation analysts have found that in everyday conversation people do not normally correct each other. There is a marked tendency for *self-repair* (Schegloff, Jefferson and Sacks, 1977), for the person who produced the 'problem talk/conduct' (the *repairable*) to themselves repair that talk or conduct, and to be granted the opportunity to do so by the other person (even in aviation settings, Neville, in press). Conversation analysts have shown that participants distinguish between the *initiation* of the repair (i.e., showing that there is a problem) and *actually doing* the repair (i.e., fixing the problem). So, even where the *other* might initiate the repair, there is still the tendency for self-repair. Conversation analysts have shown that when another person *both* initiates *and* performs a repair (called *other-initiated other-repair*), that repair is typically delayed, hedged or qualified in some way. The person doing the repair softens the blow.
 - When does repair occur? What is repaired? Who initiates repair? How is the repair managed and responded to? What happens after the repair?

4. *Actions* Another way to approach data is to consider the *actions* of the sequence or sequences of communication. When people communicate in interaction they do not only exchange of information, and when they do exchange information they do so for particular purposes. In CA the notion of action tries to capture *what participants do* with communication, and how what is seen to be getting done impacts the flow and trajectory of the interaction (Schegloff, 1995). Action refers not just to a simple sense of speech acts (question, command, etc.),

but actions as tied to interactional moments, as contributing to jointly produced order and intelligibility in interaction. Action is what the participants themselves understand to be going on and to be accomplished, as evidenced in what they say and do. For example, an action might be a question, an assessment, a telling, a confirmation, a greeting, a disagreement, a complaint, a repeat, repairing a misunderstanding, a search for a word, an announcement, a challenge, a claim, a noticing, closing an interaction, and so on.

One or more communication turns can perform an action, or change mid-course to alter the action being performed, or can be involved in more than one action. An action may be undertaken or completed by one participant, or by more than one participant. Examining actions involves getting a sense of what is going on. What is it the participants are doing in and with their communication, individually and together? The important point here is that the analyst is identifying actions as performed and understood by the participants, as evidenced in the data, and does not rely on pre-conceived and theorised categorisations.

In aviation, an *action sequence* might be associated with a particular task, or even stage of flight. It might be an instruction followed by a response, or a question and its response, or a whole checklist, an approach briefing, etc. Within one larger sequence there may be smaller sequences, for example a checklist itself consists of, and is produced as, a series of smaller sequences corresponding to each item (Neville, 2005b). It is possible to examine the whole action sequence (how does it start? how does it end? how is it organised?), or there may be value in focussing on a particular sequence or turn within it (e.g., in a checklist, how was the landing gear item completed?).

At least the following can be considered.

- *What action is occurring?* What is it that one or more participants are *doing*, or seeking to do, with their communication?
- Does a turn at talk do more than one action?
- How do communicative actions relate to operations and tasks?
- How is the action *presented and made understandable* to others?
- How is the action *recognised* (or not)?
- How does the *recipient* treat and accept the speaker's action?
- In what way is the action *made or seen as accountable*, as needing some warrant or explanation, clarification, justification etc.?
- *Who does what action*, and how do they do so?
- How do *actions over time* relate to one another?
- How is a *course of action* carried out as one turn, or over more than one linked turn?
- What evidence is there that particular actions are *successful or unsuccessful*? Why were or weren't they successful?

5. *Roles* When people communicate they often do so to act in particular roles, associated with their personal, social, cultural, or institutional characteristics and affiliations, and as relevant for the setting in which the interaction is occurring. We often have lay or common sense understandings of what these can be, for example categories such as age, gender, status, work role, family position etc. There are also more transient roles in interaction, such as story or joke teller, instructor, complainer, inquirer, etc. However, in CA such categories and roles are not seen as merely available to people unproblematically, as taken-for-granted, assumed, and pre-existing. Instead, conversation analysts look in the transcribed communication data for how roles are *situated*, made and treated as relevant and accountable by the participants themselves. In interaction, participants inevitably create and present themselves in relevant roles, and ascribe roles to others. People therefore always draw upon and claim a range of obligations, entitlements, responsibilities and so on, associated with their own and others' roles. Roles are always *occasional*, and are something people do, not simply something they are (see Antaki and Widdicombe, 1998). Participants *act in, and as*, this or that role, and are or are not recognised and accepted by other as doing so.

How do participants in aviation settings use and orient to particular roles, how do they create, act upon, understand, and accept roles, moment-to-moment, right there and then? Participants have roles associated with their formal roles and places, such as pilot, maintenance crew, air traffic controller etc., and these are well defined and understood. Participants will also have more specific roles. For example, airline pilots' duties and responsibilities are aligned to the particular roles that they have on each flight. Each pilot will always have two formal roles. The first relates to an official rank, or status, as either a Captain (C) or a First Officer (FO). The second role is to be either the Pilot-flying (PF) or the Pilot-not-flying (PNF) for the particular flight. Pilots also occupy a general crew member role. However, while roles may be fixed and known, participants in aviation settings still have to communicate to act appropriately and acceptably according to relevant roles, in context.

The following can be considered, focussing on the evidence in the transcription data of what the participants say and do.

- What roles do the participants act in and make relevant through communication, and how do they do this?
- How do participants, through communication, develop and demonstrate to one another their understandings of which roles they are occupying, at any given moment? For example, what evidence is there, at this moment, that someone is acting as the Pilot-flying, or the Captain, or the air traffic controller, and that they are being treated/accepted as acting in that role?
- How do participants make their own or others' roles apparent and significant?
- Are roles challenged somehow, or under dispute?

- How do roles impact on the actions participants undertake, individually or together?
- How do roles relate to specific actions or events?
- Do participants change over time in how they communicate to act, or are treated as acting, in a particular role? How are roles significant at any specific time?

Conclusion

Together with a previous paper, this paper has presented a conversation analysis (CA) model for transcribing and analysing aviation communication as it occurs in context. The model can be used by anyone in aviation settings who is interested in communication, and its significance for effective, appropriate and safe human performance. A fundamental assumption of the model is that if communication is important then there is value in representing, analysing and understanding it, with regard to its rich and authentic detail. Language in communicative interaction is potentially one useful window to participants' (operators') understandings. The model is not a comprehensive introduction to all aspects of conversation analysis relevant for aviation communication data. Rather the model is intended to be starting point to allow interested parties in aviation to consider the possible relevance, value and utility of conversation analysis, as a well developed scholarly methodology, to complement other approaches to communication and human performance data. Increased familiarity with conversation analysis will enable better use of this model.

Possible human factors areas for applying the model include crew resource management (CRM), situation awareness (SA), and human error. For CRM, the model can explore the important role of communication for realising such team processes as information gathering and sharing, planning, leadership, decision-making, and identifying and managing errors and problems (Wiener, Kanki, and Helmreich, 1993; McAllister 1997; Flin et al. 2003). For SA, the model can explore awareness as a social phenomenon, developed and demonstrated across team and collaborating operators through processes of communication. For example, what features of communication in context are more or less conducive to maintaining and improving team SA? How do operators communicate to identify when SA is lost or being threatened? Are there communication warning signs of threatened SA? Finally, the model can examine how human error emerges, and is routinely identified and responded to, within ongoing communication. An error can be examined within the rich and immediate circumstances of its occurrence. Analysing error as occurring within communication in context can allow us to ask not only 'What kind of error is that?', but 'How, in the circumstances evolving at the time, did the operators come to make that error?' (see Dekker, 2001a, 2001b, 2002). In his major book *Human Error*, Reason (1990:xii) noted that 'cognitive

psychology has little to say about how individual tendencies interact with complex groupings of people working in high-risk systems. And it is these collective failures that represent the major residual hazard.' In routine communicative interaction, what counts as an error, and how are errors labelled and treated? How do operators communicate to identify, manage, and recover from error? What features of communication might be conducive for error to occur, or make error less likely?

The conversation analysis model can allow analysts to examine the communicative composition and trajectory of, for example, a crew's state of awareness, or a decision, or an instruction, or a plan, or an error. Conversation analysis can be to communicate what the microscope is to the biologist, or the telescope is to the astronomer, or the ultrasound is to a radiographer or medical researcher. The common aim is to see closer and more clearly what is actually there, so to make interpretive decisions that are better evidenced. Some psychology and human factors based studies of cognition in aviation have begun to appreciate the value of examining aspects of interaction in greater detail, and may even include basic transcriptions of pilots' verbal and other non-verbal conduct (see e.g. Hutchins and Klausen, 1996; Hutchins and Palen, 1997; Hazlehurst, 2003). These studies advance previous work by considering cognition as situated, embodied, observable, and socially shared understandings, evolving over time, and not as limited to an individual's mental capacities. However, in analysing details of actual human communication, these cognition-oriented studies do not make use of a purpose-built tool for this task. In short, they are looking in the right spot but could use a different lens to see more precisely the detail of what is there. The model offered here is such a possible lens.

A select bibliography of texts in conversation analysis

The following bibliography acts as a resource for using the model. It lists selected key texts for understanding and conversation analysis. Items were chosen for their potential utility, as well as likely availability and accessibility. The bibliography favours books and edited collections, especially those concerned with 'doing' conversation analysis, or that deal with specific areas. For example, topics include conversation and cognition, interaction with technology, negotiation, identity in interaction, interaction and grammar, prosodic features of interaction, interaction in institutional or work settings, analysing video data, or the origins of conversation analysis and the related sociological discipline of ethnomethodology. Most items have informed the model here, either directly or indirectly. Items marked with an asterisk (*) are introductory in nature or are particularly accessible or relevant for analysing aviation data.

- *Antaki, C. and Widdicombe, S. (1998). *Identities in talk*. London: Sage.
- Arminen, I. (2005) *Institutional interaction: Studies of talk at work*. Aldershot: Ashgate.
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