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ATSB RESEARCH AND ANALYSIS REPORT

B2005/0118

Final

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A conversation analysis tool for examining recorded voice data in investigations of aviation occurrences

Dr Maurice Nevile, PhD

Research Fellow

University of Canberra

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CONTENTS

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Communication in context: A conversation analysis tool for examining recorded voice data in investigations of aviation occurrences

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As I developed this analytic tool I drew on two sources. First, I drew on my understanding of the research literature in conversation analysis, which I represent with a list of key books provided at the end of the tool. Particularly significant for the content and organisation of the tool were Hutchby & Wooffitt (1998), ten Have (1999), Seedhouse (2004), and Wooffitt (2005). Second, some features of the tool are informed by my participation in a number of short courses dealing in whole or part with conversation analysis. I have benefited in particular from the teaching of Paul Drew, John Heritage, Gail Jefferson, Gene Lerner, Emanuel Schegloff, and Marja-Leena Sorjonen.

I am grateful to Dr Michael Walker, Senior Transport Safety Investigator at the Australian Transport Safety Bureau, for acting as Project Officer for this work. I acknowledge the substantial efforts of other ATSB staff, and especially Patrick Hornby, Joy Sutton, and Neil Campbell, who helped in many practical ways to make the project possible.

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ABBREVIATIONS

ATC	Air traffic control
ATSB	Australian Transport Safety Bureau
BASI	Bureau of Air Safety Investigation
C	Captain
CA	Conversational analysis
CRM	Crew resource management
CVR	Cockpit voice recorder
FO	First Officer
PNF	Pilot-not-flying
TRP	Transition relevance places

1 INTRODUCTION

This report presents a tool for representing and analysing recorded voice data in investigations of aviation occurrences, or other transport occurrences. The report is one part of a research consultancy project conducted by the author for the Australian Transport Safety Bureau (ATSB). The two project outcomes are the result of around one month's full-time activity, conducted over March to June 2006.

The overall aim of the project is to explore the potential value of an established sociological academic research methodology, called *conversation analysis* (often CA), for representing and analysing recorded voice data for investigations of aviation or other transport occurrences. The project can expand the level of understanding that investigators can obtain from a voice recording as part of an investigation. Conversation analysis may be especially valuable for investigating transport occurrences because it focuses on examining the details of *communication in context*, as it actually occurs in real time.

The project has two parts. The first part is a series of sample transcriptions and analyses of recorded voice data from five occurrences previously investigated by the ATSB or BASI[1]. The second part is this report, and is a tool for using conversation analysis to inform and guide analysis of recorded voice data in investigations.

1.1 The conversation analysis tool

The tool presented in this report takes the form of an analytic framework developed from insights and methods of *conversation analysis*. Conversation analysis has developed over four decades as a micro-analytical approach to the study of naturally occurring interaction. The author actively researches and publishes within this field, and has written and published extensively on aviation data.

Development of the conversation analysis tool is informed by the sample transcriptions and analyses for five occurrences completed for the first component of the project. The official Investigation Report for each of those occurrences identified communication issues as possibly contributing adversely to the occurrence, or as otherwise significant for examining other factors considered in the investigation. The Investigation Report for each occurrence cited communication problems as possibly affecting or being evidence of a person's understanding of a situation and their subsequent actions or omissions. The sample transcriptions and analyses for these occurrences are given in the first report form this project. That report is strictly confidential and is not for publication. Its distribution and is strictly limited to approved staff within the ATSB.

The tool is a resource for investigators of aviation occurrences, to assist the investigation of communication problems in accidents and incidents in aviation and possibly other modes of transport. The tool offers just one possible means for understanding communications and human factors as relevant circumstances in occurrences. The tool can not, and is not intended to be, a comprehensive and

1 The Australian Bureau of Air Safety Investigation (BASI) became part of the newly formed multi-modal Australian Transport Safety Bureau (ATSB) on 1 July 1999.

definitive overview of all aspects of conversation analysis. Rather, the tool can be used as a guide for using some important aspects of conversation analysis for recorded voice data in investigations. Conversation analysis is a developed scholarly discipline, and increased familiarity with conversation analysis will enable better use of this tool.

The principal value of the conversation analysis tool is that it can give investigators a sense of how to represent recorded voice data in greater and more revealing ways. Investigators can represent voice data more authentically. That is, investigators can show and see much more of the actual rich details available in the voice data. Investigators can therefore have available to them more of the details that were actually available to the operators themselves as they constructed their own talk, and interpreted and understood others' talk, in context, moment-to-moment. Investigators can as a result be better placed to know what might be there in the data to inform their analyses of what happened and why. Conversation analysis is to spoken discourse what the microscope is to the biologist, or the telescope is to the astronomer, or ultrasound is to a medical researcher. The aim is always to see better what is really there, so understanding can be better informed, and interpretive decisions can be better evidenced.

This analytical tool cannot be a comprehensive introduction to conversation analysis and how it might be used for conducting investigations of occurrences, but rather it is intended to be starting point to allow researchers to consider its possible value and utility. There are recently published introductory texts on conversation analysis to which investigators can refer (eg Hutchby & Wooffitt 1998, ten Have 1999, Wooffitt 2005).

1.2 Conversation analysis (CA)

Recorded voice data for occurrence investigations represent real-time naturally occurring interaction, therefore such data can be the focus for conversation analysis study. Such data can be subject to the range of analytic principles, methods, assumptions and interests arising from research findings in conversation analysis over four decades. Conversation analysis has shown that interaction is highly ordered, and this order is discoverable. Participants themselves create order in interaction, there and then, in order to accomplish intelligible, accountable, and consequential action. That is, operators in the aviation or any other work or institutional setting, just as in ordinary casual conversation, have to develop understandings of what they are doing and what is going on.

Particularly fundamental to conversation analysis is an emphasis on the sequential analysis of interaction, of how turns at talk follow and build on one another. Conversation analysis pays very close attention to how participants in interaction display in both the content and details of production *of their current talk* their understanding and treatment of another's previous talk. This is absolutely critical: the evidence of *participants' own understanding* is available right there in the data. The task of the analyst is to show how the participants themselves, demonstrably (in the data), understood and acted on some talk, as evidenced in their own next actions, and so produced collaborative interaction moment-to-moment in real time.

So, the basic guiding question for anyone doing conversation analysis, analysing the details of naturally occurring interaction (recorded voice data), becomes *why that now?* A conversation analyst wonders always how this piece of talk, or this detail of the talk, reveals something about how that participant, there and then,

understood what was happening, and made some new contribution by performing some new action. Conversation analysis is interested in the in situ creation, order and intelligibility of social life, including work and professional life in a wide range of settings, including aviation. Conversation analysis is interested in the details of the reality of social conduct, as it is produced and interpreted by real people in real situations, right there and then.

A critical difference between conversation analysis and other forms of discourse analysis, especially those used in the aviation communication research literature, is that conversation analysis attends closely to how precisely talk develops in context in real time, not just to the content of what people say. It attends to how the participants themselves, in the details by which they build and coordinate their contributions to interaction, demonstrate their understandings of what was meant and what is going on. Unlike other forms of discourse analysis, conversation analysis is data driven and does not start with pre-determined and analyst driven categories. Conversation analysis does not assume that it is possible to categorise and code utterances, and then for analysis isolate utterances from the rich details of the contexts in which they actually occurred. Conversation analysis does not guess at what people are thinking, or at the motivations of their actions, but looks for evidence in the transcription data themselves. A fundamental notion in conversation analysis is that people exhibit in their own talk and conduct their understanding and treatment of other's talk and conduct. A central principle of conversation analysis is that participants display their understanding and treatment of prior talk in their own next talk. This is why conversation analysis focuses on sequential development of interaction, in seeing what happens and what happens next. This is why conversation analysis emphasises examining communication in context.

1.3 Five aviation occurrences

Development of this tool was informed by transcriptions and analyses of five aviation occurrences. These are available in the other report for this consultancy project. The five occurrences were selected in consultation with the ATSB Project Officer for this work, Dr Michael Walker (Senior Transport Safety Investigator).

There were three principal criteria for selecting the occurrences:

1. Communication problems, or aspects of communication, could be identified as possibly contributing adversely to the occurrence, or as providing evidence of a person's understanding of a situation and the grounds for their subsequent actions or omissions. Communication issues may have been cited and discussed in the official Investigation Report for the occurrence.

2. The quality of the sound recording was suitable for further and independent transcription and analysis.

3. Further transcription and analysis of recorded voice data, using methods of conversation analysis, had the potential to reveal new understandings of the role and significance of aspects of communication for the occurrence, and could inform development of a conversation analysis tool for representing and analysing recorded voice data.

In selecting the five occurrences, the present author and Dr Walker also sought to ensure a mixture with respect to the nature of the occurrence, including the type of event, the aircraft type, the form of data (CVR and ATC recording[2]), and how aspects of communication featured.

The following occurrences were examined for this project:

1. VH-OJH, Boeing 747-438, Bangkok, Thailand, 1999

   (ATSB Investigation Report 199904538)

2. VH- INH, Boeing 747-312, Sydney (Kingsford Smith) Airport, NSW, 1994

   (BASI Investigation Report 9403038)

3. VH-AJS, Israel Aircraft Industries Westwind 1124, Alice Springs, NT, 1995

   (BASI Investigation Report 9501246)

4. VH-NEJ, Fairchild Aircraft Model SA227-AC, Tamworth, NSW, 1995

   (BASI Investigation Report 9503057)

5. VH-GEN, Cessna 182J, near Esk, QLD, 1999

   (ATSB Investigation Report 199904842)

1.4 Summary of the CA analytic tool

The analytic tool consists of the following:

- Background: representing and analysing recorded voice data for investigations
- Origins and principal features of conversation analysis
- Protocols for using conversation analysis for investigations
- Resources: key texts in conversation analysis

2 CVR: cockpit voice recorder recording from the so-called 'black box' carried on an aircraft. ATC: air traffic control recording made by the air traffic control authority of broadcasts between an aircraft and air traffic controller.

2 REPRESENTING AND ANALYSING RECORDED VOICE DATA[3]

2.1 Background

It is now well recognised that human factors contribute to most aircraft accidents (Wiegmann & Shappell, 2003). For many of these accidents that involved larger aircraft and crews with two or more pilots, a contributing factor was problems in communication or task coordination between the pilots (Pope 1995; Salas et al, 2001). Alternatively, the human element can also be important for making the most of dire situations and so be a valuable defence in the aviation system (eg BASI 1993, 1994; Job 1996:186-202, MacPherson 1998:152-176). It is also recognised that communication is especially critical, because it is typically through communication that other human factors are actually realised or made possible across members of a crew, such as information gathering and sharing, planning, leadership, decision-making, and identification and management of errors and problems. Consequently, there has been a considerable amount of research examining the nature of crew communication and coordination (Helmreich, Merritt & Wilhelm, 1999; Wiener, Kanki & Helmreich 1993). There has also been considerable amount of effort expended in training airline pilots in crew resource management techniques (see Wiener, Kanki, Helmreich 1993; McAllister 1997; Salas et al., 2001), and a considerable amount of effort expended in developing and applying techniques to evaluate crew performance in these areas, using behavioural markers and techniques such as the Line Operations Safety Audit (Flin et al., 2003; Helmreich, Klinect & Wilhelm, 1999).

Recorded voice data, such as from CVRs or air traffic control tapes, can be an important source of evidence for accident investigation, as well as for human factors research. Such data can offer vital evidence for determining how operators acted, and why, that is, what operators did and understood of what was going on around them at the time. Such evidence is important for revealing both immediate and individual contributions, as well as system features and possible deficiencies contributing to an accident. That is, knowledge of human factors can be a window to aspects of the functioning of the system as a whole.

Often when investigating the sequence of events which led to an accident, much hinges on investigators' interpretation of what someone said or understood at the time, or what was meant by what was said, or how someone's talk was interpreted, or how the mood in the cockpit or between operators (pilots and/or controllers) could best be described. Or investigators seek to interpret data for evidence of fatigue, stress, workload, anxiety, doubt and hesitancy, situation awareness, error, and so on. To date, investigators have had few tools to confidently and systematically make such interpretations, drawing on evidence of *processes of interaction* between operators, as available in recorded voice data. Indeed Dekker (2001a:39) claims that there has been a "disembodiment of data in the analysis of human factors accidents", and that investigators "are left to draw inferences and produce ad-hoc assertions that bear some relationship with an ill-defined psychological or sociological phenomenon" (Dekker 2001a:48). For example, of

3 Wording of this section is taken and adapted from Nevile & Walker (2005a, 2005b, 2005c).

human error Dekker (2001a:39) argues for a need for investigators to "reconstruct the unfolding mindset of the people they are investigating, in parallel and tight connection with how the world was evolving around these people at the time", in short, to return human factors data to their context, and to understand human error in the context in which it occurs (Dekker 2001b, 2002).

The analytic tool presented here draws on an academic research methodology, *conversation analysis*, for understanding communication as language in interaction, and so to help make visible how the operators' world was evolving at the time. Conversation analysis can offer an additional source of evidence for investigators to interpret how operators themselves, in real time, moment-to-moment and in context, developed and demonstrated to each other their understandings and interpretations of what they were doing, what was said and what was meant, and what was going on.

During accident investigations, the extent of analysis of these recordings depends on the nature and severity of the accident. However, most of the analysis has been based on subjective interpretation rather than the use of systematic methods, particularly when dealing with the analysis of crew interactions. When transcriptions are conducted, they typically list only the speaker, the time at which the utterance started, and the words spoken. Detailed information about how the words are spoken is usually excluded. This is probably because investigators have limited tools to analyse this data in a structured manner. However, it may also be due in part to sensitivities associated with releasing CVR information.

Two main types of techniques have been used for structured analysis of recorded voice communications. The first type, commonly termed 'speech analysis' (or 'voice analysis') looks at a pattern of voice information and related behaviour to identify possible factors affecting an individual's performance. This will generally involve measurement of variables such as fundamental frequency (pitch), speech rate (number of syllables per second), intensity (or loudness), speech errors, response time, and aspects of the speech quality. The data is then compared with carefully selected samples, generally from the same person under normal conditions. Speech analysis has been successfully employed to examine the influence of factors such as stress and workload (Brenner, Doherty & Shipp, 1994; Ruiz, Legros & Guell, 1990), alcohol (Brenner & Cash, 1991) and hypoxia (Australian Transport Safety Bureau, 2001). However, it focuses on the factors affecting a specific individual, rather than the pattern of communications between individuals.

The second type of technique has involved the coding of speech acts (Helmreich, 1994; Predmore, 1991; Transportation Safety Board of Canada, 2003). This process typically involves coding each utterance in terms of its function or 'thought unit' (eg command, advocacy, observation, inquiry). It also involves coding 'action decision sequences' of utterances in terms of their task focus (eg flight control, damage assessment, problem solving, and emergency preparation). The coded data are then examined for how they are distributed between the crew, and how they change over time during the flight. Where possible, comparisons are made with available data from other crews.

Although speech act coding can offer useful insights into communication dynamics, its effectiveness can be limited by a lack of available data on how other crews from similar backgrounds communicated in similar situations. Also, it does not use all the available information about how things are said or communicated, and this

information can be important for understanding communications as they are produced in their actual context of occurrence. Accident investigative bodies have in the past relied on transcriptions from voice recordings which included fewer details than are actually available in the data, and therefore analyses may miss potentially vital information and evidence. When transcriptions are conducted, they typically list only the speaker, the time at which the utterance started, and the words spoken. Detailed information about how the words are spoken, and showing how different operators' contributions occur relative to one another, is usually excluded. For example, transcriptions may not precisely represent how turns at talk are timed and coordinated relative to one another, or may not indicate the exact durations of periods of silence within and between turns, or do not show just when and how the talk of two or more operators overlaps, or do not show how talk relates to cockpit and aircraft noises, or may include no or minimal details of prosodic features of talk (eg loudness, pitch, speed) or of voice quality (eg breathiness, creaky voice). An academic research methodology that includes and shows the potential value of this additional information is *conversation analysis*. This report presents a tool, developed from principles and methods of conversation analysis, for representing and informing analysis of recorded voice data for investigations of aviation occurrences, and potentially for other transport occurrences.

2.2 Aims and value of the analytic tool

- To develop protocols for using conversation analysis to develop the ATSB's ability to conduct analyses of recorded voice data to investigate occurrences, and maximise the value of recorded voice data for investigations.
- To develop the ATSB's ability to analyse and understand human performance in context as a contributing factor in aviation occurrences.
- To develop the ATSB's ability to use findings from analyses of recorded voice data to develop recommendations for policies, procedures, informal practices, training (eg crew resource management or CRM), and for other areas which can impact on safe operations in aviation. For example, the tool can develop the ATSB's ability to describe and interpret the significance of communications for situation awareness and human error, especially as these emerge from processes of interaction between operators.
- To increase the ATSB's understanding of the applicability of conversation analysis as a valuable methodology for representing and analysing recorded voice data.
- To apply a innovative approach to analysis of recorded voice data, known to be an important source of evidence for interpreting human factors in the emerging sequence of events leading to aviation accidents.
- To identify and outline the features of conversation analysis most relevant for accident investigation, specifically for aviation but also for other transport and sociotechnical settings where human interaction and performance are critical for safe operations.
- To contribute to safe and effective aviation practice and a safe aviation system by developing the ATSB's investigative resources.

2.3 Developing the analytic tool

The author is a university-based academic researcher with a background in applied linguistics, and interactional sociology (ethnomethodology and conversation analysis). The author is not a psychologist or engineer, and is not experienced in investigating transport occurrences. Rather, the author has a background that complements existing expertise typically drawn on for investigations. The following influences informed the analytical tool's development.

1. The author's analyses of recorded voice data for five aviation occurrences, using insights and methods of conversation analysis, forming the other output of this consultancy research project for the ATSB. Access to these analyses is restricted to staff approved within the ATSB.

2. The author's previous experience in transcribing and analysing recorded voice data for two aviation occurrences, in previous consultancies for the ATSB, using conversation analysis. The author's analysis for one accident was published by the ATSB as Aviation Research Report B2005/0108 (Nevile & Walker 2005a). Slightly modified versions of that report have been published in the research journal *Human Factors and Aerospace Safety* (Nevile & Walker 2005b), and in *Flight Safety Digest* (Nevile & Walker 2005c)

3. The author's own conversation analysis research on communication in naturally occurring interaction in commercial aviation, using video recordings of airline pilots in the cockpit on actual scheduled flights. Publications from this research include a book that launched the new series Directions in Ethnomethodology and Conversation Analysis (Nevile 2004a), chapters in edited books on interaction and discourse analysis (Nevile 2001, 2005b, in press b), and papers published in key international and national journals for discourse and interaction research, such as *Discourse Studies* (Nevile 2006), *Language in Society* (in press a), *Research on Language and Social Interaction* (Nevile 2004b), *Text and Talk* (Nevile in press c), and the *Australian Review of Applied Linguistics* (Nevile 2002, 2005a). The author's PhD was in ethnomethodology and conversation analysis.

4. The author's active participation in the conversation analysis research community, including presentations at four Australian conferences in conversation analysis, at the first two international conferences on conversation analysis (Copenhagen 2002, Helsinki 2006), participation in short courses with leading researchers in conversation analysis (Denmark 2000, 2002, 2003, 2004, 2006, Finland 2000, and USA 2006), and co-editing a special issue of the *Australian Review of Applied Linguistics* on Australian studies in conversation analysis and ethnomethodology (forthcoming 2007).

5. The author's familiarity with wider conversation analysis research literature, and particular reference to key texts in conversation analysis.

3 ORIGINS AND MAIN FEATURES OF CONVERSATION ANALYSIS

This analytical tool is based on principles and methods of an academic methodology called conversation analysis. Here it is possible to give only a general summary of this research methodology. General introductions to conversation analysis are provided by Psathas (1995), Hutchby & Wooffitt (1998) and ten Have (1999), and Wooffitt (2005). Conversation analysis is a micro-analytical approach to the study of recordings (audio or video) of naturally occurring interaction. As a scholarly discipline, its origins are in sociology and are usually traced to a paper on the organisation of turn-taking in conversation, written in the mid 1970s by Sacks, Schegloff & Jefferson (1974). The early development of conversation analysis is especially associated with the ideas of Harvey Sacks (Sacks, 1992; see Silverman, 1998), and two colleagues working with him in California (Emanuel Schegloff and Gail Jefferson).

Conversation analysis is related to another field within sociology called ethnomethodology, founded by Harold Garfinkel (for recent introductions see Francis & Hester 2004, or ten Have 2004). Conversation analysis shows in micro-detail how naturally occurring interaction is sequentially ordered and collaboratively produced and understood by participants, moment-to-moment. It examines the "intrinsic orderliness of interactional phenomena" (Psathas 1995:8). Conversation analysis looks at the means and order by which people accomplish interaction, jointly and locally (i.e., there and then). It explores practical reasoning and understanding, and social actions, as situated and developed in processes of interaction.

The author's research with aviation communication data is part of growing attention in conversation analysis to interaction in workplace and institutional settings, for example in education (eg classroom, teacher-parent interviews), law and policing (eg courtrooms, calls to emergency services, interrogations), business (eg interaction within and between firms, retail transactions), medical and counselling settings (eg doctor-patient, operating theatres), human-computer interaction, architecture (collaborative design), the media (news interviews, newsrooms), and sociotechnical settings (eg research settings, or control centres such as air traffic control or the London Underground) (see especially Drew & Heritage 1992; Button 1993; Heath & Luff 2000; McHoul & Rapley 2001; Richards & Seedhouse 2004; Arminen 2005).

Conversation analysis is used worldwide. Key locations include the USA, the UK, Scandinavia and Finland, Germany, Holland, France, Japan. In Australia, there are active conversation analysis researchers in conversation analysis in most major cities (especially Canberra, Sydney, Brisbane, Melbourne, and Perth). Conversation analysis is networked and promoted through the Australian Institute for Ethnomethodology and Conversation Analysis, the Murdoch University Symposium on Talk-in-Interaction (1999, 2001, 2003), and national Symposia on Conversation Analysis held approximately every two years.

The following are key principles and strengths of conversation analysis (CA), and have made its findings particularly resilient over time:

- CA uses naturally occurring data;
- CA uses highly detailed transcriptions of talk and nontalk activities;

- CA is data driven and reliant;
- CA does not rely on abstract theories, constructs or categories, preconceived by the analyst;
- CA emphasises analysis of the sequential organization and accomplished orderliness of interaction;
- CA analyses language and interaction in context; and
- CA is primarily a qualitative approach.

I will consider each of these in turn.

- *CA uses naturally occurring data*. CA does not use experimental data, but uses audio and video recordings of people interacting in authentic settings, not interacting for the benefit of the analyst. Analysts may make refer to observations, interviews, written materials, or other ethnographic techniques, but the core of conversation analysis is on how the participants in interaction develop and demonstrate their actions and understandings in real time, to create the intelligibility and order of social life.
- *CA uses highly detailed transcriptions of talk and nontalk activities*. CA transcriptions indicate much more than participants' words. They include also numerous details to represent features of the manner of talk and the sequential organisation of utterances and other contributions to interaction. These features have all been found to be treated as significant by participants themselves, that is, for how they create and interpret their turns at talk, and establish and understand what is going on. The features are not treated, in advance of analysis, as merely random, irrelevant, messy, and unworthy of analytic attention.
- *CA is data driven and reliant*. CA bases its claims on transcriptions that show in detail what the participants themselves say and do, and exactly how and when they do so, as *evidence for how the participants themselves create, interpret and understand what is going on*. CA examines what and how participants themselves, not the analyst, understand and treat what is being said and the social actions are being undertaken. Analysts avoid pre-theorising and forming preconceptions of participant's conduct and its influences. For example, any claims about participants' understandings or interpretations, or appeals to psychological states (thinking, emotions, motivations etc.), *must be evidenced* in the transcription data, in the details of participants' conduct.
- *CA does not rely on abstract theories, or constructs or categories, preconceived by the analyst.* Instead, CA relies on categories and terminology that arise from and can be seen in the data, and are demonstrably significant for the participants themselves. For example, in CA constructs and categories such as status, or role, or power, or gender, or culture, are not treated by analysts as given and taken for granted as determining participants' conduct. Rather, CA sees how they are evidenced in the data, treated as real and significant by the participants themselves, in this moment in this interaction. Status and other categories (eg Captain) are analysed for how they are treated by the participants themselves as real and able to be taken-for-granted, or as influencing current communication and conduct.
- *CA emphasises analysis of the sequential organization and accomplished orderliness of interaction*. This is a key principle distinguishing CA from approaches to discourse analysis. A critical and guiding insight of CA is that

how some utterance is designed by its speaker, and what its recipient understands it to mean and to be doing (as an action), depends greatly on where and how it appears within a series of utterances within a developing interaction as jointly produced by the participants themselves. For participants and analysts alike, interpreting the content of talk is not separate from understanding how and where it occurs in sequence in interaction. In CA therefore a critical analytical principle is examining what happens next.

- *CA analyses language and interaction in context.* Utterances are analysed as they emerge in real-time, as relative to immediately prior talk and as creating the context for immediately subsequent talk. CA typically does not isolate utterances and examples of conduct from one another and the circumstances that gave rise to them, for example for quantitative analysis. Analysts may track a feature of interaction across many transcription segments, or may examine one or more features as occurring in an extended segment of interaction (eg in aviation perhaps a decision or an error). CA can be used for data as small as a single exchange of turns.
- *CA is primarily a qualitative approach*, but allows for generalisations to be made from close and richly detailed analyses of specific instances. CA is particularly valuable because it can be applied even to very small segments of data (such as a simple exchange of communications). This makes the approach ideal for accident analysis when findings and recommendations must be made from limited available voice data. Validity of findings in CA analyses is grounded in CA's focus on naturally occurring interaction, on moments of social and professional life as created and interpreted then and there by the participants themselves.

Conversation analysis (CA) has developed as a powerful method for representing and understanding language for communication as it occurs as talk in context. It is potentially useful for examining recorded voice data for investigating aviation and other transport occurrences because communication is central to human performance in transport systems, either where operators work as a team (eg on a flight deck, or in a control centre) or when individuals relate to others (eg a pilot talking to an air traffic controller). A fundamental assumption of this analytic tool is that if communication is central to human performance then there is value in representing and understanding it with regard to its rich detail, as it really occurs in context and in real time. Language in communicative interaction is potentially one useful window to operators' understandings as demonstrated through their own talk and actions.

As a point of clarification, some psychology-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' talk and other non-talk conduct (see eg Hutchins & Klausen 1996; Hutchins & Palen 1997). Such research has also appeared in the leading journals in aviation psychology (eg Hazlehurst 2003). These studies represent an advance on previous work because they consider cognition as situated, embodied, and socially shared understandings, evolving over time, not as limited to an individual's mental capacities. However, in analysing details of actual human communication, these cognition-oriented studies can be limited because they do not make use of a purpose-built tool for this task. In short, they are looking in the right spot but do not have the lens to see the precise detail of what is there.

4 PROTOCOLS FOR USING CONVERSATION ANALYSIS FOR INVESTIGATIONS

The following protocols set out ways for using insights and methods of conversation analysis to examine voice data. The protocols can act as a starting point for transcribing voice data, and then for analysing voice data.

It is important to note that it is not necessary to attend to everything for every analysis of voice data, but the protocols aim to help investigators to identify what is in the data that might be significant for understanding human communication and action as a contributing factor to an occurrence.

The protocols emphasise the need to examining communication in terms of both how it is produced *and* how it is acted upon by its recipient. That is, the protocols emphasise that evidence for how some communication was understood, what it was taken to mean or be doing, is available in the voice data in what happens next.

Summary of protocols

1. Transcribe the recorded data
2. Examine the recorded data

    Turn-taking

    Turn-design

    Sequence organisation

    Actions

    Roles

4.1 Transcribe the recorded data

4.1.1 Background

The starting point for all conversation analysis (CA) is detailed transcription of recorded data. CA transcriptions included much more than the actual spoken words alone. CA studies over four decades have found that numerous details of precisely how talk is produced, how people communicate to develop interaction together in real time, reveal a great deal about how the participants themselves create, interpret and understand what is going on. Participants in interaction use these details to build their own communication in particular ways, for particular ends, and to interpret and understand one another's conduct. These details of communication have been found to be not random messy details, but to be essential information for examining how real communication emerges in context in real time.

Three points ground the discussion here:

1. transcription is itself a process of discovery;
2. transcriptions form the data for the analysis of voice recording, and the evidence on which claims are based; and

3. transcriptions aim to represent in textual form the richness of details available to, and used by, the communicating participants themselves.

In conversation analysis, transcriptions were traditionally made from tapes, but analysts now increasingly use digital sound files. Digitised recordings can make some transcription tasks easier, such as repeated replaying of small segments of data, or identifying the location of silences and precisely timing them.

I will present transcription as a process consisting of a series of steps, where each possible succeeding step can add further detail. Increased levels of detail represent greater levels of detail available in the recorded data, and so can make possible a greater range of analytic observations. That is, increasing levels of transcription detail can allow the analyst to see more of what is there in the voice data, of how the communicating participants themselves produced and understood what was going on. Increased levels of detail try to capture more of what was actually available to and used by the participants themselves as they interpret one another's talk.

Progressing through steps in transcription involves *repeated listening* to the recorded data. Each listening prioritises (but is not limited to) the current step. It is almost always the case that repeated listening will allow the analyst to hear and add some new detail. Transcription in conversation analysis is therefore very labour intensive and time consuming. However, the payoff of CA transcriptions is that they can provide an immensely rich and more authentic representation of communication as it actually occurs in context, as occurring within a developing interaction that participants accomplish jointly in real time.

For investigations it can be possible to vary the level of transcription detail for different parts of the recorded data. For example, higher levels of detail might be reserved only for those parts of a recording identified as of particular interest for an investigation. For example, investigators might be able to identify critical moments when operators did or did not seek or share information, or when a command or decision was or was not made, or when an alert required a response, or when an error or technical problem occurred. It is likely that investigators will see value in targeting their efforts in CA transcription. This approach might well be suitable, or even necessary, but there is always an inherent risk that possibly revealing details in the recording could be missed. It is not always possible to know for certain in advance, from just listening to the recording or from basic transcription, or indeed from other information emerging in the investigation, that non-targeted parts of the recording have nothing of interest to offer. Transcribing at lower levels of detail than is possible can diminish the value of the transcription for what it can reveal.

4.1.2 What can be included in conversation analysis transcriptions?

Typically, conversation analysis transcriptions of audio data can include at least the following:

- how interaction is sequentially ordered as turns, and how and when participants exchange roles as speaker and listener (recipient);
- periods of silence, timed in seconds and tenths of seconds, both within and between turns;
- periods when more than one person talks at once (overlapping talk);

- tokens or markers such as ‘mm’, ‘hm’, ‘oh’, ‘um’, ‘ah’, etc.;
- speed and volume of talk;
- lengthening (stretching) and shortening (abbreviating) talk, or cut-off words and sounds;
- other prosodic features (including variations in pitch);
- aspects of voice quality (eg breathiness, creaky voice, smiley voice);
- audible in-breaths and out-breaths;
- laughter: precisely when laughter occurs, when it begins and ends, relative to other talk, represented as individual pulses (huh, heh, he, ha etc.);
- if video data are available, non-verbal activities such as gestures (pointing), shifts in gaze, bodily posture and movement, and handling of objects (for analysis of aviation video data see Nevile 2002, 2004a, 2004b, under review). Timing of these details can be indicated precisely, relative to the transcription of details of verbal communication.

4.1.3 Transcription notation

Conversation analysis (CA) has developed particular notation for representing systematically many details of talk (or nontalk activities) that studies have shown to be significant to participants themselves, for how participants create and interpret what is going on. One advantage of transcribing recorded data by using notation developed in conversation analysis is that the transcriptions can show much more about what is actually happening, and why. In short, conversation analysis shows how, and with what added value, transcribing recorded voice data can involve much more than merely noting what (the words) people say.

The transcription notation presented here is adapted from a system originally developed by Gail Jefferson, and is consistent with notation commonly used in CA research. Recent variations and explanations of CA transcription can be found in Hutchby & Wooffitt (1998), or ten Have (1999). The author has used this notation in previously published studies of aviation data.

(0.3), (1.4)	periods of silence, within or between turns, in seconds and tenths of seconds
(.)	a micro pause, less than two-tenths of a second, within a speaker’s turn
bravo one	italics represents talk beyond the cockpit eg spoken over the radio
>five<	talk which is noticeably faster than surrounding talk
<five>	talk which is noticeably slower than surrounding talk
five	talk which is emphasised, louder than surrounding talk
FIVE	talk which is significantly louder than surrounding talk
°five°	talk which is noticeably quieter than surrounding talk

fi::::ve	stretching or lengthening of a sound, the more colons the longer the sound
fi-	a word or sound that is cutoff, begun but not completed
gonna	words are run together (gonna for ‘going to’)
t’, ‘n’	words are said in abbreviated form eg t’ for ‘to’, ‘n’ for ‘and’.
=	talk which is latched to other talk i.e. follows immediately with no gap
[alpha]	talk produced in overlap (simultaneously) with other talk (or noise) ‘[’ indicates beginning of overlap, ‘]’ indicates end of overlap
five,	flat or slightly rising pitch, talk which can be heard as incomplete
five?	terminal rising pitch
five¿	less marked terminal rising pitch
five.	terminal falling pitch
fi::ve	rising pitch within word
fi::ve	falling pitch within word
you:.	rise fall pitch
you:.	fall rise pitch
□five	marked rise in pitch
↓five	marked fall in pitch
( )	talk which could not be transcribed
(five)	doubt about the talk transcribed
(your/yeah)	doubt about the talk transcribed, with possible alternatives indicated
.hh	inbreath
hh-	outbreath
ha/huh/heh	pulses of laughter
fi(h)ve	breathiness or laughter within a word
five	creaky voice
$five$	smile voice

4.1.4 A sample transcription

The following is a sample transcription, showing some of the notation listed above. The transcription is taken from Nevile (2004a:191-192). The transcription includes details of an overheard radio call, and how it occurs relative to the in-cockpit talk of the two pilots. Call signs are fictitious.

1		(2.6)
2	ATC:	>bravo juliet tango< ah (.) two miles east centreline and closing,
3		reduce to final approach speed er (1.4) cleared a visual approach
4		caution: wake turbulence, (.) contact tower on final.
5		(1.5)
6	C/PNF:	reduce to (.) final approach, tower on final, (.) bravo juliet tango.
7		(0.9)
8	ATC:	>juliet juliet< mike (.) cli:mb to [: flight level two hundred]
9	C/PNF:	[o::kay::] speeds,
10	FO/PF:	ok[ay I might (0.3) decrease: ah: (0.7) to:: one hundred and eight,
11	JJM:	[two hundred juliet juliet mike
12		(0.3)
13	FO/PF:	for the approach,
14		(1.8)
15	FO/PF:	cause of the:: ah [: tur-turbulence] and the ah:: (0.2) crosswind
16	C/PNF:	[yeah º (yeah) ( ) º.]
17	FO/PF:	there.
18		(0.9)
19	C/PNF:	(ºalrightº) (º º)
20		(1.0)
21	C/PNF:	spee::d,
22		(0.6)
23	FO/PF:	check,
24		(5.6)
25	C/PNF:	belt sign's on,
26	FO/PF?:	(ºcheckedº) ( )
27		(8.9)
28	FO/PF:	speed's checked.
29		(5.2)
30	C/PNF:	oh: he said final approach speed Mal (ºsoº).
31	FO/PF:	yeah
32		(0.2)

33 FO/PF: come back ºto finalº.

34 (1.8)

35 FO/PF: are we cleared to,

36 ( ): ºyeahº

37 ATC: mike alpha quebec's leaving controlled airspace radar and control

38 service is terminated.

39 (2.1)

40 MAQ: mike alpha quebec.

41 (5.9)

42 C/PNF: ( )

43 (2.4)

44 C/PNF: spee::d,

45 (0.4)

46 FO/PF: check.

47 (1.1)

48 FO/PF: we're cleared for a visual approach?=

49 C/PNF: =ye:s [we're] cleared.

50 FO/PF: [okay]

Other transcribed data segments for aviation interaction are available in publications by the author (Nevile) listed in the References at the end of the Report.

4.1.5 Doing transcription for conversation analysis

This section outlines possible steps for doing transcriptions for using CA for recorded voice data. Transcription typically involves repeated listening to the recording.

1. Listen to the recording (or the segment of interest) right through, and prioritise transcription of only the words, and any tokens (mm, um, oh etc.). Note any points of laughter. Note any audible in-breaths and out-breaths.

2. Listen to the recording and add to or correct the transcription as necessary, still prioritising transcription of only the words and any tokens. Begin to allocate particular talk to particular persons.

3. Listen to the recording and finalise allocation of particular talk to particular persons.

4. Listen to the recording and determine the boundaries of speaker turns. A simple way to understand this is to consider the end of turns as the points where a speaker might reasonably be heard to have completed, and where speaker change could occur acceptably and unremarkably, that is, without

being seen as a problem (i.e. seen by the participants themselves). A recipient starting up as next speaker at *that* point would *not* be heard as speaking out of turn and interrupting. An important point to note is that a complete turn can be as short as one word, or as long as many utterances (for example in an approach briefing). The end of a turn can be signalled by moving to the next line of transcript. In aviation often many features of turns, for example their content, size, and allocation to different participants, is pre-determined in formal procedures. This can inform identification of turns in a transcript, but is not sufficient. It is important to see how the participants themselves allow such talk to emerge as scripted turns.

5. Listen to the recording and include details of turn sequencing. Include periods of *overlap*, when two participants talk *simultaneously*. Locate precisely where overlapping talk begins, and possibly also where it ends. Location of overlap refers to the words or parts of words that overlap. It might be many words overlap, or only one word, or not a full word but only part of a word such as a syllable or single sound.

6. Listen to the recording and note the presence of silences, within and between turns.

7. Listen to the recording and time silences precisely. Silences are measured in seconds and tenths of seconds. A micro pause is less than two tenths of a second, and within a turn is represented as (.). Many silences will be between turns, and between exchanges of speaker. Many silences will occur within a speaker's turn, that is, before the speaker has got to a point of possible turn completion where it would be acceptable (interactionally) for the other person to start up as next speaker (in CA called the 'transition relevance place').

8. Listen the recording and note details of manner of talk. For example, note prosodic features such as pitch changes, speed of talk, sound modifications like cut-offs, voice quality like creaky voice, note exact placement of pulses of laughter.

9. Lastly, number individual lines of the transcription.

4.2 Examine the recorded data

Examining data can involve both unmotivated looking (open), and motivated looking (targeted).

Unmotivated looking

Look at the data with no particular focus or intention, just to see what is there:

- identify any phenomena of interest recurring over the whole recording;
- identify key periods of interaction for close analysis

Approaching the data by *unmotivated looking* can be a first go through the transcription of the voice data in its own terms, to see what is there as possibly significant as evidence of the operators' actions and understandings. At this stage the investigator can approach the data with no particular view or theory in mind, but be open to what the data reveal. The investigator is looking for anything in the data

that is possibly revealing of the role of communication for developing the world as it was evolving for the operators moment to moment.

Motivated looking

Looking at the data can be motivated by knowledge of the occurrence from other forms of information gained in the investigation, such as technical and performance data, interviews, site examination etc. It might be possible to narrow examination of voice data to:

- identify any communication phenomena of special interest that recur over the whole recording;
- identify key periods of interaction for close analysis.

4.2.1 Turn-taking

The model of *turn-taking* at the core of conversation analysis accounts for the observation that, overwhelmingly, one party talks at a time (Sacks, Schegloff & 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 overlap. 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 in a heavily scripted environment such as in aviation or other transport systems. Examining aspects of turn-taking is essential for understanding how the participants created and understood what was going on, and how they were communicating with one another. The following can be considered.

Who takes turns, and how do different participants get to be speaker?

How do turns relate to *scripted wordings* for formal standard procedures?

Where are the turns (where/when in the interaction do they occur), and what are their boundaries? How is the talk created by the participants, as turns?

How do turns *begin*? Turn beginnings are important because they show how someone connects their new talk to immediately prior talk (or to silence or some non-talk activity or event). Connecting talk properly can be evidence of understanding (Sacks 1992, V1:717).

How do turns *end*? Turn endings are important because they are the point to which the next speaker must connect their new talk.

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 can occur unproblematically, that is, at that place the current speaker could reasonably be heard to be ending a turn. At this moment speaker change could occur acceptable 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* act while the speaker is talking? Do they offer response tokens? (eg ‘right’, ‘yeah’, ‘mm’, ‘mhm’, ‘uhuh’ etc.).

When does *overlapping* talk occur? Note precisely any points of overlapping talk, where more than one person talks at the same time. Where exactly in the flow of talk does overlap begin and end? Such moments can be revelatory of 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? Who initiates overlap? What do the participants do? What happens to the talk? Do the participants treat the overlap as a problem and do something to resolve it, and why is it a problem?

When/where do *silences* occur relative to the development of the sequence of turns at talk? Silence is not necessarily a problem at all, and it is a routine feature of aviation interaction. However, silence can also be interpreted by participants as significant, and can have an impact on talk. Participants can interpret silence as meaning certain things, and as prompting action of some kind. Does silence occur within one participant’s turn, or between the turns of different participants? Does the silence between sequences of talk, 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 significant or noticeable to the participants? What happened just before the silence, and what happens just after the silence? Is there evidence that something is happening during the silence eg a non-talk activity (eg at instrument panel) or flight/aircraft event. Who is responsible for the silence? If the silence occurs within someone’s turn, it could be understood as the speaker’s responsibility. If silence occurs between turns, between speaker change, it might be the recipient’s responsibility. That is, 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 possibly signals a problem with the first turn, such as it was not heard, or was not understood, or was unexpected, or will be disagreed with or declined. In aviation communication silences are common, but still they can be examined for their possible significance.

4.2.2 Turn design

Conversation analysis research has shown that as people pay close attention to exactly how one another’s turns at talk are *designed*, or built. People do not just attend to the words or content of talk. That is, people 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 has been claimed in some branches of linguistics that such details are merely superficial and messy aspects of communication, and are

irrelevant to understanding language and communication, that such details just got in the way of a focus on the important content of what people say. It has been claimed that such details could be ignored. However, such claims were made by researchers who were not trying to engage with materials of actual language use. Such claims were not based on study of language as it is really used, by real people, in real time, in real context. Four decades of research in conversation analysis has 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 talk as separate from how it is produced. People attend very closely to exactly others design their talk, and especially as it coordinates with other (eg prior) talk. People attend to how the content of a turn at talk is in sequence is organised and tied to the sequential moment, to that point in that interaction.

For doing conversation analysis is not necessary for these details of talk to be captured and analysed with specialist technical 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 talk. For these details, instead it can be informative to see what is happening immediately preceding and after the particular talk. Is there an impact on the direction of the talk or how it is being understood? The following details can be considered.

In-breaths and out-breath: 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 talk? 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 operators? Speakers can use such markers to hold the turn as they prepare further talk, or to claim speakership for next talk. Such markers can also signal something problematic in developing the talk, for example that the talk will be a *dispreferred* response, such as disagreeing or declining or rejecting etc. (see below).

Silence: Are there silences mid-utterance? What comes just before and just after the silence? Why might the speaker have stopped talking at just that point? What do the two participants do in response? Note both the current speaker – what do they do next? - and what the other party the other party do? Do the participants treat the silence as a sign of a problem of some kind, either in producing the talk or in what the talk refers to?

Cutoffs and restarts: Are there cut-offs and restarts? What immediately precedes and follows the cutoff or restart? Why might the speaker have cutoff or restarted talk? How does the cutoff or restart 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 talk repeated, either by the current speaker or by the recipient participant? What is repeated? Is it repeated in full or in part? What is repeated and what is not repeated? Does repeated talk occur mid-turn (within a current speaker's turn), or in a speaker's or another participant's subsequent turn? Aviation talk is of course full of repetition, but this does not mean it can be

ignored. Much repetition is part of standard operating procedures, but some talk might not be. 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 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 talk as complete or incomplete, or to signal how talk can be attended to in particular ways (for example to make talk 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 the words? How does the stretch relate to the rest of the talk in 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 line 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 talk get noticeably faster or slower? How much talk, and when? What is the significance or impact of this? How does the other participant treat such talk?

Laughter: Are there instances of laughter? What is treated as worthy of laughter? Exactly where does laughter occur relative to a current turn at talk, or relative to the sequence of turns? When does the laughter begin? When does the laughter end? Who laughs? Does only one participant laugh, or both participants? 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 affiliation, or a form of joint understanding of something. Laughter that is not shared or well coordinated might be a sign of different interpretations of what is meant or what is going on.

4.2.3 Sequence organisation

A great deal of research in conversation analysis has shown how people speak in *sequences* of turns at talk, and orient to (or are sensitive to) the *sequential nature of interaction.* This means that, overwhelmingly, turns at talk occur in close relationship to one another. When one person in an interaction produces a turn at talk (the first of a pair of utterances – or 'first pair part'), the other person produces talk that is appropriate as a response to that first turn ('second pair part'). These *adjacency pairs* are strongly projective. By producing the first of a pair, a speaker creates a place for the expected second of the pair to be produced. Turns at talk are interpretable for how they fit into, or don't fit into, the places that are continually

created in the progression of the talk (see ten Have 1999:113). Participants are always 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 will be responded to with a greeting, an offer will be responded to with an acceptance or rejection, a question will be responded to with an answer, an invitation will accepted or declined. Sequences can also be expanded by preliminary sequences, inserted sequences, or post sequences.

Of course it is not always the case that someone will in fact produce the expected response type, but not doing so can be noticeable and accountable. That is, it is something that can be attended to and interpreted by others as significant in some way. Also, the initiating turn of a particular sequence can be thought of, treated as, expecting (or *preferring*) particular forms of response (eg question and answer, telling and acknowledgement). 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, for an invitation the preferred response is an acceptance. Declining an invitation, in everyday interaction, is very difficult to do on its own. It is very difficult just to say 'no'. Mostly, declining an invitation involves offering some form of reason, apology, regret etc. When some form of extra work is not forthcoming, the inviter might pursue it. On the other hand, typically it is possible just to say 'yes' to an invitation. 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 hesitation markers, or there may be perturbations in the production of the talk (such as cut-off words, restarted words, repeats, sound lengthening etc.).

In aviation, sequences of talk are very often formalised in *scripted* wordings for standard operating procedures and other required practices. However, pilots, including airline pilots, and other operators in aviation, routinely vary the talk in these sequences in subtle ways by adding to them or embellishing them somehow (Nevile 2001, 2004a, 2005a, 2006). Also, non-routine situations may lead pilots and others to depart from standard and prescribed formal wordings, or to engage in talk not formally provided for them.

The following can be considered.

> *What is the sequence* of talk underway? What is the evidence for this?
>
> 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 relate to scripted wording for *standard operating procedures*? How might any departures be significant?
>
> How does the sequence *end*?
>
> How do the participants *show their understanding* that the sequence is finished?
>
> What *preference organisation* is at work? Are any turns presented or treated as *dispreferred*?

Do the data show instances of *repair*? Conversation analysts have identified systematic processes of a general conversational practice, repair, as an 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 & 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. 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. This *preference* for *self-repair* is seen in data for flight crews (Nevile 2004a). 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.

4.2.4 Actions

Another way to understand data is to consider the *actions* of the sequence or sequences of talk. The notion of action tries to capture *what participants actually do* in interaction. This refers not just to a simple sense of speech acts, but actions as tied to interactional moments, as evolving and accomplished in an interaction that is jointly produced. Action is what the participants themselves understand is going on, as evidenced in what they say and do. For example, an action might be a question, an assessment, a greeting, a disagreement, a complaint, a repeat, a repair, a closing (of a conversation), and so on.

One turn, or an utterance of many turns, can perform an action, or change mid-course to alter the action being performed, or can be involved in more than one action. Or one action can take place over a number of utterances. An action may be undertaken by one participant, or by more than one participant. Understanding actions involves getting a sense of what is going on. What is it the operators are doing in their talk, individually and together? The important point here is that the analyst is identifying actions from the data, not bringing 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 (Nevile 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 (eg in a checklist, how was the landing gear item completed?).

The following could be considered.

What action is occurring? What is it that the talk is doing? Or, what is it that one or more participants are doing, or seeking to do, with their talk?

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 action of the talk?

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* built as one turn, or over more than one linked turn?

What evidence is there that particular actions are *successful or unsuccessful*?

4.2.5 Roles

When people communicate they often talk and act in particular roles, associated with their personal, social, cultural, or institutional characteristics, 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 etc. However, in conversation analysis such categories and roles are not understood as merely available to people unproblematically, as taken-for-granted, assumed, and pre-existing. Instead, conversation analysts look in the data for how roles are 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 are therefore always drawing upon and claiming a range of obligations, entitlements, responsibilities and so on, associated with their own and others roles.

How do the participants use and orient to particular roles, how do they create, act upon, understand, and accept roles, moment-to-moment, right there and then? This is not to deny that people have formally recognised roles, just that people have to draw upon and demonstrate them in what they do and how they do it, in their own talk and conduct and how they treat the talk and conduct of others. Roles are always *occasioned*, and are something people do, not simply something they are (see discussion by Widdicombe, and others, in Antaki & Widdicombe 1998). Participants act in, and as, this or that role.

In aviation participants have roles associated with their formal roles and places within the aviation system, such as pilot, 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 pilots have on each flight. Each pilot will always have two formal roles. The first comprises 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 the system still have to act according to them, and be recognised as doing so.

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

> What roles do the participants act in and make relevant in the interaction? How do they do this, what evidence of this is there in the transcription data?
>
> How do participants, in their talk, develop and demonstrate to one another their understandings of which roles they are occupying, at any given moment? That is, what evidence is there that someone is acting as the Pilot-Flying, or the Captain, or the air traffic controller, and that they are being 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?
>
> Do participants change over time in how they act, or are treated as acting, in a particular role? How are roles significant at any specific time?
>
> How do roles relate to specific actions or events?

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6 KEY TEXTS IN CONVERSATION ANALYSIS

The following selection of texts is presented as a resource for users of this analytic tool. The texts were chosen for their potential utility, as well as likely availability and accessibility. All texts are books that are specifically concerned with doing conversation analysis, or present collections of studies in conversation analysis, or deal with issues of particular interest to conversation analysis. For example, topics include conversation and cognition, identity and negotiation in interaction, interaction and grammar, prosodic features of interaction, interaction in particular institutional or work settings, or the origins of conversation analysis and the related sociological discipline of ethnomethodology. Most texts have informed the development of the analytic tool, either directly or indirectly. Texts marked with an asterisk (*) are introductory in nature or are particularly accessible or relevant for analysing aviation data.

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