Radiotelephony communications: threats in a multicultural context*

Comunicações radiotelefônicas: ameaças em um contexto multicultural

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ABSTRACT: *Possible threats to oral comprehension related to the use of the English language by Brazilian pilots and air traffic controllers in a multicultural context are here minutely investigated. From taxonomies proposed by researchers in international contexts, a range of factors which can lead to misunderstandings was identified and later correlated with the personal reports of the research subjects. These reports were obtained from focus groups and individual interviews. The analysis of the corpus revealed what Brazilian pilots and air traffic controllers perceive as problems in radiotelephony communications where they must use the English language. A revision of the taxonomy of previously identified factors is proposed in order to include the ones that are particularly relevant to Brazilian professionals in the international aviation context.*

KEYWORDS: *radiotelephony communications, pilot-air traffic controller interaction, multicultural context, cultural interfaces, international air traffic safety.*

RESUMO: *Possíveis ameaças à compreensão oral relativas ao uso da língua inglesa por parte de pilotos e controladores de tráfego aéreo brasileiros em um contexto multicultural são aqui investigadas em detalhe. A partir das taxonomias propostas por pesquisadores em contextos internacionais, um conjunto de fatores que podem gerar mal entendidos foi identificado e posteriormente correlacionado com os relatos pessoais dos sujeitos de pesquisa. Os relatos foram obtidos a partir de grupos focais e entrevistas individuais. A análise do corpus revelou o que pilotos e controladores de tráfego aéreo brasileiros percebem como problema nas comunicações radiotelefônicas em que devem utilizar a língua inglesa. Uma recategorização dos fatores identificados anteriormente é proposta para incluir aqueles que sejam relevantes para os profissionais brasileiros no contexto da aviação internacional.*

Palavras-chave: *comunicações radiotelefônicas, interação entre pilotos e controladores de tráfego aéreo, contexto multicultural, interfaces culturais, segurança do tráfego aéreo internacional.*

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1 Introduction

Radiotelephony communications between pilots and controllers have been receiving special attention due to the significant role of the language in many accidents and incidents, thus promoting a greater interest also to applied linguists. This interest can be justified by the broader focus that Applied Linguistics has today, which was highlighted by Tucker (2007) in an article published by the *Linguistic Society of America:*

> Following the adoption of English as the working language for all international flight communication by the International Civil Aviation Organization (ICAO), some applied linguists concerned themselves with understanding the kinds of linguistic problems that occur when pilots or flight engineers from varying backgrounds communicate using a nonnative language and how to better train them to communicate in English more effectively. (Tucker, 2007, p. 1)

In order to contribute to research conducted on radiotelephony communications problems (Cushing, 1995; EUROCONTROL, 2006; McMillan, 1998; Morrow and Rodvold, 1998; Prinzo and Briton, 1993); and to identify factors contributing to accidents, a further step was taken through an additional study which was carried out between 2006 and 2009 (Monteiro, 2009), aiming at investigating possible threats to the oral comprehension related to the use of the English language by Brazilian pilots and controllers in a multicultural context. Therefore, some research questions were proposed and the main ones are:

1) Based on a literature review, which factors can lead to misunderstandings in radiotelephony communications?
2) Are the categories proposed by researchers in international contexts sufficient or adequate to describe the problems mentioned by Brazilian pilots and controllers?
3) According to Brazilian professionals' experience, what are the possible threats to oral comprehension which can affect pilot-controller communications while interacting in English?

After stating the research questions, in the second part of this paper I will describe some aspects of the multicultural context in which radiotelephony communications take place, and its multiple interfaces. In section 3, I will introduce Grice's principle of cooperation and how it applies to the universal conventions for radiotelephony communications. In section 4, I will explain how the literature review was conducted and how the factors which can lead to misunderstandings were identified and organized into a unique taxonomy, to be used in the corpus analysis. Then, in section 5, I will discuss the research methodology, data categorization and analysis, as well as data triangulation and the proposed taxonomy of the factors which affect pilot-controller interactions according to Brazilian professionals' point of view. Finally, in sections 6 and 7 I will present my conclusions and recommendations.

2 Cross-cultural factors in aviation safety

Concerned about the absence of a clear understanding of the importance of cross-cultural interactions, and seeking to identify the areas which can be a potential threat to international civil aviation, the International Civil Aviation Organization - ICAO published a circular in 2004, entitled *Human Factors Digest Nº 16*, aiming at raising the readers' awareness "of cultural interfaces and the impact of cross-cultural factors on aviation safety" (ICAO, 2004b, p. 1).

As the contact between distinct cultures has become more frequent in the globalized context in which civil aviation is set today – "cross-cultural contact is the norm rather than the exception" (ICAO, 2004b, p. 2) – ICAO didn't focus on the isolated cultures but on the cultural interfaces, which are characterized in the following way:

> […] as long as we stay within the bounds of our own culture, all of the advantages of cultural membership hold: Fellow members and the environment are predictable, thereby making daily routines easier and quicker. But as soon as we encounter members or artefacts (aircraft, procedures, regulations) from other cultures, these cultural efficiencies are challenged and the opposite occurs: The environment becomes less predictable, more uncertain, and requires more cognitive effort. (ICAO, 2004b, p. 2)

Before moving forward to the question of safety involving cultural interfaces, it's necessary to make some considerations about culture, context and cultural interfaces. The first one is a broad definition of culture, adopted by ICAO (2004b): "culture can be defined as the ongoing interaction of a group of people with their environment. The environment shapes the responses of the people, and these responses in turn modify the environment." (ICAO, 2004b, p. 4) This continuous process of adaptation which happens when a group shares beliefs, values, expectations and objectives is the core of culture, it being national (of a country), organizational (of a company) or professional (e.g.: among pilots)[2]. The second consideration is that since "culture and context are really inseparable" (ICAO, 2004b, p. 5) due to this ongoing modification, it's possible to distinguish different contexts which influence a certain culture. Finally, the last one regards the cultural interfaces in aviation, which are "many and diverse" (ICAO, 2004b, p. 8), involving interactions among people and between people and products of other cultures. For example, some cross-cultural interactions which happen in the aviation personnel routine, among others, are: a) pilot-pilot (multicultural cockpits); b) pilot-air traffic

[2] It would be an oversimplification of the dimension of culture if we just considered one notion of it, the national culture. As a consequence we must take into account that a range of sub-cultures exist, or cultures within cultures, for example: professional, organizational, and safety culture, which impact directly on one's professional and interpersonal behavior in the work place.

control (international airspace); c) pilot-flight attendants (foreign crews); d) pilot-trainer (training in a foreign country).

In order to keep the same level of reliability and efficiency that the members of the same culture have while interacting, it's necessary to expose the participants of intercultural interactions to the cultural interfaces with the purpose of developing new habits: "Understanding new habit formation and its implications in human interactions is at the heart of cross-cultural endeavors". (ICAO, 2004b, p. 8)

Considering that the present work encompasses issues related to the safety of international civil aviation, reports on different cultural interfaces, and remarks the intercultural interactions between pilots and air traffic controllers during radiotelephony communications, it's crucial to mention two conceptual frameworks or models explored by ICAO in the *Human Factors Digest Nº 16.* The first one is the SHEL Model. This Model refers to an individual perspective, and presents the interfaces of the Human element – Liveware – with the Environment, Hardware, Software and other Liveware, as shown in figure 01.

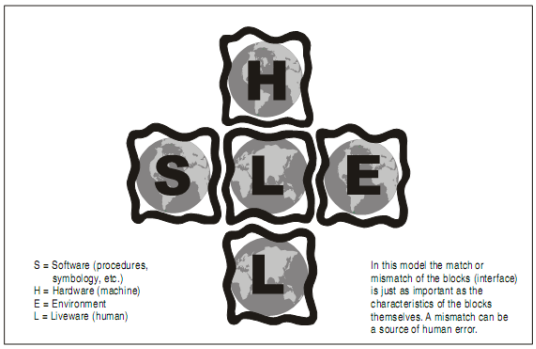

Figure 01: The SHEL Model of Aviation Interfaces – ICAO (2004b)

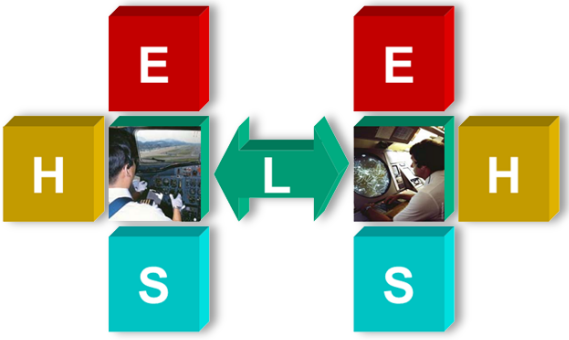

Figure 02: The SHEL Model- EUROCONTROL (2004)

Considering the latter, I want to emphasize the interface pilot – air traffic controller. EUROCONTROL highlighted that "the SHELL[3] model provides a simple framework within which to review and discuss some of the common features of the air-ground communication problems between controller and pilots" (EUROCONTROL, 2004, p. 33). In order to do so, this European organization proposed an extension of the SHEL model, in which the interface Liveware-Liveware is between the air traffic controller and the pilot performing the radiotelephony communications on board (Figure 02).

It is worth noting that each participant has different expectations, values, priorities, objectives, attitudes, and training, among other things. As a consequence, the environment becomes less predictable, more uncertain and requires more cognitive effort. Additionally, both pilot and controller have interfaces with their own environment, hardware and software.

[3] Although EUROCONTROL mentions the SHEL Model with two letters "L", I will keep the terminology proposed by ICAO, with only one "L".

The second model is the Reason Model, also known as the "Cheese Model". This model introduces a systemic perspective in order not to blame only one person for a systemic failure. "Reason argued that as unsafe acts were often only the proverbial tip of the iceberg, safety efforts should be directed at identifying and mitigating these latent unsafe conditions on a system-wide basis, rather than resorting to localized efforts to minimize unsafe acts by individuals." (ICAO, 2004b, p. 17) The model displays slices of cheese in sequence, which represent the system's layers of defense, while the holes represent imperfections in each layer. When all layers have the holes aligned and are run through, results can be catastrophic. Figure 03 shows the Reason Model adapted to the context of radiotelephony communications, proposed by Jeremy Mell (2004). He stated that it is "a convenient representation of the ways in which language deficiencies may have a negative impact in a safety critical environment" (Mell, 2004, p. 12). In this specific case, the layers of defense are: a) design of standard phraseology; b) adherence to standard phraseology; c) plain language proficiency; and d) awareness of communication constraints.

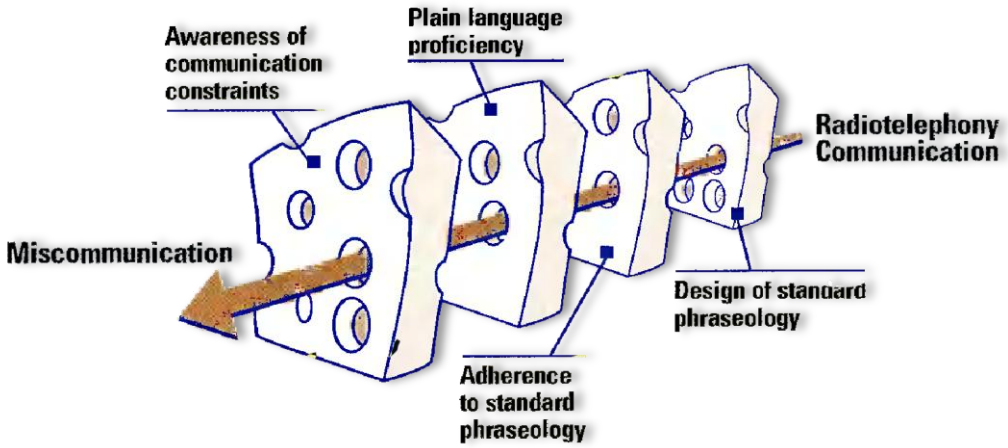

Figure 03: The Reason Model (Mell, 2004)

So, by raising pilots' and controllers' awareness of the importance of identifying, understanding and managing the cultural interfaces and the communication constraints which exist in this context, we can minimize the possibilities of miscommunication.

3 Radiotelephony communications and Grice's theory

According to Grice (1991, p. 307) "our talk exchanges do not normally consist of a succession of disconnected remarks", but are "cooperative efforts" with a common purpose or at least a mutually accepted direction. In this way, he formulated the general principle of conversation as guidance to the cooperative use of the language in an effective way, in order to reach a common aim and which participants are expected to observe. This principle was called

the Cooperative Principle, which says: "Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged." (Grice, 1991, p. 307) In order to support this principle, Grice further developed conversational conventions, which were established by four main categories: quantity, quality, relation and manner, under which fall more specific conversational maxims and sub-maxims.

The relevance of Grice's theory to the present work is given by the fact that there are "universal" conventions established for the radiotelephony communications, applicable to all interaction participants, no matter where they come from, where they are going to or even what their native language is. As examples I can mention : a) standard phraseology, which acts as a code to be used by the whole international community; b) radiotelephony procedures, including the standard format to be followed, which comprises a four-step closed loop; and c) rules for the air traffic management, among others.

Considering the cooperative efforts, which in the context of pilot-controller interactions are efficient radiotelephony communications, I realized that we can find a correlation between this principle and the universal/international conventions for radiotelephony communications, stated in ICAO Annexes and Manuals (Table 01).

Table 1: Radiotelephony communications and the Cooperative Principle

THE COOPERATIVE PRINCIPLE:	**'UNIVERSAL' CONVENTIONS FOR RADIOTELEPHONY COMMUNICATIONS:**
Make your conversational contribution such as is required...	Discipline: "*In all communications the highest standard of discipline shall be observed at all times."(ICAO, Annex 10, Vol II, 5.1.1)* Standard phraseology: *"ICAO standardized phraseology shall be used in all situations for which it has been specified. Only when standardized phraseology cannot serve an intended transmission, plain language shall be used."(ICAO, Annex 10, Vol II, 5.1.1.1)* Transmitting technique*: "Speech transmitting technique should be such that the highest possible intelligibility is incorporated in each transmission."(ICAO, Annex 10, Vol II, 5.2.1.5.3)*
... at the stage at which it occurs...	At the correct time: *"Concise and unambiguous phraseology **used at the correct time** is vital to the smooth, safe and expeditious operation of an aerodrome." (ICAO, Doc 9432, 4.1.1)* *"Controllers should not transmit to an aircraft during take-off, initial climb, the last part of final approach or the landing roll, unless it is necessary for safety reasons, as it may be distracting to the pilot at a time when the cockpit workload is at its highest."(ICAO, Doc 9432, 4.1.2)*
... by the accepted purpose or direction of the talk exchange in which you are engaged.	Purpose: *"Radiotelephony (RTF) provides the means by which pilots and ground personnel communicate with each other. The information and instructions transmitted are of vital importance in the **safe and expeditious operation of aircraft."(**ICAO, Doc 9432, 2.1)* *"States shall ensure that the level of air traffic services (ATS) and communications, navigation and surveillance, as well as the ATS procedures applicable to the airspace or aerodrome concerned, **are appropriate and adequate for maintaining an acceptable level of safety in the provision of ATS." (**ICAO, Doc 4444, 2.1.1)*

And it was amazing to find out that the initial correlation of the basic principle of cooperation was also applicable to its maxims and sub-maxims, proving to be very close to the conventions of radiotelephony communications (Table 02).

Table 2: Radiotelephony communications and the conversational maxims

CATEGORIES	MAXIMS	SUB-MAXIMS	'UNIVERSAL' CONVENTIONS FOR RADIOTELEPHONY COMMUNICATIONS:
Quantity	l. Make your contribution as informative as is required (for the current purposes of the exchange). 2. Do not make your contribution more informative than is required.		Transmission of necessary information: "*The text shall be as short as practicable to convey the necessary information; full use shall be made of ICAO phraseologies." (ICAO, Annex 10, V II, 5.2.1.6.2.1.1)* Avoid unnecessary transmissions: *"The transmission of messages, other than those specified in 5.1.8, on aeronautical mobile frequencies when the aeronautical fixed services are able to serve the intended purpose, shall be avoided". (ICAO, Annex 10, V II, 5.1.1.2)*
Quality	Try to make your contribution one that is true.	l. Do not say what you believe to be false. 2, Do not say that for which you lack adequate evidence.	Say only what you are able to do: *"If at any time a pilot receives a clearance or instruction which cannot be complied with, that pilot should advise the controller using the phrase "UNABLE" and give the reasons." (ICAO, DOC 9432, 2.8.3.10)*
Relation	Be relevant. I expect a partner's contribution to be appropriate to the immediate needs at each stage of the transaction.		Comply with the messages' sequence: *Ex: "Request information/give information;* *Request permission/give permission:* *Ask about intentions/state intentions;* *Request confirmation/give confirmation;"* etc *(ICAO Doc 9835, Appendix B)* Comply with the messages' categories: *"a)Distress calls, distress messages and distress traffic (MAYDAY)* *b)Urgency messages, including messages preceded by the medical transports signal (PAN, PAN or PAN, PAN MEDICAL)* *c) Communications relating to direction finding* *d) Flight safety messages* *e) Meteorological messages* *f) Flight regularity messages"* *(ICAO, Annex 10, V II, 5.1.8)*
Manner	Be perspicuous.	1. Avoid obscurity of expression. 2. Avoid ambiguity.	Direct statements: *"Direct statements which avoid idiomatic expressions are easier to understand than indirect statements or colloquialisms or slang." (ICAO, DOC 9432, p. (iii)* Be as clear as possible: *"When it is necessary to use plain language, it should be used according to the same principles that govern the development of phraseologies in that communications should be clear, concise, and unambiguous." (ICAO, DOC 9432,*

		3. Be brief. Avoid unnecessary prolixity. 4. Be orderly.	*p. (iii)* Conciseness of transmissions: *"Transmissions shall be conducted concisely in a normal conversational tone."(ICAO, Annex 10, V II, 5.2.1.5.2)* 1) Order of messages: *"Messages handled entirely by the aeronautical mobile service shall comprise the following parts in the order stated:* *a)call indicating the addressee and the originator (see 5.2.1.7.3);* *b) text (see 5.2.1.6.2.1.1).* *The following examples illustrate the application of this procedure:* *(call) NEW YORK RADIO SWISSAIR ONE ONE ZERO* *(text) REQUEST SELCAL CHECK."* *(ICAO, Annex 10, V II, 5.2.1.6.1)* 2) Order of phases: *"The communications technique required by ICAO is a four-step 'confirmation/correction closed-loop':* *1)the sender transmits a message;* *2)the receiver actively listens to the message;* *3)the receiver repeats the message back to the sender;* *4) the sender actively listens for the correct readback."(McMillan, 1998, p. 26)* *"The flight crew shall read back to the air traffic controller safety-related parts of ATC clearances and instructions which are transmitted by voice." (ICAO, Doc 4444, 4.5.7.5.1)* *"The controller shall listen to the readback to ascertain that the clearance or instruction has been correctly acknowledged by the flight crew and shall take immediate action to correct any discrepancies revealed by the readback. (ICAO, Doc 4444, 4.5.7.5.2)*

4 Literature review

In order to identify factors which can lead to misunderstandings between pilots and controllers in an international context, a literature review of around 100 titles was carried out, including articles, papers, books, dissertations, documents and reports, from a number of specialists and international organizations, such as *National Aeronautics and Space Administration* – NASA, *International Civil Aviation Organization* – ICAO, *European Organization for the Safety of Air Navigation* – EUROCONTROL, *Federal Aviation Administration* – FAA, *Flight Safety Foundation* – FSF, and others.

Many of these titles presented similar results. They did not only identify contributing factors to accidents and incidents, but also problems which exist in the context of radiotelephony between the aircraft and air traffic control although with different approaches: a) analysis of incident reports sent to the Aviation Safety Reporting System – ASRS, b) taxonomic approach, c) analysis of recordings of pilot-controller interactions in control stations and during international flights, d) experimental simulations, e) discourse analysis of incidents

and accidents transcriptions, f) analysis of questionnaires, and others. Some of the authors who presented categories or taxonomies of the threats to radiotelephony communications in international contexts were selected[4]. The proposed categories were reorganized according to their similarity and renamed in groups of factors. By doing so, it was possible to identify the most cited problems in this kind of interactions, according to the selected authors: a) Readback/hearback failures; b) Non-standard phraseology ; c) Equipment technical failures and/or signal transmission; d) Call sign confusion, from the sound point of view; and e) Difficulties related to the prosodic features of speech.

Finally I proposed a new taxonomy including all categories (Table 03). These were divided into five main groups of factors:

Table 03: Taxonomy of the factors related to radiotelephony communications failures

FACTORS	CATEGORIES	
LINGUISTIC	**SOUND ASPECTS**	Call sign confusion, from the sound point of view Difficulties related to the segmental properties of speech Difficulties related to the prosodic features of speech[5] Qualitative information in speech Lack of familiarity with native or non-native accent Homophony (phonetic-phonological ambiguity)
LINGUISTIC	**LEXICAL AND/OR STRUCTURAL ASPECTS OF THE UTTERANCE**	Non-standard phraseology Alphanumeric failures Ambiguity Transposition (incorrect order of numbers and words) Content imprecisions (wrong data, confusing message, unsure reference) Long and complex messages
LINGUISTIC	**GENERAL ASPECTS**	Language barriers English as an international language Intelligibility Lack of language proficiency Lack of awareness of language nuances

[4] Grayson and Billings (1981); Porter (1981); Morrison and Wright (1989); Wilson (1990); Cushing (1994); Morrow (1994); Prinzo (1996); Wulle and Zerr (1997); Fegyveresi (1997); Orasanu, Davison and Fischer (1997); McMillan (1998); Morrow and Rodvold (1998); Flight Safety Foundation (2000); Eurocontrol (2004); Eurocontrol (2006); Baron (access in 2008).

[5] By prosodic features of speech we considered all aspects which are not classified as segmental.

DISCURSIVE-INTERACTIONAL	Code switching Readback/hearback failures Non-cooperation, conflicts and relationship problems Lack of conversation monitoring Turn taking by a non-ratified participant Multiple communications Repetition problem using another language Incomplete content (information omission) Lack of coordination (combined positions/sectors, confusing hand-offs) Message sent or heard, but not understood Untimely transmissions Pilot reluctance to declare emergency Problems with kinds of repetition Engagement (interlocutor's role) and ritualization Failure to clarify instructions Excessive words (inclusion of words to what is prescribed) Inferences and false suppositions Filtering communications Interruptions Lack of situational awareness Acting on message interpretations that are not explicitly accepted as understood Wrong interpretation of speech acts	
INTERCULTURAL	Cultural differences	
OTHER HUMAN FACTORS	Memory limits Actions and reactions due to emergency situations Fatigue Failure to maintain vigilance Expectation and fixation High workload Distraction	Little professional experience Give/receive training Gender (male/female) and physiology Age Boredom Personal problems
EQUIPMENT AND/OR SIGNAL TRANSMISSION	Technical failures of equipment and/or signal transmission (incorrect use of microphones, blocked transmissions, distorted messages, frequency congestion)	

It is necessary to make some comments about the categories. Although they are classified according to linguistic, discursive-interactional and intercultural factors, as well as the other human factors and the technical failures of equipment and/or signal transmission, we can say that they overlap, because when someone uses language many of the categories are involved, although some of them are more emphasized than others.

Considering the idea of language a complex in which linguistic, discursive-interactional and intercultural aspects are always part of the game, and once it happens in an interactional context, from cultural conventions, expectations and use of certain linguistic aspects, I understand that the categories can always be present, but in some moments one of them will exceed as the factor which generates the communicative problem. So, my hypothesis is that the categories are not exclusive; instead they are used to perceive the predominance of a specific problem.

5 Data categorization and analysis

Aiming at answering the third research question, I decided to correlate the factors identified in the literature with opinions of Brazilian pilots and controllers. Two data generating instruments were used: focus groups and individual interviews. The first focus group was conducted with four Brazilian pilots, who worked in the same airline company, thus members of a pre-existing group, and all experienced in international operations (Pilots A to D). The second one was conducted with four Brazilian air traffic controllers, who share the experience of using and teaching international aeronautical phraseology, and who, similarly, were members of the same working group (ATCO A to D). Taking into account the limited number of focus group sessions, the possibility of the participants being inhibited to share their points of view and personal experiences in radiotelephony communications, and also the difficulty to interview the same research subjects from the focus groups, I decided to conduct a number of individual semi-structured interviews, to give voice to professionals with heterogeneous international experiences. So, five Brazilian pilots (Pilots 1 to 5) and an examiner of pilots' aviation English were interviewed, as well as five Brazilian air traffic controllers (ATCO 1 to 5), one of whom was also a pilot.

The transcriptions totalized 165 pages of comments and examples, which were then selected and classified according to the taxonomy proposed in Table 03. When none of the pre-existing categories were enough to classify them, a new category was suggested. Based on a theoretical framework which privileges the view of language as action (Austin, 1962; Searle, 1969) and cooperation (Grice, 1975), and in light of relevant definitions of concepts such as English as an International Language, pronunciation, intelligibility and prosody, the qualitative analysis[6] of the corpus enabled me to discover what Brazilian pilots and controllers perceive as problems in radiotelephony communications when they must use the English language.

5.1 Analysis of pilots' focus group

The analysis of data revealed that not all the factors were mentioned by the pilots. However, from the comments we can say that, although many categories received only individual comments, there was consensus among all the participants in two topics: lack of familiarity with native and non-native accents and lack of language proficiency. Controversy was found in only two: the intonation of the messages (difficulties related to the prosodic features of speech) and the occurrence of quarreling on the radio (non-cooperation, conflicts and relationship problems). Apart from that, a new category was cited as relevant to the Brazilian

[6] For the complete analysis, also with a number of comments made by Brazilian professionals, please refer to Monteiro, 2009.

pilots' reality: lack of knowledge of the other's activities. A few comments made by the pilots are as follows:

-The people may even know the English language, but the accent itself can interfere. (Pilot C - lack of familiarity with native and non-native accents)

-But the French accent is also very hard. (Pilot C - lack of familiarity with native and non-native accents)

-For sure, politeness, courtesy… You should avoid as much as possible reaching the point when you have to quarrel with a controller. This must be avoided. It cannot happen. It's not that it must be avoided. It must not happen. (Pilot B - non-cooperation, conflicts and relationship problems)

5.2 Analysis of pilot's interviews

From the analysis of pilots' interviews, a little more controversy than consensus was noticed, and some topics received very few comments. But surprisingly, pilots mentioned seven different problems which can affect their communications with controllers. Two of them resulted from a sub-categorization of the category little professional experience – of pilots and controllers, one had already appeared in the pilots' focus group discussion, lack of knowledge of the other's activities, and the others are: saving face, power relations, differences in local procedures and attitudes and controllers' training failure. Although some of the categories received only individual comments, there was consensus among all the participants only in relation to the lack of familiarity with native and non-native accents. However, many categories received controversial comments: difficulties related to the prosodic features of speech, non-standard phraseology, code switching and non-cooperation, conflicts and relationship problems. What follows are a few comments made by the pilots:

-But in reality, we see that there are many other standards. It's the case, for example, if you arrive in Europe you are greeted in a way, if you arrive in the US, you are greeted in a different way. When you request some information from ATC, even the pre-recorded messages are organized in a sequence different from ICAO standards. (Pilot 1 - non-standard phraseology)

-The approach phase is the one which requires the most from both pilots and controllers. The level of concentration and the focus on the process is very high at this moment. Sometimes, it's when everybody speaks English inside the cockpit, in order to avoid confusion. The situation itself obliges you to do that, but there is….it's something like, sometimes you begin mixing Portuguese and English. If things get worse, normally everybody turns to Portuguese in order to understand. (Pilot 1 – code switching)

-Look, the American controller, let's talk a little bit about him. He is not very patient with foreigners. He sometimes makes jokes about the way we speak or a speech mistake. For example, in the US you don't report reaching a level, you report leaving a level, and once I

reported, one of the first times I went there, I reported reaching the level and he said: "Thanks for advising me", ironically. And other radio conversations as well, recordings that we listen to, they really get impatient. (Pilot 4 - non-cooperation, conflicts and relationship problems)

5.3 Analysis of controllers' focus group

The analysis of controllers' focus group indicated that a greater number of categories from Table 03 were mentioned, revealed some consensus, but again, not in all categories. On top of that, they mentioned six new categories, that's to say, they provided comments on six different issues from the ones organized in the original taxonomy to express their points of view and attitudes: first language interference, power relation, differences in local procedures and attitudes, controllers' training failure, pilots' training failure, lack of knowledge of the other's activities. There was consensus among all the participants in two topics: difficulties related to the prosodic properties of speech and lack of knowledge of the other's activities. On the other hand, there was only one controversial topic: non-cooperation, conflicts and relationship problems. It is important to mention the comments made about the Brazilian pilots and controllers training. They did not only emphasize some failures, but also the professionals' lack of stimulus and the negative influence on the performance of their tasks. Illustration of a few comments made by air traffic controllers follows:

-I think all pilots should visit the control center to have this idea. He forgets that the controller is observing that he has an overall view. (ATCO A - lack of knowledge of the other's activities)

-There are cases in which the relationship between pilots and controllers is a friendly one, professional. And tensions really exist. (ATCO B - non-cooperation, conflicts and relationship problems)

-During his initial training, the pilot learns how to fly the aircraft, learns the rules and procedures and also phraseology. It does not exist, in any moment of his training, instructions on how to behave on the radio, intonation, nothing related to this, for the pilot. (ATCO D - pilots' training failure)

5.4 Analysis of controllers' interviews

From the analysis of controllers' interviews, on the one hand, two categories were controversial: code switching and cultural differences. But, on the other hand, three of them were consensual: a) non-cooperation, conflicts and relationship problems, b) non-standard phraseology, and c) difficulties related to the prosodic features of speech. However, seven new categories were suggested in order to cope with the analysis of the controllers' opinions. One of them resulted from a sub-categorization of the category little professional experience – of

controllers. The other six had already appeared in the controllers' focus group discussion: a) saving face, b) power relations, c) differences in local procedures and attitudes, d) lack of knowledge of the other's activities, e) controllers' training failure, and f) pilots' training failure. A lot of comments related to the training of these professionals were made, similarly to what was mentioned in the controllers' group discussion. These emphasized the need of improvement, recurrent training and a greater interaction with the pilots' working context. I selected some examples to illustrate ATCO's point of view:

-In general, I consider that we have a good relationship. But, depending on the situation, depending on the day, depending on the level of stress, one can become rude or not. So, there are controllers and controllers, pilots and pilots, as a result of their own educational background, I mean, their family, the way they were brought up at home. There are people who also bring that to work, to the tower, to the control center, to the cockpit. (ATCO 3 - non-cooperation, conflicts and relationship problems)

-I think that the purpose of using standard phraseology is exactly to avoid, as much as possible, the possibility of these differences affect communication. So, it doesn't matter if the pilot is Brazilian, Arabic or Japanese, if he is an atheist, catholic or Muslim, because he will use the expression: "request FL 350". And the controller who will receive this request, no matter where in the world he is, will understand what he is talking about (if it's pronounced correctly, of course) and he will answer accordingly. There's no need to use politeness expressions, which I believe, can vary from culture to culture. (ATCO 4 – cultural differences)

-I don't know if you heard about that, but we had a problem in Congonhas with a pilot from (Brazilian airliner) and a sergeant air traffic controller. In Congonhas, you know, from 11 pm it's not possible to take off or land. The tower clock was showing 11:01 and the pilot's clock, from GPS, was showing 10:58. So, he questioned if he could take off. She said no, that she had to comply with the rule, that there was a document. And then he complained, and told her that the air traffic controller worked very badly, that the air traffic controller had taken the Tele Curso 2º Grau[7]. (ATCO 3 – power relations)

-He (the Brazilian pilot) behaves well over there, because there the profession is serious. Depending on his training, sometimes he avoids generating a conflict in order not to receive a very difficult instruction, one that he would not understand. (ATCO 2 – saving face)

-What we have been noting is that, as years go by, the quality of the professional who is coming to the operation is decreasing, and decreasing considerably, but I still consider the English language training a good one. What makes things worse is that there isn't a continuation to this training. Sometimes the professional keeps a year training and studying the English language and also phraseology. Depending on the place he is going to work at, many times he stays five or six years without applying what he learned because he goes to a domestic airport, where he uses phraseology but nothing in English, and then when he is sent to another place where it's necessary to use the English language, he finds himself in a difficult situation, because he didn't

[7] A type of high school course on TV. It was mentioned by the pilot to express his idea of a poor educational background.

have recurrent training, he was not required in that area.[8]*(ATCO 1 – controllers' training failure)*

5.5 Discourse analysis of the incidents/accidents considered by the research subjects as relevant to radiotelephony communications problems

The data analysis was conducted in three parts. So far, I presented the discussion of data obtained from the focus groups and individual interviews with pilots and controllers. From these data I selected one aeronautical accident and one incident mentioned by the research subjects as relevant to radiotelephony communications problems in the context of international aviation, with the purpose of illustrating how the categories apply to real situations.[9]

5.5.1 Tenerife accident, Canary Islands

It was possible to identify a number of categories from the taxonomy in Table 03 which revealed communication problems during the interactions between the pilots and controllers involved[10]. Nevertheless, in the research subjects' perceptions, four categories somehow contributed to this accident: non-standard phraseology, first language interference, lack of language proficiency, and power relations.

5.5.2 Air China incident, Kennedy Airport

Similarly, it was possible to point out many categories related to failures which happened in this interaction[11], from the linguistic factors to other human factors, although the research subjects highlighted three of them: a) difficulties related to the prosodic features of speech, b) non-cooperation, conflicts and relationship problems, as well as c) wrong interpretation of speech acts.

[8] This interview was conducted in January, 2008, before the deadline for the implementation of ICAO Language Proficiency Requirements.
[9] For the complete analysis, please refer to Monteiro, 2009.
[10] Description of the accident: March 27, 1977/Tenerife, Canary Islands/Pan American, Flight 1736 / KLM, Flight 4805/Boeing B-747-121 / Boeing B-747-206B/N736PA / PH-BUF. Both aircraft were diverted to Tenerife because of a bombing at Las Palmas Airport. After an extended delay, both planes were instructed to back track up the runway. The KLM plane reached its take-off point while the Pan Am plane was still on the runway. The Pan Am plane continued up the runway missing the taxiway turnout. There was heavy fog on the runway. The KLM plane began its take-off roll without permission with the Pan Am plane still on the runway. The KLM plane hit the Pan Am plane just as it was taking off. Both planes burst into flames. KLM 234 + 14 crew, Pan Am 326 + 9 crew killed. (www.planecrashinfo.com)
[11] This incident happened at JFK International Airport, involving a Chinese pilot from Air China Airlines and the American ground controller. The video, audio and transcription of the interaction are available at YouTube.

To sum up the results from this last part of the analysis, I organized in Table 04 the categories selected from the analysis of the Tenerife accident and the Air China incident which were perceived by the research subjects and by myself as factors related to radiotelephony communications failures. The categories in red are the ones which were not mentioned in the original taxonomy.

Table 04: Taxonomy of the factors related to radiotelephony communications failures detected in the analysis of the accident and incident

LINGUISTIC	**SOUND ASPECTS**	Difficulties related to the segmental properties of speech Difficulties related to the prosodic features of speech
	LEXICAL AND/OR STRUCTURAL ASPECTS OF THE UTTERANCE	Non-standard phraseology Alphanumeric failures Ambiguity Content imprecisions (wrong data, confusing message, unsure reference) **First language interference**
	GENERAL ASPECTS	Lack of language proficiency
DISCURSIVE-INTERACTIONAL	Code switching *Readback/hearback* failures Non-cooperation, conflicts and relationship problems Acting on message interpretations that are not explicitly accepted as understood Wrong interpretation of speech acts **Saving face** **Power relations**	
INTERCULTURAL	Cultural differences **Differences in local procedures and attitudes**	
OTHER HUMAN FACTORS	Fatigue Expectation and fixation High workload	
EQUIPMENT AND/OR SIGNAL TRANSMISSION	Technical failures of equipment and/or signal transmission (incorrect use of microphones, blocked transmissions, distorted messages, frequency congestion)	

5.6 Data triangulation

I now present how the multiple perspectives used in the present study were organized and triangulated. First of all, data triangulation was possible through three different data generating instruments: a) focus groups; b) individual interviews; and c) data obtained from the transcription of accidents/incidents available on the internet. Additionally, it was possible to triangulate the participants' points of view, considering the pilots' and controllers' perceptions, as well as mine, as a researcher. As a result, I proposed a final taxonomy (Table 05) which comprises all categories identified during the three phases of data analysis, highlighting in red the new ones which were included to cope with the participants' opinions and experiences.

Table 05: Taxonomy of the factors which affect pilot-controller interactions according to Brazilian professionals

FACTORS	CATEGORIES	
LINGUISTIC	**SOUND ASPECTS**	Call sign confusion, from the sound point of view Difficulties related to the segmental properties of speech Difficulties related to the prosodic features of speech Qualitative information in speech Lack of familiarity with native or non-native accent Homophony (phonetic-phonological ambiguity)
	LEXICAL AND/OR STRUCTURAL ASPECTS OF THE UTTERANCE	Non-standard phraseology Alphanumeric failures Ambiguity Content imprecisions (wrong data, confusing message, unsure reference) **First language interference**
	GENERAL ASPECTS	Language barriers English as an international language Intelligibility Lack of language proficiency Lack of awareness of language nuances
DISCURSIVE-INTERACTIONAL	Code switching *Readback/hearback* failures Non-cooperation, conflicts and relationship problems Multiple communications Incomplete content (information omission) Lack of coordination (combined positions/sectors, confusing hand-offs) Message sent or heard, but not understood Pilot reluctance to declare emergency Excessive words (inclusion of words to what is prescribed) Inferences and false suppositions Interruptions Lack of situational awareness Acting on message interpretations that are not explicitly accepted as understood Wrong interpretation of speech acts **Saving face** **Power relations**	
INTERCULTURAL	Cultural differences **Differences in local procedures and attitudes**	
OTHER HUMAN FACTORS	Actions and reactions due to emergency situations Fatigue Expectation and fixation High workload Distraction	
	Little professional experience	**of controllers** **of pilots**
	Personal problems **Lack of knowledge of the other's activities** **Failure in the controllers' training** **Failure in the pilots' training**	
EQUIPMENT AND/OR SIGNAL TRANSMISSION	Technical failures of equipment and/or signal transmission (incorrect use of microphones, blocked transmissions, distorted messages, frequency congestion)	

It is worth mentioning that many identified categories represent a violation of Grice's principle of cooperation or of its maxims and sub-maxims, as the following examples illustrate:

a) Non-standard phraseology - violation of the principle of cooperation ("Make your conversational contribution such as is required..." - use of standard phraseology);
b) Difficulties related to the prosodic features of speech - violation of the principle of cooperation ("Make your conversational contribution such as is required..." - transmitting technique);
c) Content imprecisions (wrong data, confusing message, unsure reference) - violation of the conversational maxim of manner ("Avoid obscurity of expression" and "Avoid ambiguity")
d) Readback/hearback failures – violation of the conversational maxim of manner ("Be orderly" – order of phases);
e) Incomplete content (information omission) – violation of the conversational maxim of quantity ("Make your contribution as informative as is required");
f) Excessive words (inclusion of words to what is prescribed) – violation of the conversational maxim of quantity ("Do not make your contribution more informative than is required").

6 Conclusions

First of all, let me recall the research questions formulated in the Introduction to make some final considerations.

- Based on a literature review, which factors can lead to misunderstandings in radiotelephony communications? Table 03 presents the taxonomy of the factors related to radiotelephony communications failures in international contexts, organized into linguistic, discursive-interactional, intercultural factors, other human factors, as well as equipment and/or signal transmission. Each of them comprises a number of categories mentioned by the selected authors.
- Are the categories proposed by researchers in international contexts sufficient or adequate to describe the problems mentioned by Brazilian pilots and controllers? Initially, the proposed taxonomy appeared to be adequate, although not sufficient to categorize all the problems mentioned by Brazilian professionals. It was necessary to include new categories, for example: first language interference, saving face, power relations, differences in local procedures and attitudes, lack of knowledge of the other's activities, failure in the controllers' training and failure in the pilots' training. Additionally, the category 'little professional experience' was sub-categorized in order to separate the controllers' experience from the pilots' one.

Notwithstanding, a number of categories from Table 03 were not identified by Brazilian professionals, such as: long and complex messages, failure to monitor communication, lack of conversation monitoring, turn taking by a non-ratified participant, multiple communications, repetition problem using another language, untimely transmissions, problems with kinds of repetition, engagement (interlocutor's role) and ritualization, failure to clarify instructions, filtering communications, memory limits, failure to maintain vigilance, give/receive training, gender (male/female) and physiology, age, boredom, apart from others which were less cited, although this does not mean that they don't occur and are not relevant. Probably, the list of questions used in the focus groups and individual interviews did not encourage the discussion of these problems nor explored all the possibilities.

- According to Brazilian professionals' experience, what are the possible threats to oral comprehension which can affect pilot-controller communications while interacting in English? The factors which affect pilot-controller interactions, according to Brazilian professionals, are listed in the final taxonomy, proposed in Table 05. Among the categories originally presented in Table 03, some are worth mentioning as the most cited in the corpus analysis: difficulties related to the prosodic features of speech; non-standard phraseology; non-cooperation, conflicts and relationship problems; and lack of familiarity with native or non-native accent.

Additionally, some conclusions can be drawn from the present study, which I classify into three groups of distinct nature:

- Conclusions which corroborate what was found in the literature review: radiotelephony communications take place in a very particular context: it's complex, dynamic, and subject to a number of factors which can jeopardize pilot-controller interactions.
- Conclusions which emerge from data:
  a) The relationship between the interaction participants appeared to be fragile and with a certain rivalry "in the air", mainly concerning the Brazilian professionals;
  b) Some false assumptions still exist about air traffic control and aircraft operations which guide the pilot-controller relationship, derived from the lack of knowledge of the activity and working place of each other;
  c) Grice's principle of cooperation and its conversational maxims suited very well to the context of radiotelephony communications and revealed that, through the correlation with the "universal conventions" prescribed to this context, compliance with the existing rules would eliminate a great amount of the detected problems.
  d) The recognition of speech acts, or language functions expressed by pilots and controllers during their interactions, is of vital importance to effective communications;

e) One of the new suggested categories – saving face – though also discussed by the controllers, received comments concerning pilots' professional performance only, showing that the preoccupation of saving face and not feeling threatened or humiliated in the communicative event comes from the pilots, who, in its majority and according to their comments, consider themselves superior;

f) Failures in the pilots' and controllers' training were pointed out; however, it is worth noting that the controllers emphasized the differences between their training and that of pilots, considering the training they have as insufficient.

- Partial conclusions which require further research:

a) Since cultural interfaces in the context of international radiotelephony are multiple and distinct, knowledge and practice of the concepts included in the models proposed by ICAO (2004b) related to safety and human factors in aviation can contribute to a holistic view of the problem and to find out jointly solutions, under a systemic perspective;

b) Even though the intercultural factors were not considered relevant by all participants, and some of their comments were rather vague, it is noteworthy that some categories which were classified as pertaining to the group of linguistic factors (e.g.: qualitative information in speech, lack of familiarity with native or non-native accent, language barriers, etc) or to the group of discursive-interactional factors (e.g.: pilot reluctance to declare emergency, saving face, power relations, etc) are also culturally influenced, either by the national culture of the participant or by his/her professional or organizational cultures;

c) Comparing the consensual and controversial categories among the groups, it can be said that the pilots' point of view appeared to be very similar in the focus groups and interviews. For instance, the lack of familiarity with native or non-native accent was a consensus in both data generating instruments, as well as difficulties related to the prosodic features of speech and non-cooperation, conflicts and relationship problems caused controversy in both instruments. However, considering the controllers' point of view, some differences could be noted. On the one hand, only one category appeared as consensual in the focus group and in the interviews (difficulties related to the prosodic features of speech), but, on the other hand, the category 'non-cooperation, conflicts and relationship problems' was the reason for controversy , in some moments, but also for consensus, among the controllers. I believe that these categories are the ones which will deserve more attention in future researches.

7 Recommendations

Some general recommendations can be made to improve radiotelephony communications in the Brazilian context, but which can also be applied to the international aeronautical community:

- Raise pilots' and controllers' awareness of the linguistic, discursive-interactional and intercultural factors, as well as of the other human factors and problems with equipment and/or signal transmission, through lectures, publications, discussions and working groups, involving the ones responsible for curriculum design of pilots and controllers training;
- Promote joint training activities between pilots and controllers aiming at expanding the knowledge of the other's activity, during simulator sessions, international flights, visits to air traffic service providers, and so on;
- Alert aviation professionals of the risks of not complying with rules and procedures of radiotelephony communications, highlighting that this non-conformity corresponds to a violation of a language basic rule, the principle of cooperation and its conversational maxims;
- Promote professional cooperation and data availability to provide conditions for the development of a more effective safety management in the context of radiotelephony communications;
- Conduct ethnographic studies which enable the observation of pilots and controllers in their working place to perceive the relation between the categories identified and communication failures, as well as their reactions, behavior and performance while they are using the English language in radiotelephony communications;
- Deepen the study of linguistic, communicative and intercultural competences in order to, through their correlation with the categories identified in each group of factors, propose training activities to reduce the impact of cross-cultural factors on aviation safety;
- Finally, foster international cooperation to continue research on this issue. As a first step, I launched an online survey for pilots and air traffic controllers, no matter where they come from. By answering the questions, it will be possible to gather data from the international aeronautical community perceptions and experiences in radiotelephony communications, to draw some conclusions and propose additional recommendations.

References

AUSTIN, J. *How to Do Things with Words*. Oxford: Oxford University Press, 1962.

BARON, R. *Barriers of effective communication: Implications for the cockpit*. Available at <*http://airlinesafety.com/editorials/BarriersToCommunication.htm*>. Access on 27/10/08.

BENITEZ, A. *Kennedy Ground – ATC*, 2007. Available at <*http://br.youtube.com/watch?v=uSgl3A82ItU*>. Access on 05/07/2008.

CUSHING, S. *Fatal Words:* Communication Clashes and Aircraft Crashes. The University of Chicago Press, Chicago, 1994.

CUSHING, S. Pilot-air traffic control communications: It's not (only) what you say, it's how you say it. *Flight Safety Foundation*, V. 14, No. 7, July, 1995.

EUROCONTROL. *Air-ground communication safety study:* an analysis of pilot-controller occurrences. Brussels, 2004.

EUROCONTROL . *Air-Ground Communication Safety Study:* Causes and Recommendations, 2006.

FEGYVERESI, A. E. Vocal cues and pilot/ATC communications. *Proceedings of the Ninth International Symposium on Aviation Psychology* (pp. 81-84). Columbus, OH*: OSU*, 1997.

FLIGHT SAFETY FOUNDATION. Pilot-Controller communication. FSF ALAR Briefing Note 2.3 – *Flight Safety Digest* (Aug/Nov), 2000.

GRAYSON, R. L.; BILLINGS, C. E. Information transfer between air traffic control and aircraft: Communication problems in flight operations. In Billings, C. E. and Cheaney (eds.), Information transfer problems in the aviation system, *NASA Technical Paper* 1875, 1981.

GRICE, H. P. Logic and conversation. In DAVIS, S. (ed.), *Pragmatics – A Reader* (p. 305-315). Oxford University Press, 1991. (Reprinted by permission of Harvard University Press from Studies in the Way of Words, by Paul Grice. © 1968, 1975 by H. P. Grice, © 1989 by The President and Fellows of Harvard College).

INTERNATIONAL CIVIL AVIATION ORGANIZATION. *Annex 10 to the Convention on International Civil Aviation – Aeronautical Telecommunications*, Vol 2, 6 ed. Montreal: ICAO, 2001.

INTERNATIONAL CIVIL AVIATION ORGANIZATION. *Manual on the Implementation of ICAO Language Proficiency Requirements*. Doc 9835. Montreal: ICAO, 2004a.

INTERNATIONAL CIVIL AVIATION ORGANIZATION. Cross Cultural Factors in Aviation Safety. *Human Factors Digest*, Nº 16. Montreal: ICAO, 2004b.

INTERNATIONAL CIVIL AVIATION ORGANIZATION. *Manual of Radiotelephony*. Doc 9432, 4 ed. Montreal: ICAO, 2007.

INTERNATIONAL CIVIL AVIATION ORGANIZATION. *Procedures for Air Navigation Services - Air Traffic Management*. Doc 4444, 15 ed. Montreal: ICAO, 2007.

McMILLAN, D. *"...Say again?..."* Miscommunications in Air Traffic Control. A project submitted in partial fulfillment of the requirements for the award of the degree of Master in Education, Faculty of Education, Queensland University of Technology. Brisbane, Australia, 1998.

MELL, J. Language training and testing in aviation need to focus on job-specific competencies. *ICAO Journal*, v. 59, No. 1, 2004.

MONTEIRO, A. L. T. *Pilot-controller communications*: linguistic, discursive-interactional and intercultural factors. Master Thesis, Universidade Federal do Rio de Janeiro – UFRJ, Graduate Interdisciplinary Program in Applied Linguistics, Brazil, 2009.(in Portuguese)

MORRISON, R. e WRIGHT, R. H. ATC Control and communication problems: An overview of recent ASRS data. In R. S. JENSEN (eds.) *Proceedings of Fifth International Symposium of Psychology*, Columbus, Ohio, Vol 2, 1989.

MORROW, D. G. Collaboration in pilot-controller communication. To Appear: *Proceedings of the NASA/FAA/Air Force Methods and Metrics of Voice Communication Workshop*, San Antonio, May, 1994.

MORROW, D. G. e RODVOLD, M. Communication Issues in Air Traffic control. In SMOLENSKY, M. e STEIN, E. (eds.) *Human factors in Air traffic Control*, Academic Press, San Diego, p. 421-456, 1998.

ORASANU, J. M., DAVISON, J. e FISCHER, U. What did he say? Culture and language barriers to efficient communication in global aviation, In R. JENSEN (ed.), *Proceedings of the Ninth International Symposium on Aviation Psychology* (pp. 673-678). Columbus, OH: OSU, 1997.

PORTER, R. F. Information transfer during contingency operations: emergency air-ground communications. In BILLINGS, C. E. and CHEANEY (eds.), *Information transfer problems in the aviation system*, NASA Technical Paper 1875, 1981.

PRINZO, O. V. e BRITTON, T. W. ATC/Pilot Voice Communications: A Survey of the Literature. *Federal Aviation Administration Report* DOT/FAA/AM-93/20, 1993.

PRINZO, O. V. An Analysis of Approach Control/Pilot Voice Communications. *Federal Aviation Administration Report* DOT/FAA/AM-96/26, 1996.

SEARLE, J. *Speech Acts:* An Essay in the Philosophy of Language. Cambridge: Cambridge University Press, 1969.

TUCKER, R. G. Applied Linguistics. *Linguistic Society of America*, 2007. Available at: <*http://www.lsadc.org/info/ling-fields-applied.cfm*>. Access on 2008.

WILSON, D. R. My own Mouth Shall Condemn Me. *Flight Safety Foundation – Accident Prevention*, V. 47, Nº 6, 1990.

WULLE, B. W. e ZERR, A. R. Factors that affect controller/pilot communications: Readbacks, volume of information, experience level, personal problems, standard phraseology and the relationship to safety. In *Proceedings of the Ninth International Symposium on Aviation Psychology (pp. 90-94). Columbus, OH: OSU*, 1997.