Introduction

The modern flight aviation system operates as a communication process constructed, organized, regulated, and realized through human actions. Aviation safety is and will remain the central concern of our era, for all people living allover the world. Unpublished and intra-sector data demonstrate that communication problems have indeed cost lives or provoked major incidents. Comprehensive studies of the role of communication in aviation incidents are limited, but they demonstrate how incident data provide insights to accident causes. Incidents are violations of instructions or legal parameters that may or in fact affect the safety of operations. US Federal Aviation Administration (FAA) anonymous Aviation Safety Reporting System (ASRS) reveals over 60% communication problems, in reported cases.

Earlier studies in the 1980s indicate that those communication issues contain problematic information transfer and exchange. Thus, systems approach that is concerned with information flow and sender-receiver perception in the cockpit environment is a contributing factor in the current analysis. Human factors analysis on cognitive interactions in mission critical environments offers another ground to draw on how participants implement their interaction in time constrained conditions. Aviation human factors research describes the goal of all pilots “to get people from A to B, without disturbing or killing them”. Conversation analysis literature provides a framework of understanding interaction, turn-taking and implementation of processes via communication. Interaction phenomena in the case of cockpit conversation extend...
common encounters of turn-taking and routine discussions to pressing operating conditions where human actors need to have established interaction relationships and apply disciplined actions to correct errors and follow consequential steps, accomplish cockpit identities and roles. A successful flight is a systems result of the interactional accomplishment of human performance.

**Flights as Communication Sessions**

Airplane flights are abstract representations of the basic model of communication (Shannon & Weaver, 1948; Wiener, 1954) in an ideal flight session situation. The discursive space of Pilots and Air Traffic Controllers (ATC) is determined by operational structures and cultures, in a highly-mediated environment. Institutional interaction differs from ordinary conversation in sequential organization and actions that actors undertake. The role of ATC actor extends interaction to “outeraction” (Nardi & Whittaker, 2000) when contextual features are negotiated through conversation. Cockpit as a context includes pilots, crew members, tele-present air traffic controllers, technological-mechanical devices and procedures. These participants are roles expressed with talk-in interaction.

From a human factors point of view the importance of understanding routine work, repeated and confirmed actions, practices, and situational requirements of the users in the design of tools and technologies that they use is recognized by several theorists (Norman & Draper, 1986; Winograd & Flores, 1987; Moran & Anderson 1990). NASA researchers analyzed the causes of civil aviation accidents and incidents between 1968 and 1976 (Cooper, White & Lauber, 1980; Murphy, 1980) and concluded that pilot error was more likely to reflect failures in team communication and coordination than deficiencies in technical proficiency. Human factors issues related to interpersonal communication have been implicated in approximately 70%-80% of all accidents over the past 20 years, especially in the issue of task management (Iani C. & Wickens C. D., 2007). Consequently, more than 70% of the first 28,000 reports made to NASA’s
Aviation Safety Reporting System (ASRS, which allows pilots to confidentially report aviation incidents) were found to be related to communication problems (Connell, 1995). Studies of collaboration among scientific and professional communities suggest that an initial period of physical proximity is necessary in order to build trust and to come to consensus on the focus of proposed goals and projects (Carley & Wendt 1991).

The International Civil Aviation Organization (ICAO, 1998) has embraced a systems analysis approach while people have become instrumental in aviation safety in an analogous of a “liveware” in the cockpit (Edwards, 1988) and stakeholders beyond that cockpit towards the air traffic controller. The European Air Traffic Management (EATM), known as Eurocontrol, issued its guidelines for best practices in 2007, introducing the human factors pie that follows:

![Figure 2: The Human Factors Pie EATM (2007)](image)

This is a complete systems view of a systems working environment with the human actor, in team work accomplished via communication, applying procedures- roles and responsibilities cultivated in training phases that develops staff necessary to populate and operate an organization around the clock, with appropriate transition and vigilance when shifts change.
Team collaboration is disclosed in versed dialogic exchange of interactions that is efficient only when all human actors share a feeling of trust without question. There is a broad agreement on trust in automotive environments where accuracy of information is crucial in building and retaining trust. Proposed benefits of trust include better task performance (Golembiewski & McConkie 1975) and the ability to cooperate (Deutsch 1962; Argyle 1991). There are a number of taxonomies for trust in human-machine communication and interaction (Barber 1983; Rempel, Holmes et al. 1985; Muir 1987; Muir 1994). These taxonomies tend to distinguish three categories of trust (Lee and Moray 1994): (1) observed consistency of behavior, persistence or predictability; (2) belief in competence or dependability; and (3) faith in purpose or obligation, confident responsibility or faith. While faith-based trust is difficult to establish for machines, these taxonomies suggest that trust by consistency and competence can be achieved by explaining the purpose, capability, and reliability of the process (software and information flow in the cockpit) or the system to the users-actors. Thus, when human actors operate mechanical and communication devices in flights they have to build trust in a mutual manner with all the other human actors, in each stage of a flight mission.

The cockpit system has to be tolerant to function and accomplish the mission even when fault occur. Most airline accidents are attributed to errors made by the flight crew (Loukopoulos, 2001; 2003; 2009). One of the greatest challenges in aviation operation and accident investigation is the uncovering of the causes of such an error, as many factors intermingle. That is why a flight mission should be represented via its communication events, as interactions that materialize the intangible reality of a flight. Communication has long been suggested as a critical issue in all aspects of human interaction. Most testimonies in ASRS and National Transportation Security Board database illustrate how critical communication is in aviation and aviation safety, from the cockpit-controller interface to coordination in the cockpit to cockpit-cabin interaction to the management of safety and creation of a safety culture (Krinovos, 2007). Communication has a multi-faceted nature with a variety of settings and situations. Kanki and Palmer (1993) provide a useful structure for the functions communication plays in aviation and aviation safety, especially as it affects crew performance: communication provides information, initiates interpersonal relationships,
establishes predictable behavior patterns, maintains attention to task and monitoring, and it is a management tool.

Cockpit conversation is a very important starting point for any investigation in any aviation failure. The new view of human error has its origin to Fitts (1947) who stressed aviation human factors to examine 460 “pilot error” occurrences, considering them as systematic and connected to cockpit layout. Following this analysis, as described by Dekker (2006), we need to find how actors’ assessment make sense at a time, given the surrounding circumstances encountered in a complex system with multiple, sometimes irreconcilable goals. Furthermore, when cockpit communication actors interact speaking in one language (English) but thinking maybe in their own mother tongues (like Greek) then meaning-making may extend from language relativity (Sapir-Whorf, in Caroll 1956) to meaning of words habitat (Pinker, 2007).

The systems view of the cockpit emphasizes the assemblance of parts, facts, principles and processes forming a unitary whole with human actor operators- interactants. The entity of a cockpit is composed of a set of primitive concepts and formalized rules and criteria that determine when concepts apply. On the other hand, typical instances can be compared to specific phenomena to access similarities and differences. In the systemic view of the cockpit, the latter approach is applied when actor- members are practicing what they have learned through training, where as the former conceptualizes knowledge embedded in mechanical parts and expertise in “doing something based on knowing something” and not vice versa.

In the current proposal, the cockpit meets the system complexity hierarchy that takes predeterminism, self consciousness and language to connect it with the operational sociocultural environment where actors conceptualize rules that operationalize roles, values, and mainly trust in all instrumental parts. Control hardware devices provide messages, signals and symbols that are considered dependable and the human actors provide feedback actions forward, interpret and exchange signals to continue the flow of information that governs each flight. That is why in the collective work of a cockpit in flight, the pilot evolves from an expert to a decision maker (Kohan, 2010) and the Air
Traffic Controller to a gatekeeper of meaning making. Human actors in the cockpit perceive messages from mechanical channels, interpret voice signals received from communication channels and follow rules of compliance imposed by the Air Traffic Controller.

Information based conversation analysis in the cockpit incorporates a cultural account of human action (Hofstede G., 1980; Hofstede G. & Hofstede J, 2004). This focus on conversation, as communicative use of information by the human actors, outgrows the traditional Computer – Supported Cooperative Work (CSCW) situations (Monteiro, 2004). Computers and communication devices in the cockpit are artifacts with purposes following the designer’s intentions but also the intentions of the machine (Suchman, 2009), to be responsive to the others’ actions. Analyzing this interaction is expected to provide useful insights on those operational requirements. Air communication or air-ground communication is mainly using voice-mediated language (Cushing, 1994).

**Methodology of CA**

Conversation analysis (CA) studies all kinds of conversation. It puts under the microscope anything from schizophrenia diagnosis to answering questions in court, and from talking over family matters at dinner to guiding a pilot through fog. All are done through talk and talk-in interaction.

So “conversations” studied are not just the casual chat among friends - though the conversation analyst is interested in those too- but those utterances in social life, business life, healthcare, education, leisure, politics, mission critical occupations and aviation. CA is an established discipline, developed since the pioneering work in the 1960s by sociologist Harvey Sacks (1992). When language is used in interaction it brings in light subtleties that are often invisible or routine from a more “common-sensical”, straight-down perspective.
In the case of cockpit communication, where ATC is included, talk makes things happen, and the conversation analyst has the goal to identify and explain something about how (Atkinson & Heritage, 1984; Hutchby & Wooffitt, 1998). CA seeks to focus on behavioral, and not cognitive or internal, elements of talk-in-interaction. In the current proposal we investigate the situated concerns of interactants inside the physical cockpit, focusing on its virtual aspect when ATC is included and the flight mission could be in the military aviation or civil aviation, when a crisis is observed, unfolds or is under resolution. Furthermore, the current study will incorporate cases for different aviation systems that start from different mother tongues, in order to identify the effect of linguistic factors in effective communication under pressure.

Ethnomethodological inquiry treats social facts as accomplishments (Garfinkel, 1967). Ethnomethodology deals with the “process” instead of “things’, “givens” or “facts of life”; it is the process of creating and sustaining stable features of socially organized environments. In traditional anthropological studies “tribe” is used to disclose an evolutionary stage, to define one society from others and to label and “ethnos”, as any population with members sharing a common culture. The ethnos examined in the current proposal consists of cockpit participants, as well as ATC members that communicate with them. They all share aviation culture in terms of flight mutuality.

CA is really involved with the organization of turn-taking in conversation, starting its tradition with Sacks, Schegloff & Jefferson (1974) that studied the organization of turn-taking in conversation. Introducing the idea of “mundane conversation” they described the formative sense of variable turn form, turn content, and turn length as variable parameters referring to: a) what people have to say b) how they say it and c) the length of the turn they say it. In the case of cockpit conversation this proposal is expected to bring light to fixed turns, formalized lengths and standardized content may be observed, as well as deviance from the protocol, intense turns to correct errors that are consequential (without associating them with previous interactions), as well to how “awareness of the immediate” guides paired- versed interaction that need to react to instant realities.
Sacks et al (1974) in their studies noted that conversation is factual when turn-taking occurs, one speaker talks at a time, and turns are taken with small gaps or overlaps when possible. Turn-taking includes turn-construction and turn-distribution. In the case of cockpit conversation the current study is expected to show how projectability and transition-relevance are accomplished with much inter-speaker coordination. Also, how orientation to rules is displayed and what are the situated practices that require expertise to resolve erroneous communication and accomplish interactions that have to be fault-resolvable and not just fault-tolerant. Cockpit interactants share a mutual subjectivity that is negotiated to establish an intersubjectivity of their own awarenesses while they constantly encode-decode messages “behind observable phenomena of speech” (Hutchby, 2001).

**Analysis of Data and Inquiries**

This proposal applies ethnomethodology (Psathas, 1990; Sacks, 1992) to approach empirical interaction in flights characterized with an event (‘συμβάν’) or crisis (‘μείζον συμβάν’) using transcripts of real crisis/accident cases reported in Hellenic Civil Aviation Authority (HCAA), as well as typical interception conversations revealed for the first time. The Greek case is important as Greece resides in the eastern borderline of the European Union, operates 40 airports in a population of 11 million people and Hellenic Air Force (HAF) estimates 3,500 hours of interceptions per year, coupled with countless readiness, briefing and de-briefing hours.

On the other hand, international and domestic civil aviation flights are crucial for the country due to its geographical location, island configuration and economy and to the fact that it remains a popular destination for in-coming visitors. The spread of airports is represented in the following figure:
In an extensive search in HCAA and with full cooperation of Captain Akrivos Tsolakis and his team, several aviation incidents were discovered with the criterion of having an
Attribution to communication. Indicative crisis cases are: US1549 flight in Hudson River, HCY 522 or ZU522 in Helios Flight from Cyprus, Falcon 900B SX-ECH flight with late Alternate Minister Kranidiotis in Romania, Yakovlev Yak-42 as well as the deadliest aviation accident, the Tenerife Crash (1977).

An unmanned flight that is considered in the data is shown in Figure 2 (emphasis added):

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**Figure 2: Unmanned Predator Drone Transcript**

U.S. military transcript of the radio transmissions and cockpit conversations that Feb 21, 2010 day, obtained by the LA Times through a Freedom of Information Act request (April 2011, USAF).

Understanding communication error, in vocalization or content, is a crucial step to improve flight safety. Barshi (1997) used a cognitive/psycholinguistic approach to analyze natural language, message length, speech rate, and intonation. In Simmons experiments (1978), ATC and pilots take a calm and relaxed-sounding voice as highly regarded, due to its transmitted intelligibility, trust and confidence. Specific crisis cases
have been acquired to explain the order/organization/orderliness of speech actions in discursive practices of aviation actors in emergency preparedness or resolve. Figure 3 contains an excerpt of the iconic flight that “landed” on NY Hudson River.

Figure 3: An Excerpt of transcription of flight US1549 (New York Terminal Radar Approach Control Facility, Jan 15, 2009)

Accident investigation, aviation human factors, situation awareness are sectors to benefit from a communication look in human performance. Situation awareness, workload, stress and trust, human error and reliability, decision making and problem solving are elements of human factors that are negotiated in flight conversation creating social affordances (Gibson, 1977) of aviation conversation. In cockpit situations, “time” is used as a Gibsonian resource affecting decisions and speech acts of all cockpit interactants. A characteristic case of a mission critical real situation is the tragedy with the “dolphin movement” of the Greek Prime Minister’s Falcon in 1999:
One set of problems involves issues of reference, repetition, ambiguity, sequence breaking, and the like. A second set of problems concerns the implementation of SOPs/RoE. The comparison of US and Greek transcripts/cases will inform our understanding on mediated Greek language and will explore strategic crisis management communication, introducing testimonies and restricted-access data, for the first time.

Although, there are highly detailed SOPs, what counts as following them in a crisis situation is not always clear, and sometimes not to be followed at all. All of these problems need to be negotiated in time-critical situations. It will be the purpose of this dissertation to examine how this is done, how, for example, pilots and air traffic controller’s talk, interact, and outeract with orderliness; how they engage in conversation repair; and how they negotiate whose interpretation of an SOP will prevail. Also, in the process, it will be examined how inner and outer identities and culture are sustained in crisis conversation. Additional transcripts acquired from Federal Aviation Administration, as well as landmark cases or air-incidents in US and Greek airspace are used to provide a comparison pool. Structured interviews on selected questions are developed to reflect expert users’ opinions on ATC- Pilot discourse: fighter pilots of two HAF Squadrons, members of HCAA, and Air Traffic Controllers.
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