ARE ERRORS IN AIR TRAFFIC CONTROL SOCIALLY CONSTRUCTED AND DO THEY, AS A RESULT, GET PUT INTO CATEGORIES AND MANAGED DIFFERENTLY?

Thesis work submitted in partial fulfillment of the requirements for the Master of Science in Human Factors and System Safety.

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Date of submission: 2009-06-27

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Version 2.0

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« Tous ces hommes, je les aime, mais ce n'est pas eux que je combats. C'est ce qui passe par eux… »

Antoine de Saint-Exupéry
Vol de nuit, 1931

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ABSTRACT

This report presents the result of a comparative case study conducted within an Air Traffic Control organization with the intent to examine how professional groups rely on the notion of human error to instil the moral values demanded by the profession. It aims to contribute to the generalization of the findings reported by sociologist Charles Bosk in a study about how practitioners account for errors in the domain of American elite surgery (2003). Despite the existence of significant differences between these two domains, the present study revealed that in Air Traffic Control, socialization mechanisms subordinate technical errors to moral breaches in order to create and maintain a high level of mutual trust within operational groups. This not only confirms the socio-constructivist nature of human error but also the fact that unexpected outcomes are considered differently depending on the goals pursued by those in charge of assessing people's behaviour in retrospect. It concludes by emphasizing the need to gain a better understanding of group culture prior to attempting to further improve safety by promoting justness or by engineering resilience into organizations, and discusses the difficulties in doing so.

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THESIS DEVELOPMENT

Introduction

Literature review

Reviewing previous research can help in developing sharper and more insightful questions about a specific topic. Thus, a thorough literature review – when seen as a "means to an end" and not as an end itself – can be very helpful in determining a good and interesting research question (Yin, 2003, pp. 7-9). Such a preliminary work allowed me to better understand why our comprehension of failure within complex socio-technical systems can be significantly increased by the adoption of a socio-constructivist approach of human error (Barraz, 2009, pp. 8-10). Moreover, it also permitted me to emphasize the irreconcilable opposing philosophical positions about the nature of reality (pp. 10-12) as well as some of the immutable cultural and psychological mechanisms that make us resist the adoption of such a worldview (pp. 23-27). Finally, it permitted to position the compromising nature of "just culture" as a means in avoiding a never-ending philosophical debate about our ability (or inability) to capture reality (pp. 31-32).

Area of interest

Amongst the many factors that have the potential to influence our ability to renounce the notion of human error, my review refers to the conclusions of Charles Bosk's case study about the management of failures in the world of American elite surgery (2003). Indeed, in this particular domain, the self-controlled nature of the profession is legitimated by using errors as a means to socialize and exercise power on young recruits (Barraz, 2009, p. 26). This triggered my interest for conducting a comparative research inquiry in the domain of Air Traffic Control within which my experience made me suspect the existence of similar phenomenon.

Potential benefits

Before engaging in such "speculative" research, it was legitimate to ask myself whether it had any potential benefit. At first sight, it did. Indeed, a better understanding of the social mechanisms underlying the qualification process of Air Traffic Controllers may help in improving training success rates. Moreover, penetrating the "culture" instilled into the profession and showing how errors are constructed and subsequently managed could also help in better understanding safety

critical operations at the *sharp-end* [1] of complex socio-technical systems. As a result, the managers in charge of maintaining the highest possible level of safety within such systems may start seeing the human contribution to accidents differently. Finally, and in a consistent manner with the principle of "analytic generalization" (Yin, 2003, pp. 31-32), such a study has the potential to broaden Bosk's main findings to other professional setups[2].

Research question

In the light of what precedes, I choose the domain of Air Traffic Control to conduct a comparative research inquiry driven by the following question:

« Are errors in Air Traffic Control socially constructed and do they, as a result, get put into categories and managed differently? »

It was important to recognize and to address from the beginning the dangerous "biased" nature of this question. Indeed, it contains an *indirect proposition* which suggests that (1) errors are socially constructed; and that (2) their management is not totally independent from the result of this constructionist process. Addressing the influence of such bias on the objectivity of my study was difficult because it raised the whole thematic of field observer neutrality. In this respect, Bosk (2003) confessed very honestly his personal biases and explained how he constantly tried to fight them (pp. 193-213). His experience helped me in keeping the best possible level of objectivity during my interviews as well as during the subsequent data analysis and interpretation stages.

In addition to being slightly biased, my question is also somehow misleading in a theoretical point of view. In this respect, Erik Hollnagel made me aware of the fact that the interesting phenomenon it suggests is not the social construction of errors but rather the social construction of causes. Indeed, it is in the act of managing "errors" that this socio-constructivist process occurs. Thus, in this perspective, errors become "artifacts" or "mental shortcuts" which are

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[1] The idea of differentiating front line operators (the sharp-end) from designers and decision makers (the blunt-end) was introduced by James Reason (1990, pp. xi & 173-216) in his early thinking about epidemiological accident models. The main implication of such organizational view of accidents is that the failures made at the level of those who interact with hazardous processes are determined by a host of factors (Hollnagel, 2004, pp. 62-65). It is in this perspective that the words "sharp-end" and "blunt-end" are used in the present document.

[2] In this respect, Bosk confessed – in an updated edition of his book – that he had the tendency to over-generalize his findings by writing "as if the part was the whole" (2003, p. xvii) and that, as a consequence, similar studies in other work setups would be of great added value (p. 177). The present study is a modest contribution to this wish.

needed (or demanded) by the society for practical reasons but which are epistemologically meaningless. Keeping these subtleties in mind during my research helped me to understand better the social mechanisms I was investigating.

Research strategy

In social sciences, several strategies are available for the purpose of conducting research work. The form of the research question provides an important clue regarding the appropriate strategy to be chosen. In a general manner, "how" and "why" questions are likely to favor the use of experiments, histories or case studies. While experiments are appropriate when the investigator can directly manipulate behavior, histories are preferred when he must rely on documentation or cultural artifacts as the main or sole source of evidence. For what concerns the case study strategy, it applies at best when the investigator has little control over the events and when the focus is on a contemporary phenomenon within some real life context (Yin, 2003, pp. 3-8). My research question, or more precisely its indirect proposition, rises "how" and "why" questions about the socio-constructivist nature of errors as well as about the way these are subsequently categorized and managed. In addition, a field study in the domain of Air Traffic Control didn't provide any possibility to control directly the way controllers perform their duties. Finally, the problem of human error criminalization could easily be seen as a contemporary phenomenon occurring in real life contexts. Thus, I elected to conduct my inquiry on the basis of a case study research strategy.

Preliminary theory

Research design embodies a theory of what is being studied. Such a background provides a starting point that facilitates not only the choice of field contacts but also the conduct of interviews and the subsequent data analysis stage (Yin, 2003, pp. 28-31). By nature, a *comparative* study doesn't require the prior development of a new theory. However, the depth to which the comparison is foreseen to be conducted shall be determined before engaging in data collection. It is with such perspective in mind that I established the following theoretical starting point:

> By studying *social control* [3] and *social support* [4] mechanisms within the world of American elite surgery, Charles Bosk (2003) proposed an explanation about how a group of professionals

[3] In the present context, *social control* refers either to an individual or group's capacity to regulate itself on its own initiative, or to the coercive means at a community's disposal to discipline individuals (p. 18). It usually raises the following typical questions: On what kinds of behavior does somebody's good name rest? What kind of actions

conceptualize its privileges and responsibilities. His report centers on three themes: (1) how a professional group draws a boundary around itself and determines its own identity through the selection and rejection of recruits, (2) how norms of responsibility are articulated and how violations are sanctioned; and (3) how a professional copes with the existential problem of skill and knowledge limits (pp. 3-5). Thus, instead of focusing on what *causes* errors, the study rather concentrates on how surgeons *account* for errors once they have occurred. Its underlying motivation is therefore to contribute to the reduction of errors by increasing our understanding in how workers define error, understand its causes, and think it may be remedied (p. xxiii). The central point of his conclusion is that in surgery, social control of the profession subordinates technical performance to moral performance. Put differently, moral breaches are considered by superiors more serious than technical ones: *normative* and *quasi-normative* errors[5] are managed by excluding the individual from the group while *technical* and *judgmental* errors[6] are forgiven but remembered[7]:

> *" Just as the group can afford to be merciful in the face of technical error since an individual is contrite, submits itself to group authority, and pledges to do better, the group must be merciless in the face of moral error since an individual is prideful, contemptuous of the group's authority, and offers no assurance of future improvement. [...] When the behavior is not extinguished in the individual, the individual is extinguished in the group " (p. 180).*

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discredits him? How are evaluations of competence constructed by superiors? How are such evaluations shared and how consequential are they? (p. 3).

[4] In the present context, *social support* refers to the problem which emerges from the simultaneous necessity to (a) control subordinates' performance by making sure that errors are corrected and not repeated; and (b) allow subordinates enough room for error so that they can learn the judgments and techniques necessary to perform properly (pp. 3-4).

[5] Normative and quasi-normative errors are errors in *assuming* a role. A normative error occurs when somebody has, in the eyes of others, failed to discharge his role obligations conscientiously. This happens when the working understandings on which action rests are violated (p. 51). A quasi-normative error is an eccentric and superior-specific normative error (p. 61).

[6] Technical and judgmental errors are errors in *performing* a role. A technical error occurs when somebody performs conscientiously but his skills fall short of what the task requires (p. 37). A judgmental error occurs when an incorrect strategy or plan of action is chosen (p. 45).

[7] Forgiveness and punishment are two social mechanisms for establishing group membership or boundaries of a professional group. The first is an *inclusion* mechanism; the second, one of *exclusion*. They always coexist in different proportions in different communities at different times (pp. 178-180).

> Thus, moral competence acts as the organizing principle of the surgical professional community within which there is a hypertrophy of *professional-self* control and an atrophy of professional *self-control* (p. 183). In surgery, corporate responsibility is discharged through socialization and education of recruits (p. 185).

Method

Designing the case study

Before determining the *unit of analysis* within which I could conduct my research, the *structure* of my case study had to be carefully considered. In this respect, because of my intention to determine if a well-defined theory's propositions were correct or whether some alternative set of explanations may be more relevant, it appeared that a *single-case* design was preferable than a *multiple* one (Yin, 2003, p. 40). In addition, by considering the fact that the theoretical proposal intended to be verified was drawn from the analysis of a single unit, a *holistic* structure seemed to provide the most appropriate framework for collecting data (Yin, 2003, p. 45). But there is a well-known danger with such type of case studies. First, there is no possibility of direct replication and second, criticism reflecting fears about the uniqueness of the study may lead to skepticism about the plausibility of the results (Yin, 2003, p. 54). In response to this, my case study was positioned as the second piece of a larger holistic multiple-case study to which Charles Bosk's work already belongs. This created two constraints as a result: first that my unit of analysis showed similarities with Bosk's one; and second that my key definitions were not too idiosyncratic (Yin, 2003, p. 26).

Choosing the unit of analysis

The world of Air Traffic Control is wide and complex by nature. Considering the context within which the present thesis work had to be conducted, i.e. a time and resources-limited research concluding a part-time Master of Science program, it was wise to restrict the investigation field. First, for language convenience reasons, I decided to limit my investigations to a geographical area within which interviews and observations could mainly be conducted in my mother tongue. Second, for what concerns the possible working domain in this area, I elected to focus my research on approach control (APP) operations – an Air Traffic Control unit whose aim is to provide a safe, efficient and orderly flow of traffic for departing and arriving aircraft. My choice was motivated by the fact that (1) the "tactical" nature of the work sounded more interesting and complex, (2) this domain had the lower average training success rate; and (3) it had the reputation to be very "hermetic" and therefore more prone to study the "clanic" nature of the profession.

For those readers having limited knowledge in Air Traffic Control, APPENDIX 1 provides a simplified description of approach control operational principles.

Preparing the work

Before engaging in concrete field research activities, I conducted some preparatory work with the intention in mind to acquire a better understanding of how tasks are being performed within the unit of analysis I had chosen. Thus, after a theoretical introduction mainly focused on approach control operations, I made several observation shifts in the control room[8] which were advantageously supplement by two half-day simulator sessions. At this occasion, I could practice several arrival and departure control tasks in a real-time work environment. Considering this special training, my personal aviation skills (private pilot with instrument rating) and eleven years of experience in Air Traffic Control, I believe that my current understanding of the business is sufficient to conduct credible research in this domain and to produce plausible results.

Collecting data

Before starting to collect data in the field, I determined the criteria on the basis of which a representative sample of interviewees would be selected. This resulted in a list of forty-nine persons who were contacted individually and kindly asked to participate to the study. For several reasons explained later in this report, only twenty-one interviews actually took place; which represents a success rate of about 43% (APPENDIX 2). Then, the structure of the foreseen interviews was defined and the questions prepared by carefully determining the *verbal* and the *mental* lines of inquiry[9] (APPENDIX 3). On that basis, field data was collected in two phases. First, a set of thirteen interviews – with an average duration of 90 minutes each – led to the production of an initial case study report. At this stage, missing or incomplete information could be identified as well as the need for supplementary theoretical background. These initial interviews also permitted the identification of complementary data sources – mainly incident and accident reports – which had the potential to corroborate the first set of conclusions as well as to explore

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[8] This phase allowed me to identify the two incidents I used as conversation guidelines during my interviews. Unfortunately, for legal reasons, these occurrences cannot be presented here in detail. However, to keep an acceptable level of understandability, a de-identified version has been established (APPENDIX 4 and APPENDIX 5).

[9] The difference can be better understood when thinking about how a detective proceeds with an inquiry: he has in mind what the courses of events of a crime might have been (the mental line) but the questions he will pose to the suspects (the verbal line) will not necessarily betray his thinking (Yin, 2003, p. 75).

new lines of inquiry[10]. The second phase of the data collection process started with another set of nine interviews – based on the same structure than the initial ones – but dynamically focused on more specific areas. This allowed my initial dataset to be further consolidated and brought to a more mature stage. At the same time, the incident and accident reports identified during the first phase were analyzed and discussed with internal investigators and operational experts. The outcome of this complementary analysis was consolidated with the interview data and the results discussed in an updated version of the case study report. All the interviews were conducted in the form of "guided conversations" – what allowed me to dynamically focus on specific topics depending on the interviewee's background, experience and answers. The outcome of each interview was thoroughly recorded in a report form and stored in an electronic database for the purpose of subsequent analysis or eventual later retrieval.

From raw data to a plausible conclusion

The next step was to find a way to structure my data in such a manner that it became comprehensive and consistent. This was done by grouping the outcome of my interviews into so-called *findings* and *tension fields* and by supplementing these informative patterns with additional considerations drawn from the examination of several incident and accident reports. This allowed me to conduct a structured discussion based on an overall picture summarizing what my research revealed. Then, I needed to demonstrate the merits of my study by attempting to provide an answer to the initial research question. To do so, I identified how Bosk (2003) patterned the final chapters of his book (pp. 168-192) and attempted to apply a similar logic thinking to the conclusive sections of the present report. Finally, a bit of humility was de rigueur. Therefore, I attempted to honestly disclose my biases and explained what I did to minimize them.

Confidentiality and legal aspects

Air Traffic Control is a very sensitive domain with respect to confidentiality and legal aspects. Despite an increased recognition that a "just" culture is necessary to adequately balance accountability and learning, most Air Traffic Service Providers encounter enormous difficulties in protecting their collaborators against unfair criminalization (Barraz, 2009, pp. 23-27). Thus, because of its particularly sensitive nature, the content of the present report had to be carefully

[10] This is consistent with the principle of using data sources in a complementary manner. Indeed, despite the fact that interviews usually provide the most important source of information, no single source should have complete advantage over the others (Yin, 2003, pp. 85-86).

de-identified and submitted to a legal check performed by the lawyers of company within which I conducted my research. As a result, some interesting and valuable details were inevitably lost. However, those readers interested in such details can contact me directly. I will do my best to arrange access to specific data within the limits of what I will be allowed to do.

Maximising results quality

Several tests – derived from the domain of social research – are commonly used to establish the quality of a research study (Yin, 2003, pp. 33-39). In the present case, the technique of *data triangulation* was applied to maximize results quality. Thus, to avoid conclusions based on subjective judgment (construct validity test), multiple sources of evidence were used during the data collection phase: interviews, incident and accident reports, safety correspondence with National authorities, occurrence investigation and safety improvement reporting processes, safety database, student qualification records, training statistics and company organizational charts. In addition, the case study report was reviewed during its development phase by people having different backgrounds and perspectives in human factors. By doing so, my conclusions could be challenged and therefore made more robust to eventual later criticism.

Results

General considerations

The result of the data collection and analysis process is presented hereafter in such a manner that was found adequate for the purpose of subsequently addressing my research question. As it mainly calls on the notion of "culture", a preliminary discussion about the use of this term as well as about the adequacy to break it down into sub-elements has been judged necessary and is therefore preliminarily developed in the next section.

About culture and reductionism

What people mean when they talk about "culture" is extremely diverse and subject to constant controversy. For the time being, none of the hundreds of definitions proposed by many scholars and researchers could be recognized and accepted at large scale. This was interestingly pointed out by Schein (1990) who emphasized that "*each culture researcher develops explicit or implicit paradigms that bias not only the definition of the key concept but the whole approach of the phenomenon*" (p. 109).

Notwithstanding the above, Stolzenberg (2001) argued that there are good reasons in scholarly inquiries to worry about culture, even if it resists all effort at clear definition – especially when we cease to think about it as "*the name of a thing*" but come to view it as a "*placeholder for a set of inquiries*" (published in Borofsky, et al., 2001, pp. 442-444). It is with this perspective in mind that the behavioural and thinking patterns revealed by my interviews were structured and classified into so-called *cultural scripts*. By doing so, I believe that I could reflect at best the organizational climate that reigned within and at the boundaries of my unit of analysis. I found this manner to proceed consistent with Schein (1990) who (a) asserted that in order to understand better how organizations function, we need explanations for variations in climate and norms and that this need ultimately drives us to deeper concepts such as "culture" (p. 109); and (b) proposed a definition of culture[11] that reflects many of the phenomena I could observe and discuss.

This explains so far why I found adequate to present my results in the form of cultural elements. But we should go one step further and discuss also the adequacy of the *reductionist* nature of my approach. Indeed, as Chick (2001) concludes in his discussion bout the utility of cultural units: "*Reductionism has been an extraordinarily successful scientific strategy but it is not the basis for every important insight … Many properties emerge at higher levels of organization that cannot, in principle, be predicted from the understanding of the properties of lower level components*" (p. 105). Nevertheless, the idea that cultures are "patterned" – and that these patterns are composed of specific traits – is something that dates to the early days of American anthropology. Indeed, culture was initially seen as the assemblage of elements that come together through diffusion and that get modified within groups in such a manner that a relatively consistent pattern of thought and behaviour emerges (Chick, 2001, pp. 95-96). Concerning my research question, we have seen that it contains an indirect proposition that suggests the presence of an underlying socialization process. This is where the notion of culture becomes interesting – as culture is known as perpetuating and reproducing itself within groups through the socialization of "would-be" members (Schein, 1990, p. 115). Thus, by emphasizing individual *cultural scripts*, I could simplify the problem and open the door to a discussion on how each of these scripts gets "socialized" within the group. This allowed an indirect approach of my research question via the phenomenon of group socialization and the successful drawing of what I believe is a credible conclusion.

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[11] According to Schein (1990), *culture* is (a) a pattern of basic assumptions, (b) invented, discovered and developed by a given group, (c) when it learns to cope with its problems of external adaptation and internal integration, (d) that has worked well enough to be considered valid and, therefore (e) is to be taught to the new members as the (f) correct way to perceive, think and feel in relation to those problems (p. 111).

Organizing my data

As previously mentioned, the raw data collected in the field had to be carefully organized in preparation for a subsequent structured discussion of my research question. As a result, the information drawn from the twenty-one individual interviews is presented hereafter in the form of *findings* (part 1) and *tension fields* (part 2). While findings are advantageously described by nine *cultural scripts*, the tension fields emphasize several unresolved contradictions suggesting more research work. In addition, a "Bosk-like" error taxonomy table more specifically focused on Air Traffic Control operations could be established (part 3) and the way human error emerges from the investigation process that inevitably follows an occurrence be explained on the basis of the examination of specific incident and accident reports (part 4).

Part 1 - Findings

The following nine *cultural scripts* present the outcome of the twenty-one individual interviews in the form of structured patterns describing each the culture "of" something:

1. The culture of excellence
2. The culture of service
3. The culture of error
4. The culture of justness
5. The culture of socialization
6. The culture of "normal" deviance
7. The culture of "Highlands"
8. The culture of "Hollywood"
9. The culture of silence

These patterns reflect in principle opinions shared by a large majority of the interviewees. However, for illustrative purposes, they were, where deemed necessary, enriched with personal testimonies or mere individual point of views.

The culture of excellence

In Air Traffic Control, the prevailing paradigm – which is progressively inseminated by socializing young recruits into the profession – is "*Air Traffic Control is a tough job for tough guys*". Indeed, controllers are clever people, used to be obeyed without discussion, and extremely

confident in the way they are performing their duties. Without a high level of self-confidence, they are unable to maintain the degree of abstraction[12] necessary to achieve the stage of risk self-consciousness demanded by the constant search of an optimum balance between safety and efficiency (Baumgartner, 2005). Interviews confirmed that a high confidence level can only be achieved and maintained within a team where mutual trust predominates. This is particularly true for approach control operations where aircraft evolve in a single volume of airspace shared by three controllers (departure, arrival and tower) working each on different frequencies[13]. Thus, trustworthiness is seen as the main criterion on the basis of which it is determined whether or not somebody is eligible to integrate the profession[14]. Moreover, repetitive errors seem to erode the trust granted by the group to its members in such a manner that if somebody breaches a certain limit, the community insidiously engages in a process of elimination. In this respect, it is interesting to note that the members of the group rapidly feel whether or not a "would-be" member is trustworthy, i.e. eligible to become a "good colleague". If a bad feeling develops, more attention is paid to the skills of the candidate which are finally declared insufficient – providing therefore an official reason for his elimination. This suggests that "technical" causes are socially constructed by the group and unconsciously brought out as a valuable pretext to eliminate a candidate whose "moral" qualities were judged inadequate. Thus, in a consistent manner with Bosk's findings, technical errors seem to be subordinated to moral performance. To summarize, trust is a "moral" quality that lies at the root of the profession's culture of excellence. It is the

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[12] The problem is that without this ability to abstract, the controller is unable to cope with the idea that a blip on the radar screen means several hundreds of people sitting in an airplane. As a consequence, he may develop an inadequate risk-consciousness level – either too high or too low –and therefore become dangerous for the profession. In this respect, operational incidents are seen by controllers like *self-regulating* mechanisms (Baumgartner, 2005). Indeed, in the aftermath of a near-miss, the controller's level of abstraction – which lies at the root of an adequate feeling of confidence – becomes unstable and puts his "well-being" as well as the safety and efficiency of the system in jeopardy. If this unstable state of "acute consciousness" remains unmanaged by the individual; the level of trust granted by the group becomes sufficiently eroded to justify the engagement of an eliminatory process.

[13] The situation is different for upper airspace operations where aircraft evolve within demimitated sectors – each of which lies under the responsibility of a single "radarist" controller usually helped by a "coordinator".

[14] In their study about group-controlled transition rites in Air Traffic Control, Hallier & James (1999) reported that the framework used to train new recruits was also a means to conduct separate tests of admission which concentrated not so much on the trainee's technical competences as on their willingness and capacity to become a "loyal" member of the unit. In this respect, two qualities were found essential: (1) *reliability and dependability* i.e. the ability to give operational support to colleagues without question or condition; and (2) *divestment from the past* i.e. the ability to surrender previous operational habits (p. 55).

basis on which controllers build the self-confidence they need to perform efficiently. This explains why untrustworthy people trigger an insidious exclusion process which brings out inadequate skills as the main reason for extinguishing the individual from the group.

The culture of service

A large majority of Air Traffic Controllers are aviation enthusiasts. They have the laudable willingness to act in a manner they believe is adequate to make the whole system work better. This creates a tendency to confuse the notion of "providing the service" with the notion of "making favours"[15]. In approach control operations, this tendency seems to be further reinforced by the nature of the job itself; as testified by an interviewee who emphasized that:

> "*We've been trained to optimize the final sequence and have the tendency to do so even when it is not expressly requested by a crowded or difficult traffic situation*"

Numerous examples of "laudable favours" were discussed during the interviews – the most impressive being certainly the predominating feeling a particular airline pilot community developed with respect to the conduction of approach control operations around their home base: "*we are always pushed*". In that case, the service culture of approach controllers revealed to be so developed that high speed approaches were systematically proposed to pilots who were not comfortable with such procedures or who didn't need at all that kind of favour. However, such an attitude – even if perfectly laudable – has significant consequences. First, making favours often necessitates allocating more cognitive resources to monitor particular situations. Indeed, taking several aircraft out of their official route requires more attention than letting them fly standard procedures; and creates additional opportunities for error. Second, controllers sometimes underestimate the negative consequences of their favours on the global aviation system. This phenomenon was addressed in detail by the French Air Navigation Service Provider by means of a dedicated Safety bulletin in which several situations (DGAC, 2008b) were interestingly put in relation with the wrong beliefs controllers cultivate concerning the real benefits of their actions (DGAC, 2008a). In this respect, Ruitenberg (2009) has also emphasized that these "micro-improvements" – especially when done at short notice – should be carefully considered in the light of additional workload imposed to the pilots (pp. 5-6). To summarize, the culture of service is laudable but may create deeper problems within the system which can be seen as additional and unnecessary sharp-end error contributing factors.

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[15] In French, the distinction is made between "*fournir le service*" and "*rendre service*".

The culture of error

Concerning the delicate question of human error, my interviews strongly confirmed the necessity to keep the concept alive. Indeed, despite the fact that modern human factor ideas such as "local rationality", "hindsight bias", "counterfactuals" as well as the importance to "trade indignation for explanation" in the aftermath of failure (Dekker, 2006) were indirectly recognized by my interviewees, all of them needed to believe that controllers immutably commit errors at the workplace[16]. This raised an ambiguous situation which demanded an explanation. In this respect, amongst the many historical, psychological and philosophical factors emphasized by my literature review and proposed as plausible reasons why people resist new human factor paradigms (Barraz, 2009, pp. 23-27), one was found particularly relevant in the present case: the insidious need self-regulating social control mechanisms have for the notion of human error. In fact, in Air Traffic Control, group self-regulating mechanisms not only permit to socialize young recruits into the profession – as emphasized by Bosk in the domain of American elite surgery and addressed later in the present document – but also permit to monitor the level of trustworthiness granted by the group to its "confirmed" members. Indeed, when a group member goes "too far" with respect to what others perceive as acceptable (or normal) deviance, there is a strong tendency to manage the situation in autarky. In principle, this shouldn't be possible because aviation regulation requires official incident notifications to be made in case of "*Airproxes*", i.e. situations where the distance between aircraft as well as their relative position and speed have been such that safety "*may have been compromised*" (ICAO pans ops doc 4444). But the entirely negotiable nature of this definition inevitably creates situations where no official notification is made. In such cases, the management of errors remains at the level of the group within which the situation occurred. In this respect, my interviews revealed that such situations trigger a self-regulating mechanism that deserves several purposes. First, it allows overconfidence created by past success to be temporarily dampened; reducing momentarily the chances that similar errors get reproduced by the same person. Second, it creates at the level of the individual involved a moral obligation towards a group who give him temporary protection under the condition that he recognises his "fault" and takes the measures necessary to avoid reoccurrence (inclusion mechanism). Third, it allows the group to question the level of trust granted to the individual and to engage, if necessary, in a process of elimination (exclusion mechanism). When the situation goes so far, it is usually argued that the individual had repetitively demonstrated a significant lack of personal skills and is therefore no more eligible to

[16] This interestingly reflects Hollnagel's proposal to acknowledge the societal utility of human error as a term while replacing the concept by modern theories about human action and performance variation (2007).

safely exercise the profession. To summarize, the culture of error in Air Traffic Control is ambiguous because it lies somewhere between old-fashioned and modern human factors paradigms. This can be explained by the necessity for the profession to maintain self-regulating group control mechanisms that cannot function without keeping the notion of human error alive.

The culture of justness

As emphasized by Dekker (2007), the purpose of a "just" culture is to find an adequate balance between (1) the societal need to hold people accountable for their mistakes; and (2) the organizational need to learn from failure. Being successful in this endeavour requires, among other things, that sharp-end operators be carefully protected against the insidious effects of reprimand and punishment. In this respect, my inquiry emphasized a surprising and interesting paradox: the introduction of a "just" culture has created an aftertaste of "unjustness" within the operational managers' community – this, mainly for two reasons. First, because managers feel increasingly blamed for their actions by sharp-end operators who don't seem to recognize the existence of a blunt-end local rationality; a just culture side-effect identified by Reason (2005) under the qualifier of "blame-shift" (p. 125). Second, and more importantly, because they feel unjustly excluded from an essential safety learning process others consider to be threatened by their inability to fairly treat people in the aftermath of critical occurrences. Thus, instead of being "unseated" from the process of improving safety and indirectly "blamed" for their inability to adequately manage errors; operational managers expressed the sincere wish to be more actively involved in a unified internal quest against the external unfair criminalization of human error. This paradox revealed the following double bind: a "just" culture can only be lived as such when it is simultaneously addressed at *structural* level – i.e. by putting in place sharp-end as well as blunt-end blame protective mechanisms; and at *cultural* level – i.e. by ensuring that all the actors involved have understood and acknowledged the complementary nature of their mutual roles.

The culture of socialization

Socialization is a concept that was first illuminated by Durkheim in relation to how children learn social norms. It concerns the process by which individuals come to understand and internalize the attitudes and values inherent in a particular social role and which are distinct from those of society in general (Lester & Tritter, 2001, p. 857). At the root of professional socialization lies the question of *social control*, i.e. the means deployed by a profession to set its boundaries and determine its identity through mechanisms for granting or refusing admission to "would-be" members (Baszanger, 1985, p. 133). In Air Traffic Control, the socialization process of *young*

recruits [17] goes through two distinct phases: basic training and on-the-job training[18] (OJT). The basic training phase takes place under the responsibility of a certified school and aims at instilling the knowledge to be acquired before approaching the field of operations. The criteria applied to assess a candidate's eligibility to pass this stage are merely technical and can be easily appreciated by theoretical and practical examination sessions. Those who fail to demonstrate that they have reached the required level of performance are simply eliminated. Those who succeed in doing so obtain a *rating* that permits them to commence the on-the-job training phase. At this stage of his development, the trainee joins an operational group within which he is expected to acquire the skills and demonstrate the attitude necessary to safely perform the duties of an Air Traffic Controller. Hence, he progressively commences to work with real traffic under the close supervision of *coaches* [19] who will attempt to determine whether he has the potential to become a "good colleague" or, in a consistent manner with the group's *culture of excellence*, whether he can ultimately be considered trustworthy. This is done on the one hand by continuously evaluating the objectives and the performance standards applicable to each training stage and on the other hand by carefully attempting to size up the "moral" values of the candidate. While the former constitutes a mere technical appraisal based on standard European training regulations, the latter introduces a quite subjective component in the evaluation process. In this regard, my interviews revealed that the candidate has to demonstrate: (1) the ability to manage stressful situations, (2) a high level of personal maturity; and (3) the ability to "socially integrate" the team. Whereas the first two factors can be quite objectively assessed by observing and discussing the candidate's performance at the workplace, this is definitely not the case for the last one in relation to which

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[17] In my text, I make an important distinction between *young recruits* (also sometimes called *trainees* or *candidate*s) and *newcomers*. The former qualification applies to individuals seeking for ultimately obtaining an Air Traffic Control license while the latter applied to newly licensed controllers on the way to join the group as new colleagues. When distinction is not necessary, I use the generic term "would-be" member to encompass all these different qualifiers.

[18] In fact, we will see in the next section that the socialization process extends beyond this official training phase. Indeed, when the candidates gets his license, he becomes a *newcomer* and he is still expected to demonstrate that he is worthy of the trust that was conditionally granted by the group.

[19] In this respect, it is interesting to note that in the organization within which I conducted my research, becoming a coach is not a personal choice but a contractual obligation. Indeed, each controller having more than two years of experience undertakes regular coaching shifts after having received appropriate training. This interestingly shows that the whole group is involved in the socialization process of "would-be" members. Moreover, due to the fact that becoming a coach is not subordinated to individual predispositions and personal skills, some of them inevitably perform worse than the others. They inherited the nickname of "student killers" and are from time to time used as such by the group to harshly evaluate doubtful recruits.

several additional factors seem to enter into consideration. First, the trainee has to demonstrate that he is capable to impose himself towards the group while at the same time being submitted to the contradictory vagaries of his coaches. Second, he has to accept to be constantly confronted with his errors and to demonstrate that he is honestly struggling to avoid their reoccurrence. Third, he has to stick to the application of strict operational procedures while observing the "tough" guys' demonstrations of virtuosity. Fourth and more difficultly, he has to demonstrate the ability to understand and to successfully apply the undocumented "way of doing things" that predominates within the group. As already emphasized in the section discussing the group's *culture of excellence*, those candidates who fail to demonstrate adequate "moral" values are more harshly judged at the level of their skills which can ultimately serve as the official reason for their elimination. To summarize, as training progresses in time, the socialization process increasingly focuses on "moral" values in order to determine the candidate's potential of trustworthiness and decide whether he can be ultimately considered a "good colleague". Those who fail to meet these expectations are insidiously eliminated under the pretext of possessing insufficient skills.

The culture of "normal" deviance

Interestingly, the socialization process described above seems to continue for a while after successful achievement of the two training phases and getting of the Air Traffic Controller *licence*. Hence, once the newcomer is finally authorized to work "solo" in the team within which he successfully achieved "on-the-job" training, he is pushed to behave like those "tough guys" he was morally obliged to observe and secretly inclined to admire. Deviance from the strict respect of procedures that was previously imposed by the group insidiously begins[20] - as illustrated by the following story told by one of my interviewees:

> "*I remember the first solo shift from a young controller who obtained his license a few days ago. He worked very carefully and applied comfortable safety margins; what is perfectly understandable for a beginner. What surprised me was the immediate reaction of the 'old guys' who observed him very carefully. They insidiously put a lot of pressure on his shoulders by inciting him to 'take aircraft in-between' or to apply tricks he was not really comfortable with. As a newcomer myself, I was astonished and unable to react*"

It is therefore time for the young trustworthy controller to show that he has the self-ability to become in his turn a "tough guy". In this respect, strict compliance with procedures will be taken

[20] This is consistent with the findings of Hallier & James (1999)who reported that *divestment of the past* was a necessary quality newcomers had to demonstrate if they wanted to be accepted as trusted members of the unit (p. 55).

by colleagues as a sign of non-willingness to integrate the group. Thus, proof of virtuosity and efficiency in the spirit of the group's *culture of service* is for the newcomer the last obstacle to overcome before being considered "one of them". Inability to do so inevitably erode the trust conditionally granted by the group and may in extreme situations engage a late process of elimination. Notwithstanding what precedes, deviance not only affects the newcomers well on the way to achieving their integration process but also the confirmed members of the group[21]. Indeed, it is widely acknowledged that people, as a rule, never carry out a task exactly as taught or prescribed (see Hollnagel, 2004, pp. 144-159; and more specifically Hollnagel & Amalberti, 2001). What they do instead is to "adjust" their actions to meet the perceived demands and constraints of the situation so that problems can be avoided in the short or medium term. I had personally the opportunity to witness such adjustments during my observation shifts in the approach control room – one of these having resulted in a loss of wake turbulence separation minima between two aircraft in final (APPENDIX 5)[22]. In no case, the reaction of the controllers involved was such that I could have suspected the occurrence of an abnormal situation. It was just "normal work" conducted in conformance with the group's *culture of service*. To summarize, human performance adjustments represent "normal work" rather than deviations. As a consequence, it is "normal" for the newcomers to adopt the tough guy's way of doing things as well as it is normal for the tough guys to constantly adapt the prescribed procedures to the specificity and the variability of the operational context.

The culture of "Highlands"

Air Traffic Control is an over-regulated business. In Europe, Air Traffic Service Providers are meticulously supervised by National Regulatory bodies whose main task is to make sure that Air

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[21] When talking about deviance and deliberate violations, it is of the utmost important to make a clear distinction between *rules* and *procedures*. A rule is for instance the minimum separation to be maintained horizontally and vertically between two aircraft in a specific environment. In a general manner, controllers struggle never to violate rules in a deliberate manner. However, they are sometimes forced to deviate from standard procedures – like for instance when they handover an aircraft to an adjacent center while it is still flying in their area of responsibility. The problem is that such deviations become "normalized" in time and are no more a matter of discussion. They constitue an important contribution to the phenomenon of "drift into failure" that absolutely needs to be captured and better understood by those wishing to make real progress on safety (Dekker, 2005, pp. 27-30).

[22] Unfortunately, the context within which I conducted my research did not allow me to talk to the people present at the time. Fear and mistrust was prevailing within the group as a consequence of two criminal procedures running against its members. This tremendous experience showed me the difficulties modern safety organizations have to expect when engaging in a better understanding of workplace trade-off mechanisms.

Traffic Services are delivered in accordance with well-defined and mandatory safety standards and regulations[23]. Notwithstanding the fact that the companies in charge of providing these services are extremely regulated, I found that the *profession* of Air Traffic Controller has a significant "clanic" nature. Indeed, the cultural scripts described so far largely support this assertion. Let's for instance come back on the socialization process of young recruits into the profession: it is the members of the group (instructors and coaches) who train and evaluate the candidates. In case of doubt about a particular trainee, a special meeting is called by the training manager who has no other choice than trusting the judgement of coaches, especially with regard to the most subjective evaluation criteria[24]. We have also emphasized that despite the presence of corporate safety reporting systems, deviance from procedures are in principle covered up at the level of these groups – which can be seen as a self-regulating mechanism that allows the community to engage an insidious exclusion process towards those individuals who are not worthy of the trust they were initially granted. Moreover, such groups have difficulties to accept external interference – such as the harsh imposition of procedures or working methods. This creates a difficult situation for the managers in charge of implementing new regulations or safety corrective measures[25]. In fact, for the members of the group, managers are not expected to question and modify the internally agreed way of doing things. Their main role consists rather of "caring about individualities" in such a manner that working conditions remain consistent with the group's cultural scripts. Baumgartner (2005) has proposed the "castle" metaphor to explain this interesting protective mechanism. Indeed, maintaining performance, i.e. a good balance between safety and efficiency, can only be achieved if controllers have the self-ability to keep a certain level of abstraction (or risk consciousness) with respect to the "reality" that lies behind

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[23] In this respect, Eurocontrol – the European organization for the safety of air navigation – has released a set of European Safety Regulatory Requirements (ESARRs) which, in a consistent manner with the standards and recommended practices advised by the International Civil Aviation Organization (ICAO), reflect how Air Traffic Service Providers should deploy their Safety Management System. As Eurocontrol has, in principle, no legal authority on its member States, it is usually at National level – by means of the aviation law – that compliance with these requirements become mandatory. As a consequence, National supervisory bodies are tasked to verify their adequate application by the Air Navigation Service provider in charge. Those who are interested in more informations about ESARRs and safety in general can visit the Eurocontrol web site (http://www.eurocontrol.int).

[24] In particular the candidate's ability to socially integrate the group – see "culture of socialization".

[25] Forcing the evolution of a group culture is particularly difficult. In this respect, Schein (1990) reminds us that "*every group and organization is an open system that exists in multiple environments*" and that "*changes in the environment will produce stresses and strains inside the group, forcing new learning and adaptation*" (p. 116). As a result, the group deploys protective mechanisms against what it perceives as "external aggressions".

the radar plots. This requires a rigid and stable framework of rules and procedures as well as a certain freedom in defining and performing operational duties. Thus, controllers systematically reject new norms and standards by "erecting the walls of the castle" when changes are imposed from the outside without prior involvement of their community. Thus, achieving performance requires that controllers are involved in the evolution of norms and regulations in such a manner that they can keep the level of abstraction they need to perform their duties with sufficient confidence. This suggests that in Air Traffic Control, it is team performance that predicts cohesiveness and not the contrary[26]. But we have also seen that even if the group protects its integrity by joining forces against external "aggressors", it is also composed of individuals who constantly observe each-other in order to detect deviations that may erode the trust granted to its members – as confirmed by the following example raised by a former tower controller:

> "*I was on duty during the morning of the 25th of December. The weather was fine and I had no traffic on my radar display except an incoming VFR flight. To save time to the pilot, I proposed an approach in the opposite direction of the runway currently in use. He accepted and made a safe landing. Just after touchdown, the intercom system rang and my colleagues from the approach control room congratulated me for my efficiency*"

In that case, the controller showed a good "culture of service" while having adequately cared about safety. He positively responded to the trust granted by his colleagues, which was particularly important for him at the time because of his newcomer status within the group. Finally, it is interesting to mention that the protective and segregationist mechanisms described above also sometimes apply to the group members themselves. Not only because untrustworthy colleagues are insidiously excluded but also because those trustworthy members who accept to undertake non-core business responsibilities – such as becoming part-time expert in projects or collaborating with the corporate safety department – are evicted by a "nucleus" of people who have the tendency to question their integrity and marginalize them as a consequence. To summarize, the discovery of socialization mechanisms, errors cover up tendencies, resistance against external interference, mutual observation and internal segregation phenomenon showed up that the world of Air Traffic Control can be seen like an aggregation of self-regulated "clans" which are all part of a well-organized overarching structure obliged to operate in an extremely regulated environment. This "audacious" conclusion may raise some scepticism; especially in the

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[26] This is consistent with the findings of Fullagar & Egleston (2008) who questioned the "*forming, storming, norming, performing*" group developmental sequence model suggested by Tuckman (1965) within communities where social interaction is not necessary for the completion of the task.

light of the brevity and restricted scope of my research work. In this respect, two factors reinforced my convictions and may help in blunting such potential criticism. First, I had enormous difficulties to "penetrate" the profession and to talk to its members (see APPENDIX 2). Amongst seventeen requests addressed to active controllers and students, three persons accepted an interview session while most of the remainders virulently reacted towards their operational manager[27]. Thus, my intrusion created a deep feeling of anxiety which was further reinforced by the predominating context of mistrust resulting from ongoing prosecutions against three Air Traffic Controllers (p.42). Second, disparate perceptions about the "clanic" nature of the profession emerged depending on the social position of the interviewees. While former students eliminated during the OJT phase could openly talk about the existence of such cultural scripts and even provide numerous supporting examples, such phenomena were only indirectly revealed during interviews with group members or operational managers. This suggests that the frustration of those who became "victims" of these eviction mechanisms created a viewpoint that allowed better perception of the self-regulated nature of the profession. Obviously, one may counter argue by pretending that without ongoing criminalization procedures I would have had more open access to the community; or that the frustration of those who are evicted from a very demanding training program creates biased judgments about the real nature of the profession[28]. Nevertheless, I strongly believe that my findings – even if not rigorously demonstrable – largely support the idea that such self-regulated and clanic nature[29] exists.

The culture of "Hollywood"

Talking about deviance and violations inevitably raises the question about the existence of "cow-boys" within the profession. In this respect, a large majority of interviewees honestly disclosed that such individuals exist – but fortunately only in minority. I have even been told that within

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[27] This appears to confirm the fact that the controllers consider the main role of their operational manager to be the handling of individualities when the cultural scripts of the group are endangered.

[28] See also the section about perception of social control mechanisms later in this document.

[29] One of my reviewers made me aware of the fact that the relationship between the clanic nature of professional groups and the term "Highlands" used to qualify the related cultural script may not be obvious to everybody. In fact, Scotland is known to be country within which a large and complicated structure of clans emerged between the 12th and the 13rd century. Two major clanic systems, predominant at the time, were governed by the "Lowland" and the "Highland" families. Amongst the many differences between these two systems, the "Highland" families are the most famous as they identified themselves by specific tartans, wear kilts and played the great Highland pipes. It is for this reason – and nothing more – that I choose the qualifier Highlands to characterize this clanic cultural script.

the surrounding airline pilot community, an Air Traffic Controller inherited the nickname of John Wayne! Fortuitously, during one of my interviews, I realized that I had the chance to sit in front of this "Hollywood myth" as the following statement spontaneously emerged:

> "*In my opinion, a good Air Traffic Controller knows where his limits are and has the honesty to confess them, especially when he is confronted with a difficult traffic situation. This can only be achieved by carefully 'pushing the system to the edge' – not only in the simulator but also during real operations. I'm personally in a good position to talk about it because I inherited the nickname of John Wayne*"

Unfortunately, due to the brevity and late occurrence of this interview, I had no possibility to assess the influence such a personality may have on the group and especially on the socialization process of its newcomers. However, the following assertion coming from the same individual makes me suspect that the human error paradigm prevailing at the time he was supervisor allowed him to legitimate his authority by deploying "Bosk-like" social control mechanisms based on error forgiveness and "in-return" moral obligations (Bosk, 2003, pp. 112-146):

> "*I remember having witnessed a very serious incident when I was responsible for tower control operations. After temporary withdrawal of the involved controller from the position, I gave them a roasting and warned that if something like that happens again, I would personally denounce them to the supervisory authorities*"

This reinforces my initial feeling that the social control mechanisms identified by Bosk (2003) in the domain of American elite surgery also exist in Air Traffic Control. However, it would be scientifically loose and incorrect to over-generalize these findings. Not only because they were drawn from a single interview but also because they rise interesting questions calling for deeper research: are such behaviours in disappearance or do they get replicated within the group as the seniors are leaving? Is it necessary to have such personalities in the group for the purpose of maintaining its clanic nature? Is it good or bad for safety? Unfortunately, as these questions couldn't be rigorously addressed within the scope of my study, we can only conclude here that "cow-boys" exist in minority and that these individuals may be more prone to make usage of error forgiveness mechanism in order to legitimate their authority.

The culture of silence

In a general manner, the expression "culture of silence" relates to a condition or matter which is known to exist, but by tacit unspoken consensus is not talked about or acknowledged (source: Wikipedia). In this regard, my research revealed that despite the existence of "modern" safety reporting systems, such a culture was predominant in the area within which I conducted my

study. Indeed, in this particular case, the company had since several years introduced a formal Operational Incident Reporting system (OIR) that efficiently protects its employees against "evil-minded" managerial actions. Furthermore, this system was advantageously supplemented by a confidential Safety Improvement Reporting process (SIR) by means of which any safety concern, not necessarily in relation with operational occurrences, can be discretely and securely communicated. Notwithstanding the above, a rough comparison between the number of infringements automatically recorded by technical systems[30] and the amount of Operational Incident Reports actually filled by the controllers revealed that a large majority of separation infringements are not subject to official reporting. Furthermore, several interviewees honestly confessed that they stopped filling Safety Improvement Reports for several reasons – the main being that a colleague had been criminally prosecuted for having honestly reported an incident[31]. Finally, as previously mentioned, during one of my preparatory observation shifts in the control room, I had the opportunity to witness an incident that was – for good reasons – never officially reported (APPENDIX 5). The point here is not to "blame" people for their "laziness" or for their lack of participation in improving safety; but rather to put these interesting findings in relation with the "clanic" nature of the profession. In this respect, it seems that protecting the group against the intrusions that may result from an open disclosure of cases is considered more important by its members than participating to a dubious safety learning process. In other words, the *resilience* achieved by protecting the group is perceived by its individuals as being more beneficial for safety than the lessons that could hypothetically be learned from isolated cases[32].

Part 2 – Air Traffic Control error taxonomy

Within the domain of American elite surgery, Bosk (2003) identified four categories into which errors are classified by surgeons in their attempt to explain failure: (1) technical errors, (2) judgmental errors, (3) normative errors; and (4) quasi-normative errors (p. 37). While technical

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[30] All separation infringements are automatically recorded and stored in a database protected against "evil-minded" access. At the time of this writing, no agreement was found between the unions and the corporate safety department in respect to the willingness of the latter to make usage of these data for the purpose of improving safety.

[31] Other reasons are mainly in relation with repetitive deceptions in respect with the way people's contribution to safety has subsequently been managed. For example: insufficient response times, meaningless feedbacks or even, in the worst case, blaming in return!

[32] This is an example that shows how teams learn to adjust their own functioning in order to "absorb" the propagation of non-recovered "sub-optimal" actions amongst its members (Hollnagel & Amalberti, 2001).

and judgmental errors are errors in *performing* a role, normative and quasi-normative breaches are errors in *assuming* a role. The fundamental difference is that the former requires adequate knowledge and skills while the latter demands a certain "attitude" or "behaviour" in respect with how things are being done. A similar distinction in the ways people talk about failure in Air Traffic Control could be identified during the interviews and is presented hereafter (Table 1).

Technical errors	Judgmental errors	Normative errors	Quasi-normative errors
Inability to maintain an adequate balance between safety and efficiency.	Deploying a plan without making sure that a safe escape lane is available.	Inability to demonstrate the capability to impose itself towards the group.	Inability to submit to the contradictory vagaries of coaches (students only).
Inability to detect and adequately manage conflicts within agreed traffic load limits.		Inability to recognize and accept errors as well as to demonstrate willingness to avoid reoccurrence.	
Inability to constantly anticipate situations and to plan ahead in order to avoid the appearance of conflicting situations.		Inability to understand and apply the (sometimes undocumented) working methods and practices of the group.	
		Endangering the group performance by behaving in an unexpected manner.	
		Inability to achieve a level of abstraction that allows maintaining an adequate degree of self-confidence.	
		Ignorance of personal limits and inability to admit them in a difficult traffic situation.	

Table 1 – "Bosk-like" error taxonomy in Air Traffic Control

Part 3 – Tensions and unanswered questions

The data collected during the interviews also emphasized some interesting contradictions which were grouped in the form of the following four *"tension fields"*:

1. Perceiving social control mechanisms
2. Training by selecting and helping
3. Inspiring respect while being submissive
4. Ensuring Safety by self-regulating

These contradictions reflect irreconcilable positions between people who attempt, with different roles and hierarchical positions, to accomplish the overarching mission devoted to Air Traffic Control organizations – ensure a safe, efficient and orderly flow of traffic. Furthermore, they raise interesting questions that would need more research in order to be satisfactorily answered. They are presented and briefly discussed hereafter – not only because they contribute to the present research work – but also because they may trigger interest for additional research in this fascinating domain.

Perceiving social control mechanisms

We have seen that one of the difficulties people encounter in their attempt to "become" Air Traffic Controllers is the need to adapt to the (sometimes) contradictory vagaries of their coaches during the OJT phase[33]. In a consistent manner with Bosk's error taxonomy, we have concluded that the inability to do so constitutes a "quasi-normative" error that may lead to the elimination of the candidate under the pretext that he has not demonstrated appropriate skills. As previously mentioned in this document, discussions with coaches have shown that the problem is perceived differently from the "inside" of the group. In fact, insiders assert trying to pass on the astuteness of the profession without forcing students' acceptance. This creates a tension between students and coaches with respect to the perception (or the existence) of social control mechanisms[34]. This tension was explicitly addressed during an interview and explained by a local training manager as being the consequence of the candidate's frustration to be eliminated:

> "*I remember a student for whom I had recommended an interruption of the training process. During a discussion with him, he pretended that he had never been encouraged by his coaches when he was facing difficulties. The consultation of the cycle reports interestingly revealed the contrary. This guy was simply frustrated and had understandable difficulties to accept my decision*"

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[33] Interestingly, this was also emphasized by Hallier & James (1999) in the following trainee statement: "*a particular mentor prefers a movement to be done one way and another one will prefer it done another way. So you have to remember that when you are training with that particular person to do it that way and when training with someone else to do it a different way*" (p. 57). Not complying with that "rule" constitutes, according to Bosk's error taxonomy (2003), a "quasi-normative error", i.e. a "normative" error which is not shared by all coaches but which is eccentric and coach-specific (p. 61).

[34] It is fair to mention here that I had unfortunately no possibility to interview students engaged in the OJT phase and that I base my conclusions on discussions conducted with former students. This may introduce a bias created by the frustration those people suffered to be excluded from the profession. In addition, the interviews with coaches were limited to discussions with a reduced number of persons who may not be representative of a larger sample.

Nevertheless, unseated students "feel" differently. For them, coaches responded to their moral inadequacies by constructing weaknesses at the level of their personal skills and by unjustly "brandishing" the result in the form of an objective eliminatory reason. Who is right? Answering this difficult question by credibly resolving these contradictory opinions is something that would demand more intensive research on the subject.

Training by selecting and helping

In addition to describing the phenomenon of social control within American elite surgery, Bosk has also emphasized the difficulties encountered by attending surgeons with respect to *social support* – i.e. the simultaneous necessity to (a) control subordinate's performance by making sure that errors are corrected and not repeated; and (b) allow subordinates enough room for error so that they can learn the judgments and techniques necessary to perform properly (2003, pp. 3-4). In this respect, the interviews showed another interesting tension between (1) managers and instructors in charge of basic training; and (2) OJT coaches, field instructors and unsuccessful students. While the former are convinced that the training process is conducted with the willingness to help those who have difficulties, the latter perceive it as a merciless selective process that even goes slightly beyond license delivery. This raises the interesting question of whether the training process is not subject to an "inversion" when entering the OJT phase whose main goal is no longer to help future colleagues but rather to socialize them by subordinating judgmental and technical errors to moral breaches. On the sole basis of my data and personal intuitions, I have the tendency to answer yes. Especially when considering the fact that a school has the mission to develop knowledge and should, as a consequence, have less interest to "socialize" its students than the group within which those will perform their future professional duties. But nevertheless, more research would be necessary to credibly confirm these intuitions.

Inspiring respect while being submissive

During one of my interviews, a senior controller told me the following about what he thinks is the ideal behavioural profile required to become a "good" colleague:

> "*What we need in the profession are 'pig-headed' guys*[35] *with good manners. Indeed, this equilibrium is very difficult to find and to maintain – especially for newcomers – but it is in my opinion of the utmost importance*"

[35] Literally in French: « fortes-têtes » what can also be translated by "headstrong" or "strong-willed".

This emphasizes another interesting tension which creates difficulties for students during the OJT phase. They need to be submissive towards their coaches and instructors while at the same time inspiring respect from the other members of the group. This difficulty was confirmed by interviews with several formal students. In particular, one of them confessed that his inability to impose himself towards colleagues was considered an important deficiency:

> "*I was working under the supervision of my coach at the tower position on a winter Saturday morning*[36]*. I had difficulties to release aircraft for takeoff because my colleagues in charge of approach control operations were not creating the 'holes' necessary to do so. The ground situation rapidly became overcrowded and despite my numerous attempts to ask them for more space, they continued to squeeze the final sequence*"

The situation described above occurred at the occasion of a practical examination session required to obtain the Air Traffic Controller license. At the end of the shift, the student was told that his skills were not sufficient because he "*had crowded the airport*". He was given another chance one week later but was finally eliminated because of insufficient skills. This example permits to emit the hypothesis that the performance of the group is subordinated to the ability of its members to fairly but firmly react against each-other in case of difficulties – and that those who are unable to demonstrate such ability are not considered eligible to exercise the profession. But again, confirming this hypothesis would require more research work and investigation.

Creating safety with self-regulation

We have seen that the "clanic" nature of the Air Traffic Control profession serves multiple goals. First, it allows "would-be" members to be socialized in such a manner that they "become" loyal colleagues. Second, it protects the group against external "aggressors" when errors are committed. Third, it maintains the group's *culture of excellence* by preventing the internal way of doing things to be threatened by outsiders. Fourth and finally, it allows detecting and eliminating those colleagues who deviate too far from agreed internal practices and become, as a consequence, untrustworthy. The problem with such a "selective" culture is that it may lead to a difficult situation of understaffing[37] which on the one side empowers controllers for what

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[36] The traffic is usually very heavy during winter week-ends around airports located in the vicinity of a mountaneous area. The situation worsens when weather conditions are good because of the sudden "emergence" of private pilots flying VFR in the area. It was during such a day that our student had to perform his duties.

[37] In this respect, Hallier & James (1999) report that "group-controlled" transition rites emerge where management has no choice but to delegate features of control to the group (p. 45). However, "*should the numbers of validation failures*

concerns the maintaining of excellent social conditions and on the other side may contribute to dangerously borrow safety margins. A tension exists therefore between the auto-regulated nature of the profession and the overarching goal to achieve the highest possible level of safety. What equilibrium (if any) shall be attained in order to maintain an acceptable balance? One may argue that safety is not affected by understaffing thanks to protective mechanisms – such as "standard acceptance rates" which determine the maximum number of aircraft a controller is in principle "allowed" to handle in a particular operational situation. But is it really so? Can we really pretend that such "rulemaking" protects the system against the insidious pressures created by conflicting goals and scarce resources? In the negative, the auto-regulative nature of the profession becomes quite frightening, especially if it is supported by a clanic culture which encourages individual interests while being blinded by pseudo protective mechanisms. In this respect, Baumgartner asserts that it is not the "clanic" nature of the profession which is dangerous in itself but rather the insufficient understanding of these protective mechanisms by outsiders who have the immutable tendency to impose changes by force (2005). But in my opinion, the ultimate question behind all these considerations remains: "is forgiveness of technical errors and punishment of moral breaches good or bad for Safety?" Bosk himself only superficially and indirectly addressed this point without really providing a clear and satisfactory answer (Bosk, 2003, pp. xxiv, 215-234). This confirms that more research in this area is definitely needed and of the utmost importance.

Part 4 – The emergence of human error

We have seen that complementary data sources were used to better understand the process by means of which human error suddenly emerges as a suitable explanation. To do so, I proceeded in two phases. First, a severe incident – which couldn't be explicitly referenced for confidentiality reasons[38] – was used to emphasize at which stage errors and causes become apparent as well as the means that can be deployed in order to positively influence the *justness*[39] of the final investigation report. Then, two other public cases – a runway incursion incident (AAIB, 2004a)

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go beyond a certain point, it is likely that the group's admission criteria would conflict with management's aims for staff flexibility and even organizational restructuring" (p. 65). This additional tension was interestingly confirmed during an interview conducted with a manager responsible for the second phase of training (OJT).

[38] The problem is that the investigation is not closed and that intense discussions about the content of the proposed report are still ongoing – what indeed makes the case particularly interesting in the present context.

[39] I use the word justness here in the sense of a "just" safety culture, i.e. in relation with the ability to find an adequate balance between accountability and the need to learn from such cases.

and a VFR accident with fatal injuries (AAIB, 2004b) – were complementarily used to show what happens when unfair and fuzzy investigation reports are seized by the legal system. The result of this dual approach is presented in the two following sections.

The fight for justness and fairness

So let's try first to go through the investigation process triggered by a typical severe incident. In the considered case, a critical loss of separation (0,4NM/100ft)[40] occurred between a climbing aircraft and an opposite traffic flying at a steady level. Immediately following the incident, an Operational Incident Report (OIR) was filled by the controller involved and submitted to the safety department's regional investigation team. On that basis, an official Air Traffic Incident Report (ATIR) was established and sent to the Aircraft Accident Investigation Board (AAIB) with copy to the National Supervisory Authorities (NSA). In return, the AAIB sent an AIRPROX notification signifying that an official investigation had been initiated. This allowed the external accident investigators to get the name of the persons involved and start collecting the information needed to proceed further. At this stage of the process, the data exchanged between the two organizations was neutral and factual in the sense that it didn't contain any mention to possible cause(s) or error(s). Then, the AAIB investigation took place with extremely reduced involvement of the concerned ANSP to whom a preliminary accident report was submitted eighteen months later with the possibility to provide comments within a period of two months. A deep analysis of this report revealed that it typically contains a lot of cues on the basis of which further research could have been made in order to present valuable explanations. But instead, it lamentably concludes that (a) the controller forgot an aircraft, (b) authorized an opposite climb through its level; and (c) validated the conflict advisory alarm without care. Human error had suddenly emerged and was proposed as a suitable explanation for failure. This triggered a virulent reaction from the ANSP who prepared an eight page letter which explicitly requested immediate removal of judgmental statements and context-irrelevant information. In addition, this letter called for several assertions to be further justified, misinterpretation of data to be corrected and potentially problematic recommendations to be revised or positioned at a more appropriate level. Unfortunately, the chances for such requests to be seriously taken into account are quite limited

[40] In the upper airspace area, the minimum legal separation an Air Traffic Controller has the obligation to maintain between two aircraft is 5NM horizontally (~8km) and 2000ft vertically (~700m) – except when Reduced Vertical Separation Minima (RVSM) apply. In such cases, a vertical separation of 1000ft is allowed. Each time these minima are infringed in such a manner that safety was compromised, a formal announcement shall be made to the Aviation Accident Investigation Board who decides whether or not an official investigation will take place.

and based on subjective unilateral judgment – as confirmed by the following excerpt of the preliminary report accompanying letter: "*only duly justified comments will be taken into account in the final report*". At the time of writing this report, the ANSP was still waiting for the answer which will come sooner or later in the form of a pre-final report against which a legal appeal can ultimately be made within a period of thirty days[41].

Tracing this investigation process in a step-by-step manner allowed me to emphasize several interesting points. First, the nature of the relationships between the ANSP and the AAIB is extremely formal and the working climate lacking in trust[42]. Opinions are only exchanged by letter – according to pre-defined processes – and never openly discussed between experts from the two parties. Second, the ANSP has a good safety approach; at least in respect of non-blaming culture and learning from failure. Indeed, at no stage of the internal process was anybody blamed for his actions. Human error was never a concern before issuance of the AAIB investigation report. The focus remained on the sole search for explanations – as particularly testified by the internal investigation report[43] and by the "formative" nature of the numerous letters sent by the ANSP to the AAIB[44]. To summarize, human error emerged from an external investigation process conducted in autarky by the AAIB and was subsequently fought by the ANSP in an *insane* work climate opposing two organizations which should in principle aim to achieve the same goal; namely in the aftermath of failure, establish a case from which something can be learned and on the basis of which a "fair" judgment could be made in case of a judiciary procedure happening.

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[41] Appealing against such a report is very costly and time consuming. It results in a long and complicated legal procedure which is launched only in case of strong disagreements. In the present case, I've been informed about the intentions of the concerned ANSP to trigger such a process should the pre-final report be unsatisfactory.

[42] For instance, it is not unusual that the AAIB investigator verifies entirely the voice communications transcript established by the ANSP on the basis of recorded data. This happened in the present case and was very demanding as the transcript represents a total of 18 pages of paper.

[43] The report concludes that a combination of workload and complexity saturated the controller in such a manner that an aircraft – which was no longer on the sector frequency – ceased to exist in his mindset, resulting in an unsafe clearance. Furthermore it questions the readability and positioning of conflict detection alarms by emphasizing that the controller may have confused the information with another conflict which had just been solved.

[44] The letters I've been shown are very *formative* in the sense that each request was accompanied by a clear explanation about the reasons why such change is important for safety. Furthermore, in certain cases, influential scholars and authors were also cited and their work and ideas mentioned explicitly. This demonstrates a good level of knowledge with respect to modern human factors theories – at least at the level of the ANSP internal investigators.

It would be incomplete and unfair to conclude this section without saying that the situation has good chances to improve in a near future. Indeed, in the company within which I conducted my research, an action plan aiming at re-establishing trustworthy relationships with "sharp-end" operators was recently deployed. This plan focuses on three complementary axes and seems to currently benefit from interesting "windows of opportunities". First, a commitment has been reached with the National AAIB to conduct future investigations "hand in hand". In this respect, two preliminary reports were recently "blocked" with the intent in mind to reformulate the conclusions in close cooperation. Second, an agreement has been reached with the National Supervisory Authorities on the basis of which the internal Occurrence Incident Reports (OIR) could possibly benefit from the "legal protection" clause offered to the airspace users who submit an occurrence report at National level. Third, thanks to intensive political lobbying supplemented by a huge amount of work produced in order to demonstrate people's local rationality (see next section), there are good chances that the two cases currently under criminal investigation (AAIB, 2004a, 2004b) result in a dismissal. If these three initiatives succeed in a near future, the everlasting internal debate within the ANSP about the essential purpose of a "just" culture will be constructively reopened and may lead to significant improvements in the way the company addresses and manages safety issues.

When justice comes on stage

Unfortunately, the *fight for justness* emphasized in the previous section is rarely successful. Many investigation reports containing unfair judgements and fuzzy information are still publicly released. When criminal investigations are initiated on such a weak basis, the consequences may become disastrous for the people involved, as highlighted by the following case.

Case 1 On the 26th of April 2004, an ATR45 taxied into the active runway behind a landing Avro RJ85 while the controller expected it to line up behind a Boeing 737 approaching in short final. This resulted in a pilot-initiated go-around procedure at about 0.5NM of runway threshold. The case was officially notified to the AAIB, resulting in the initiation of a formal investigation procedure. Notwithstanding a virulent reaction of the ANSP against the results of this inquiry, the final AAIB report concluded that "*the controller allowed a commercial aircraft to land without noticing that the runway was occupied*" (AAIB, 2004a, p. 6). In other words, another severe incident caused by "human error". As nobody was injured, the case didn't automatically trigger a criminal procedure and the report was archived – like many others of the same kind. Unfortunately, two years later, the National regulator was requested by

the public ministry to take an official position with respect to the responsibilities engaged in this case. On the sole basis of the AAIB report, the regulator produced an answer whose judgmental and blaming nature allowed the public ministry to trigger a criminal prosecution by appealing the legal clause of *public traffic disturbance*[45]. In response, the ANSP professional associations (unions) supported by the internal legal department attempted to demonstrate that the incriminated controller didn't act in a manner that had created a danger for other parties[46]. To do so, they enhanced the judicial case by producing (1) an explanatory voice communications transcript with reference to legal requirements, (2) a re-constructed picture of the visual situation as it had been perceived from the tower by the controller on duty; and (3) a certified report demonstrating that even if the 737 had pursued its landing, nobody would have been injured. At the time of writing the present report, the judge had pronounced the end of the criminal procedure by concluding that nobody had been endangered by the controller's actions. The ANSP is waiting for the official pronouncement of a dismissal that would definitely close the case; five years after the occurrence. Notwithstanding the remarkable engagement of his colleagues, the controller gave up and decided to abandon the profession after having fallen into a deep pathological distress[47]. The final battle has good chances to be won but for the person involved the damage is done and the result is becoming absolutely disastrous.

The situation is slightly different when lives are lost in an accident. In the aftermath of such misfortune, the AAIB immediately initiates an investigation whose sole purpose should *in principle* be the prevention of future similar occurrences[48]. However, as emphasized by the following case,

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[45] In french, "*entrave à la circulation publique*".

[46] At this stage of the procedure, the sole focus was to demonstrate – by means of simplified explanations – that the legal clause of *public traffic disturbance* didn't apply. As a consequence, any complementary analysis emphasizing for instance the "systemic" factors that had influenced the occurrence wouldn't have been useful and was therefore no longer within the ANSP's concern.

[47] This is a good example of a controller that had fallen into a *pathological* state that prevented him from maintaining an adequate level of abstraction with respect to the dangers of the profession. The resulting loss of self-confidence couldn't unfortunately be successfully restored – resulting in the controller definitively abandoning his activitiy (Baumgartner, 2005).

[48] In accordance with appendix 13 of the "Convention on International Civil Aviation" of 7 December 1944 and article 24 of the Swiss Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious

the subsequent determination of responsibilities by the legal system can be strongly biased by the unfair judgmental nature of the accident investigation process.

Case 2 On the 19th of September 2004, a Cessna 182R proceeding under Visual Flight Rules (VFR) encountered unexpected weather conditions. The pilot's decision to climb above a cloud layer in formation resulted in the need for intensive coordination with the Air Traffic Services in charge of the surrounding controlled airspace. When reaching a zone where the weather conditions allowed him to fly back down, the pilot did so and resumed own navigation towards his destination airport in visual conditions. Unfortunately, fifteen minutes later, the aircraft crashed into a mountainous area, resulting in four fatal injuries (pilot and three passengers). The AAIB accident report concluded that "*the Air Navigation Services didn't appropriately assist an aircraft in an emergency situation because of important internal coordination weaknesses*" (AAIB, 2004b, p. 31). Looks like another of these "human error" cases, doesn't it? As a result, the legal system initiated a criminal prosecution against two controllers. In comparison with the previous case, the problem for the defence lawyer's team was not to demonstrate that nobody had been endangered but rather that the controllers didn't act in a negligent manner. To do so, several explanatory pieces were prepared, among which (1) an explanatory transcript of radio-communications synchronized with internal phone coordination messages; (2) a tri-dimensional flight simulation video emphasizing the aircraft's relative position towards controlled airspace volumes; and (3) a voice recording of pilots experiencing emergency situations. At the time of writing the present report, the criminal investigation is still ongoing and the pieces above are about to be produced and explained by operational experts.

Within the context of the present study, four lessons can be drawn from these two amazing cases. First, despite the fact that an official accident or incident investigation process is not aiming at determining blame or clarifying questions of liability, it is often conducted in such a manner that the formulation of the conclusions result in a biased appreciation of the

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incident is to prevent future accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of an investigation to determine blame or clarify questions of liability. However, some countries like for instance Switzerland have unfortunately formally specified by law that such reports can be used by the judicial system in case of a criminal procedure being subsequently initiated.

circumstances by those in charge of the associated criminal procedure. Second, even if the ANSP has opportunities to clarify such circumstances by explaining better the difficulties and the particularities of the profession, it may be too late to avoid disastrous consequences for the incriminated person(s). Third, a criminal investigation has the very difficult task to *draw a line* between honest mistakes and negligence and to fairly position the behaviour of the accused person with respect to this subjective boundary. In this regard, the responsibility of the numerous actors involved[49] was found particularly nebulous, especially with regard to the important question about who gets to draw that line (Dekker, 2007, p. 83). Fourth and finally, the legal system does not have a *reservoir* of aviation experts at its disposal in order to help in the honest determination of the circumstances within which a severe incident or an accident occurred. It is the involved service provider who voluntarily elects to engage – sometimes at the price of high expenses – in a *fight for justness* whose outcome is at the very least quite uncertain.

Discussion

Major results of the study

The present study has revealed that Air Traffic Controllers can only fulfil their "mission" by constantly keeping an acceptable balance between safety and efficiency. To do so, they need to achieve and maintain an adequate level of abstraction that requires a high degree of self-confidence in the way they perform their duties. As time went by, the operational groups to whom this difficult mission was assigned have developed a culture prone to guarantee such endeavour. This culture can be seen as composed of nine complementary scripts interacting in such a manner that the group is, most of the time, able to adequately respond to the demands of the profession. The resulting global picture[50] is presented hereafter (Figure 1) and commented and discussed in the following sections.

[49] In the cases addressed by the present study, the following official bodies were involved in such procedure: the Air Navigation Service Provider (ANSP), the Aviation Accident Investigation Board (AAIB), the ministry of transport, the public ministry, the National regulator, the judge and the incriminated person's personal lawyers.

[50] After having individually discussed the nine cultural scripts, it is now time to reassemble the parts into the whole; while keeping in ming that something will certainly be lost throughout this reductionist analytical approach.

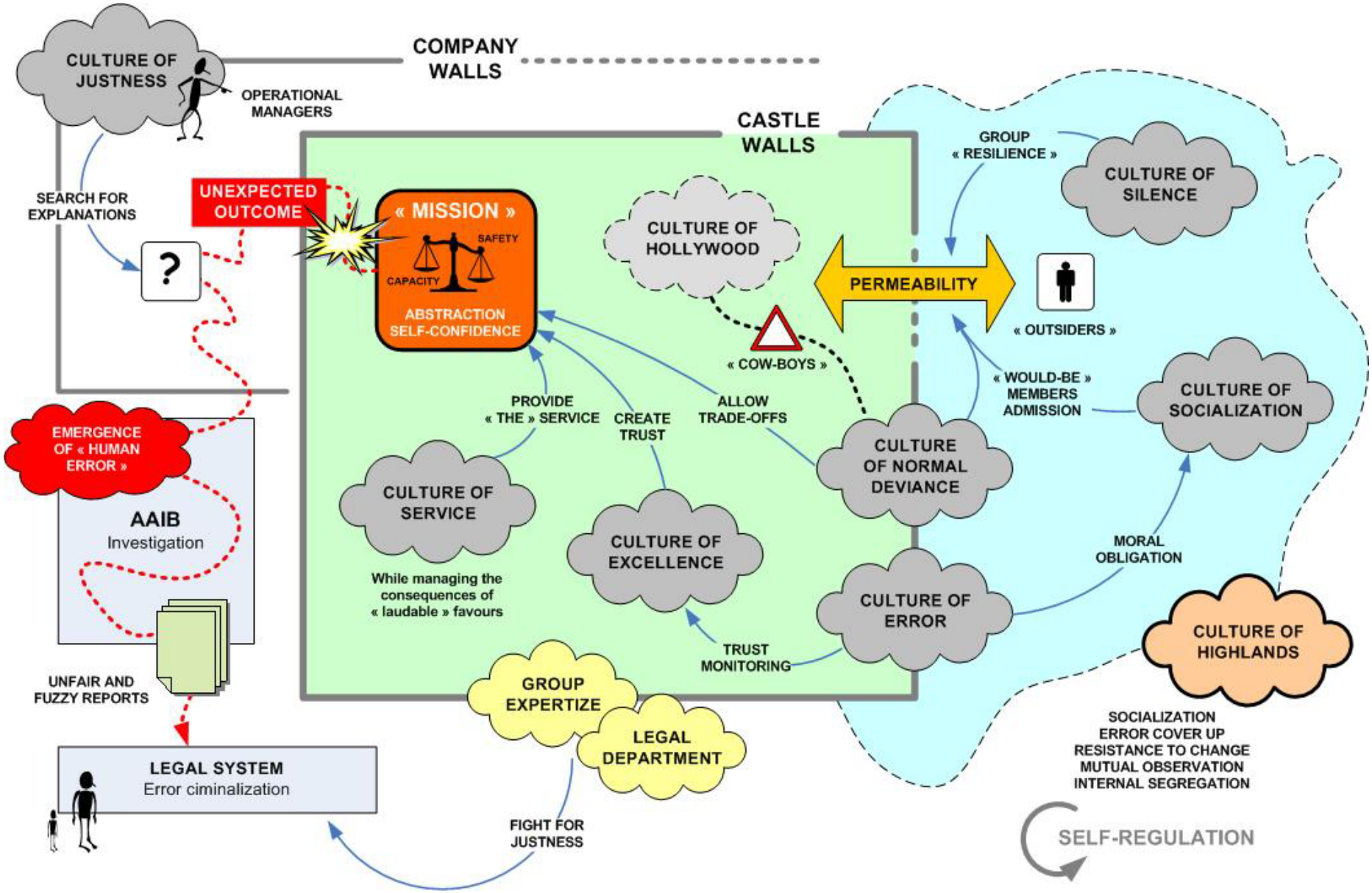

Figure 1 – Major results of the study (global picture)

Responding to the demands of the profession

In Air Traffic Control, the notion of service shall be kept omnipresent but adequately balanced with a good understanding of the consequences "laudable favours" have on the entire aviation system. Doing so is the aim of the group's *culture of service*. But providing a safe, efficient and orderly flow of traffic in an environment where business pressures often predominate is only possible by carefully trading safety for efficiency whenever deemed necessary and manageable. This is ensured by the group's *culture of normal deviance*. However, admitting deviance at the sharp-end by considering it "normal" under certain circumstances is delicate and requires the avoidance of extreme behaviours. This should be the aim of the group's *culture of Hollywood* whose effects couldn't unfortunately be fully captured by the present study. Nevertheless, making potentially dangerous trade-offs with a high level of self-confidence is only possible if mutual trust predominates between group members. Creating trustworthiness within the community is the aim of the group's *culture of excellence*. But a high level of trust between colleagues can only be maintained if the group is able to protect itself against interference from the outside in such a manner that it becomes a self-regulated entity performing within an over-regulated business. This is achieved by the group's *culture of highlands*. Consequently, these self-regulating mechanisms create social boundaries that protect working groups like "castle" walls whose "permeability" need to be carefully controlled. This is the aim of the group's *culture of socialization* whose admittance exclusion mechanisms are supported by a *culture of error* that regulates self-confidence and creates moral obligations in the aftermath of failure. Finally, the "resilience" of the group, i.e. its intrinsic ability to successfully manage unexpected situations is reinforced by a *culture of silence* which reflects the belief that protecting group boundaries is more important, in a safety point of view, than the hypothetical lessons that could be learned from honest disclosure of mistakes.

When things go awry

The study has also revealed that in the aftermath of "visible" unexpected outcomes – like for instance incidents or accidents – the company's *culture of justness* maintains focus on the search for explanations; without blaming individuals in retrospect. Interestingly, we have seen that this "just" culture is perceived "unjust" by operational managers who feel blamed for their pseudo-inability to adequately manage errors. This amazing paradox emphasized the necessity to supplement the structural arrangements aiming to protect individuals against unfair judgements by a deeper discussion with all the actors involved in this process. Notwithstanding the above, the notion of "human error" seems to emerge insidiously and be systematically proposed as a suitable explanation for failure during the external inquiry process conducted by the Aviation

Accident Investigation Board (AAIB). Despite a desperate *fight for justness* conducted at the level of the Air Navigation Service Provider (ANSP), a large majority of published investigation reports contain unfair judgments and fuzzy statements that bias the fairness of the criminalization process they trigger. Unfortunately, when the system goes so far, the personal consequences for the accused individuals are usually disastrous.

When does an error become socially constructed?

According to Dekker (2007), an offence does not exist by itself as some objective reality. What we see as a crime and how much retribution we believe it deserves is not a function of the behaviour. It is a function of our interpretation of that behaviour that not only slides over time but also differs per culture. Therefore, whether something is judged reckless or not is the outcome of the process of interpretation that follows the error (pp. 78-81). In this perspective, an error becomes "socially constructed" when the same behaviour is acceptable in a certain context and becomes an offence in another that demands it.

Are errors in Air Traffic Control socially constructed?

In the domain of Air Traffic Control, we have seen that in the aftermath of unwanted outcomes, the notion of human error insidiously emerges from the investigation processes conducted by Aviation Accidents Investigation Boards. Furthermore, the outcome of such processes – in particular the language used in investigation reports – has the dangerous potential to bias the fairness of subsequent criminal procedures. In this regard, the numerous bodies involved in the determination of negligence have different perspectives that are *in principle* [51] consistent with their predominating internal culture and with the endeavour they pursue. For instance, while Air Navigation Service Providers focus on the possibility to learn from failure; legal systems need to respond to societal demands for causes and culprits. The paradigms required to achieve such contradictory goals are profoundly different and inevitably lead to see the same behaviour with different perspectives. This means that in Air Traffic Control, errors are not an intrinsic property of some negligent individuals but are "social constructs" brandished to serve particular goals.

[51] With exception of the Aviation Accidents Investigation Board (AAIB) whose predominating paradigm is currently evolving but still in great contradiction with the main purpose of an investigation.

Do they get put into categories and managed differently?

We have also seen that errors in Air Traffic Control are of two profoundly different natures. Some inadequate conducts are perceived by professional groups as errors in *assuming* a role while others are merely considered errors in *performing* a role. While the latter are, in accordance with Bosk's taxonomy, "technical" breaches, the former are merely of "moral" nature. In a consistent manner with such differentiation, the present study has proposed a "Bosk-like" error taxonomy table that (1) clearly differentiated those two categories; and (2) allowed to better explain how professional groups socialize their members by subordinating technical errors to moral breaches. In particular, we have seen that when someone's moral behaviour doesn't match the group's expectations, technical causes – focused on the individual's skills and competences – are constructed and brandished as the sole official reason for his eviction. This confirms not only the socio-constructivist nature of human error in Air Traffic Control but also emphasizes that breaches are categorized and managed differently as a result.

Relationships and moral obligations

My research strategy consisted of conducting a *comparative* case study resting on what Bosk found out in the world of American elite surgery. Thus, the credibility of my results is subordinated to the existence of some similarities between those two worlds. So let's try to have an objective look at the situation. While both aim to provide safety critical services, there is a huge difference between a hospital and an Air Traffic Control organization. This difference lies principally in the nature of the relationship that exists between sharp-end operators and their "customers". In healthcare organizations, surgeons are – emotionally and physically – directly confronted to the people whose life may be threatened by their actions. This creates a moral obligation to "act in good faith" – or put differently, to "do everything possible" in order to extend or save the patient's life. Bosk (2003) used this argument to explain why subordination of technical breaches to moral ones is so important in surgery (p. 169). The situation is different in Air Traffic Control. In this domain, controllers and pilots share the responsibility to safely transport passengers around the world. The relationship with the system's customers is therefore not only indirect but also divided – which creates a different moral obligation. In that case the controller has the duty to do his best to preserve the aircraft occupants' lives by maintaining the highest possible level of safety within an environment where business pressure and resources scarcity constantly and insidiously borrows the safety margins. We have seen that this is only possible by promoting a *culture of excellence* whose essential fundament is trust; and that trustworthy colleagues are "formatted" by means of a socialization process that subordinates technical errors to moral

breaches. Thus, despite fundamental differences in moral obligations, professional groups in both domains cultivate elitism by means of similar socialization processes.

Alternative explanations

Alternative explanations to the social phenomenon emphasized by the present study would merely rest on anti-essentialist arguments based on the belief that errors are facts inherent to the personality of some "fallible deviants". In my opinion, there is no room here for such debate; especially in the light of its profoundly irreconcilable nature (Barraz, 2009, pp. 10-12). Furthermore, I neither see the utility to arbitrate a deadlock philosophical confrontation. The interesting point is rather to discuss the adequacy of the paradigms people adopt when attempting to achieve particular goals. In this regard, we have clearly emphasized the tension that exists – and that will always exist – between those whose main goal is to learn from failure and those who are required by the society to punish negligent acts. Thus, the question is not to know who is wrong or who is right but rather to assess whether the culture of those organizations in charge of considering people's actions in retrospect is adequate – what was addressed in the discussion section of my results.

Suggestions for further research

It is usual practice in the conclusion of such reports to make suggestions for further research. Earlier in this document (p. 35), I have emphasized several unanswered questions by discussing the tension fields that exist between actors who struggle to achieve the same goals. I would be delighted to hear about subsequent research work that had focused on these unexplored domains and raised, as an answer, new unanswered questions. After all, as emphasized by Yin (2003): "*research is about questions and not necessarily about answers*" (p. 40).

Conclusion

Bosk (2003) discovered that in American surgery, there is an hypertrophy of *professional-self* control and an atrophy of professional *self-control* and that, as a result, corporate responsibility is discharged through socialization and education of young recruits (pp. 183-185). He bewailed that the physician's conscience was the sole protection of the patient and called for developing structural changes that would hopefully build up stronger accounting mechanisms in everyday practice (p. 192). My study has revealed that in Air Traffic Control, such formal accounting mechanisms – mainly induced by safety regulation – didn't annihilate the group socialization

phenomenon needed to instil the moral values required to respond adequately to the demands of the profession. However, safety regulation has unfortunately masked the importance of investing in better understanding the social mechanisms by means of which people account for errors. Hence, I believe that any attempt to improve safety further by promoting "justness" or by engineering "resilience" into such professional groups inevitably requires penetrating and understanding group cultures. In this regard, the problem is that leaders of organizations are not always able to overcome their own cultural biases and to perceive that elements of an organizational culture are dysfunctional for survival and growth in a changing environment (Schein, 1990, p. 117). As a result, people whose paradigms would make possible such approaches of safety might not be given the key organizational positions that are necessary to trigger the required cultural changes. Instead, their ideas are "neutralized" by conservative arguments that mainly reveal fear and resistance to change. Thus, a way should be found to draw the interest of managers without scaring them with visions that create more uncertainty. Papers like the present report may help in doing so. But sending leaders academic books to read is not the ultimate solution. We should rather try to convince them to risk giving us the possibility to demonstrate what can be done with new ideas. And if we don't succeed in doing so, we will have no other solution than being patient and waiting that time finally shows them that we were right.

Limitations

Putting on the hair shirt [52]

It is now time for me to "*put on the hair shirt*" and to honestly disclose my weaknesses. Like everybody, I'm not without my biases. Two years of intensive and demanding study in the domain of human factors made me discover the fascinating world of social sciences. However, as an engineer who grew under the influence of Cartesian and Newtonian paradigms, I had to fight hard to succeed in opening my mind to different perspectives. It is this constant struggle that probably created for me the danger to lose some objectivity during the study presented in this report. Indeed, it is not impossible that in certain cases, I just saw what I wanted to see; through the lenses of my new paradigms. Thus, to keep my feet on the ground and attempt to regain

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[52] The expression "put on the hair shirt" is drawn from Bosk's study and reflects a peculiar ritual which occurs in formal peer review sessions at the occasion of which attending surgeons admit their errors by humbling themselves before an audience of colleagues and subordinates (Bosk, 2003, pp. 127-146).

some objectivity, I elected to dedicate a chapter to what I believe are the main limitations of my study. These factors are presented and discussed hereafter – hopefully in an objective manner!

Restricted scope of work

The reader should keep in mind that the unit of analysis around which my data was collected doesn't cover the entire field of Air Traffic Control but was mainly focused on approach control operations within a specific geographical area. As a consequence, any attempt to extrapolate the results of my work shall be done with extreme caution. This is particularly true for issues related to group admission criteria and rites of passage – as confirmed by a study about transition rites in Air Traffic Control which reported that "*in any setting, organizational rites of passage represent the chosen solution for satisfying a particular group's definition of its interests. Therefore, one group's membership will not be able to impose their construction of appropriate ritual practices on the members of another group*" (Hallier & James, 1999, p. 64).

Analytic reduction

Notwithstanding the fact that I have argued about the benefits of a reductionist approach in my research work, the risk to "lose something" by putting the parts together remains and constitute an important limitations. The fact that I could synthesize the major results of my study in a global picture (Figure 1) and describe what I believe are the interfaces between several cultural scripts previously considered in isolation doesn't mean at all that I could capture all the subtleties lying behind the culture of the whole group.

A few words about stories

In the present report, I have tried at several occasions to illustrate my findings with stories told by my interviewees. However, the sensitive climate within which I conducted my inquiry obliged me not to record the interviews; mainly in order to create a trustworthy discussion platform. As a consequence, these stories were "reconstructed" on the sole basis of my personal notes and couldn't be reviewed by the concerned informants before delivery of this report. Thus, they may not exactly reflect the words used by these persons at the time they were interviewed. Nevertheless, I believe that I could capture the essence of their message – of course within the limits of my personal biases. If not, I sincerely apologize for any inconsistencies and would appreciate feedback at anytime.

Access to key informants

I have mentioned in this report the enormous difficulties I had to approach "active" Air Traffic Controllers (see APPENDIX 2). Thus, despite the fact that I tried to use complementary data sources whenever possible and adequate, some of my findings are based on the opinion of a very small population sample. This constitutes of course an important limitation and suggests additional research work in order to bring my conclusion to a more mature stage. However, this wouldn't be possible without first addressing the problem of trust that prevented me from talking to several key people. Unfortunately, this may not only be very time consuming but also very difficult and even impossible within the culture that currently predominates in this domain.

Time pressure

Time shouldn't be produced as an excuse for incomplete research but was certainly a factor in the present case. My field study was conducted over a period of five months on the basis of a previous literature review. In addition, the work had to be done in parallel to a very demanding job to be assumed within a quite difficult environment. As a result, and not with the intention to excuse incompleteness, I have to admit that I had to make sometimes difficult choices that may be wrongly interpreted by the reader as lazy shortcuts – one of these being for instance that key informants were not given the opportunity to review the present report before its publication.

Acknowledgements

Giving thanks to all those who supported me during such a demanding work is a very difficult task. Not only because I may forget somebody, but also because in the present case, the most important contributors – my interviewees – cannot be named for confidentiality reasons. Thus, I will start here by honouring all those who granted me invaluable trust by kindly accepting to talk to me. My sincere thanks go also to the many opponents I met everyday during my initiation to the domain of social sciences. Thanks to their scepticism and resistance to new ideas, I could make my positions and arguments more robust than ever. The next one on the list is the guy who changed my life. Thank you, Sidney, for having opened my eyes to new perspectives that were insidiously masked by my strong Cartesian education. You also made me discover the intellectual delight to keep on asking questions and rekindled the scientific curiosity I progressively lost over the years. For this, I will never forget you. I also appreciated very much the tremendous discussions with my Lund classmates – during those amazing working-labs as well as during their subsequent "Swedish night pub-sessions". I will miss you all. My warm thanks go also to Erik

Hollnagel who kindly commented my thesis proposal and to Nancy Leveson who made me really understand what a "system" is. I will be eternally grateful to Francis Schubert who supported the idea to get a master degree in human factors and to Juerg Schmid who gave me the means to do so. Thank you also to Alain Mignard who opened me the door to the operational department, to Bernard Laydevant who made me better understand the difficulties of approach control operations, to Marc Baumgartner who advised me wisely whenever necessary and took time to deeply comment my case study report, to Ivan Rochat and Xavier Henriod whose professionalism and kindness allowed me to intensively discuss and rigorously trace the incident and accident reports used in this study, to Bertrand Dubois who impressed me very much for his engagement in what I named the *quest for justness*, to Simone Rossier who performed a difficult and uncompromising legal check of this document, to Dewi Williams who made a thorough review of its final version and to René Aebersold who kindly accepted my reduced professional availability during the final work out of my master thesis. It is usual practice to end up by thanking spouse and kids for their support and encouragements. I will not do that. Instead, I will sincerely apologize for what they endured during those two years. Education is a very egoistic activity that demands huge sacrifices for those who share your life. Barbara, you went through this ordeal with understanding and respect. I love you.

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APPENDIX 1 – APPROACH CONTROL OPERATIONS

Airspace structure

One of the most important tasks of air navigation services is the organization and management of airspace. The airspace is so organized and divided that flights are continuously monitored by Air Traffic Control Services. Because the demands of take-off and landing are very different from cruising flight, airspace is divided into various zones (Figure 2). In the immediate vicinity of the airport is the Control Zone (CTR), which takes the shape of a prism. It reaches from the earth's surface up to a defined altitude. Its horizontal spread is dictated by the runway system and the take-off and landing procedures at the airport. Above this is the slightly wider Terminal Maneuvering Area (TMA). This covers the space required for take-off and landing maneuvers and holding patterns. Aircraft proceed from the TMA of their departure airport to that of their destination along airways (AWY), defined by navigation aids or waypoints which can be precisely over-flown by pilots with the aid of their on-board instrumentation.

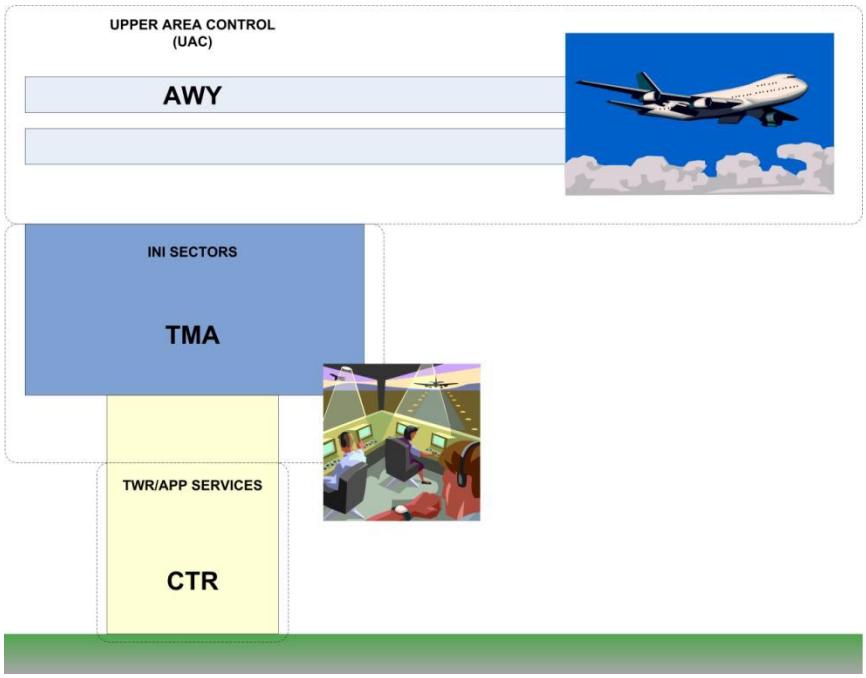

Figure 2 – Airspace structure and Air Traffic Control services (simplified)

Organization of Air Traffic Control

Air Traffic Control services are responsible for the safe and smooth flow of traffic through the airspace it controls. It is divided into various service areas defined by the different demands on

controlling the different phases of a flight. Tower control (TWR) supervises taxiing, take-offs and landings and controls traffic in the immediate vicinity of the airport. Approach control (APP) controls take-offs and landings within a defined area of the control zone. Terminal control (INI) ensures the safe and smooth flow of traffic between the airway structure and the Terminal Manoeuvring Area. Upper Area Control (UAC) ensures the safe and smooth flow of traffic within the airway structure.

Approach control operations

Basically, approach control operations work like a "delaying" machine: controllers receive irregularly spaced aircraft from Upper Area Control sectors (UAC) – or more precisely from Initial approach sectors (INI) – and hand them over to Tower control with regular spacing and stabilized speed for landing (Figure 3).

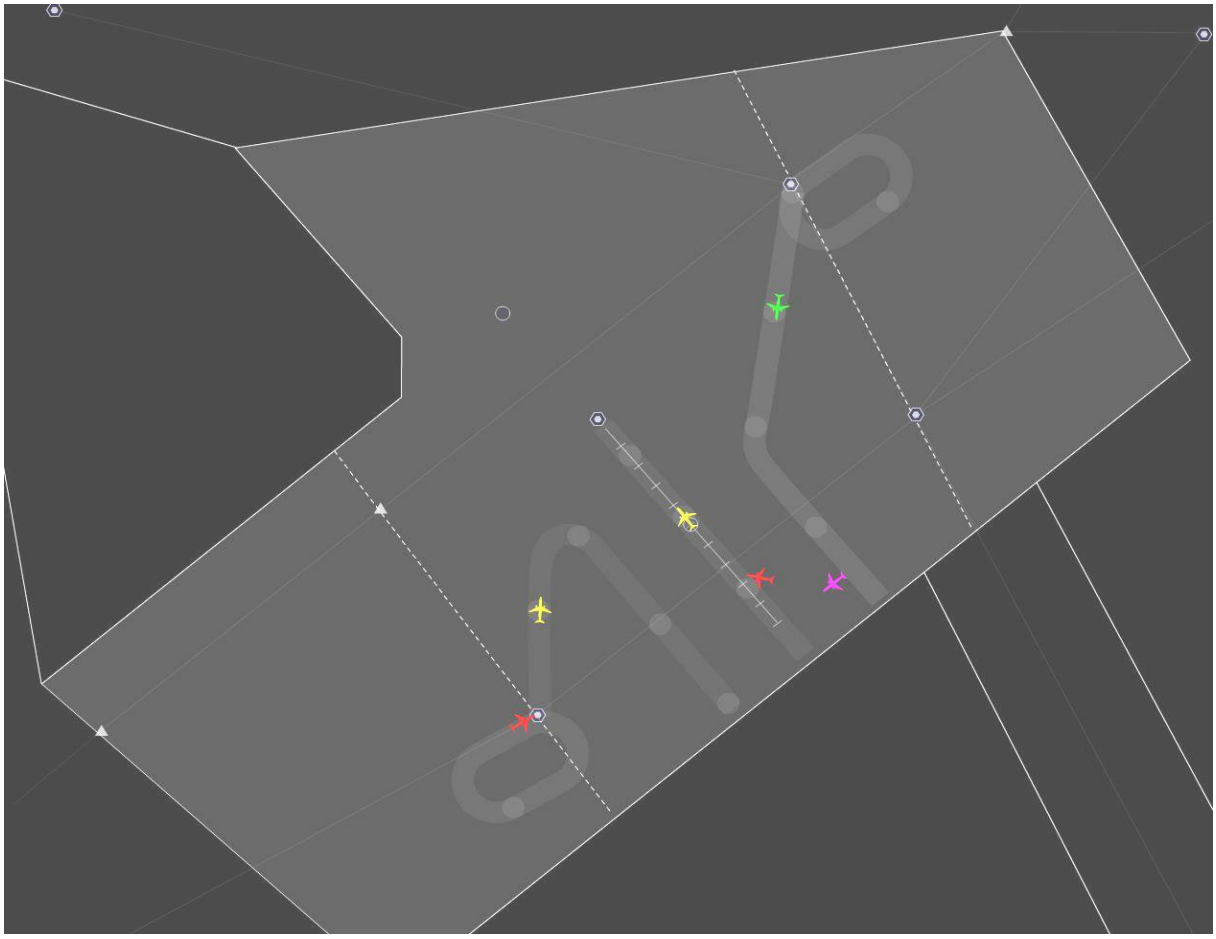

Figure 3 – Approach control as a delaying machine

Three main ways can be used to delay aircraft: putting them into hold, giving them more track miles to touchdown (vectoring) and adjusting their speed. In a general manner, speed control is

not a very effective method to provide spacing. Controllers normally use vectors to create the required separation and adjust aircraft speed to keep the spacing.

The approach procedure can be broken into two basic steps: *planning* and *vectoring*. Planning is the phase during which the controller establishes the sequence and decides how much delay each aircraft needs to get a smooth flow of traffic on final. This is done as early as possible – even before aircraft make their initial calls. Vectoring is the phase during which the controller puts his plan into action and adjusts the routing to get efficient spacing on final. As a general rule: "good planning means easy vectoring and easy vectoring means sufficient time for good planning".

Of course, it is not as easy as it looks. First, because the adjustments which are required to adequately "sequence" the aircraft on the final approach path have to take variable wind conditions and different flight performances into account. Second, because the approach sequence and the departing flow shall be coordinated in such a manner that "holes" for takeoffs can be safely inserted whenever necessary.

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APPENDIX 2 - INTERVIEWEES SELECTION CRITERIA

Selection criteria #01

applied to the selection of the interviewees working within the field of operations:

i. *Blunt-end (operational managers) and sharp-end (licensed operators and advanced students) shall be equally covered during the process of selecting the interviewees.*

ii. *Licensed operators (ATCOs) shall be selected within the unit of analysis (Approach control) as well as within the operationally adjacent units (Tower control and INI sectors).*

iii. *Students will be selected from both basic and advanced classes, i.e. when they have achieved the initial training phase and have started supervised shifts in real working environments.*

Selection criteria #02

applied to the selection of the interviewees working outside the field of operations:

i. *Interviews will be conducted within the domains of Safety Management and of Operational education (covering both ab-initio training and re-qualification programs).*

ii. *Within the domain of Safety Management, interviewees should, whenever possible, be selected among candidates who were not previously engaged in human factors training*[53].

iii. *Within the domain of Operational education, interviewees will be chosen with the intent to emphasize at best the failure and success criteria which are applied during ATCO initial qualification and re-qualification.*

Group of interviewees

Application of the criteria defined above led me to create three main groups of people within which several categories could be established. Each of these categories was assigned a label based on a convention that allowed me to easily trace back interviewees with respect to the population they belong to. Amongst other things, this facilitated the maintenance of the case study database as the data collection process went on. The results of this classification as well as the difference between the foreseen and actual interviews are presented hereafter (Table 2). For confidentiality reasons, the names of the interviewees are not published in the present report.

[53] This is to minimize the risk of bias which may be introduced by discussing the construction and management of errors with people who already studied the realist and relativist perspectives on the subject.

Interviews classification table

Field of operations				
Id.	*Category*	*Planned interviews*	*Actual interviews*	*Comment*
FO-MGR#nn	Managers	6	5	Chief Operations Officer unfortunately absent
FO-ATCO#nn	Licensed controllers	9	3	Among which one expert for accident case studies
FO-STU#nn	Students controllers	8	0	No answer from this community
FO-OTH#nn	Others	3	1	Former manager
Total		**26**	**9**	Interview success rate: **34.6%**

Field of operational education				
Id.	*Category*	*Planned interviews*	*Actual interviews*	*Comment*
FE-MGR#nn	Managers	5	2	Chief instructor ab-initio & local training manager
FE-INST#nn	Instructors/Coaches	6	1	OJT instructor
FE-FOS#nn	Former students	4	4	All eliminated during the OJT phase
Total		**15**	**7**	Interview success rate: **46.6%**

Field of safety management				
Id.	*Category*	*Planned interviews*	*Actual interviews*	*Comment*
FS-MIS#nn	Miscellaneous	8	5	Various functions in safety management
Total		**8**	**5**	Interview success rate: **62.5%**

Table 2 – Case study interviews classification table

APPENDIX 3 - INTERVIEW REPORT FORM

INTERVIEW REPORT FORM

Report Id :	
Interviewee :	
Position :	
Date :	
Duration :	
Place :	

Interview part 1 – Introduction

- ❑ Welcome and thank the interviewee for his time and effort.
- ❑ Present briefly the aim of the study without revealing the underlying assumption.
- ❑ Explain the structure of the interview and the foreseen time necessary to complete.
- ❑ Provide assurance for confidentiality and explain the neutral nature of the research.
- ❑ Ask the interviewee if he has any question or wishes before commencing.

Interview part 2 – Open questions

Why do Air Traffic Controllers sometimes commit errors at the workplace?	
Mental line of inquiry: understand the interviewee's philosophical position with respect to the notion of human error in Air Traffic Control.	
Notes	

When errors occur, what do you believe should be done to avoid re-occurrence?	
Mental line of inquiry: Understand the interviewee's level of understanding with respect to people's local rationality and just culture.	
Notes	

How would you, as a manager, decide if an Air Traffic Controller has the necessary skills to safely perform his duty? Furthermore, as an Air Traffic Controller, how do you perceive the expectations of your superiors with respect to performance and error? [54]	
Mental line of inquiry: Identify if certain type of errors are considered more important in judging ATCO's professional capabilities and if some criteria are applied for the purpose of socializing young recruits.	
Notes	

What is, in your opinion, the main weakness of the current ATCO qualification and re-qualification process and how would you address it?	
Mental line of inquiry: Identify whether the profession self-regulates its selection process in order to maintain the power of the "clan".	
Notes	

Interview part 3[55] – Discussion about two similar[56] incidents

Discussion about incident #01 and incident #02 (taken first separately)
– Do you have questions about the incident description? – What do you think about the strategy applied by the ATCO? – What factors do you see that may have contributed to the incident? – Do you think that the controller had direct influence on these factors? Why? – Can we conclude that somebody committed an error? Why? – What would you propose to avoid reoccurrence of such a case?
Mental line of inquiry: Identify whether and how errors are constructed in hindsight in the case where the rule defining minimum separation distance was violated.
Notes

[54] This question will be addressed situatively depending on the positon of the interviewee within the organization.

[55] A short description of both incidents (without findings) was submitted to the interviewee as preparatory material. Potential misunderstandings about the course of events were clarified before commencing the discussion.

[56] Both incidents created a hazardous situation but only one was officially reported and investigated because the horizontal separation standards were infringed.

Cross-analysis of incidents #01 and #02
– Now that we have discussed both cases individually, what differences and similarities (if any) do you see between these two incidents? – What are the factors that "pushed" one these cases towards a separation minima infringement? Had the involved actors (pilots and ATCO) any influence on them? – How do you consider the fact that only one of these cases was investigated while the other one was only discussed between the ATCOs present at the sector? – The ATCOs involved in both cases were legally qualified to operate. How do you believe these incidents would have been managed if they had involved a student? Do you think it is worth to make a difference? Why? – Do you think that such kind of situations have more chances to develop with a particular "category" of ATCOs? If yes, how would you qualify them?
Mental line of inquiry: Identify the factors (if any) that constitute the basis to construct an error in hindsight. In particular, is there any relationship between these factors and the rules defining the minimum distance to keep between two aircraft in flight? Identify the differences (if any) in the way both cases would have been managed if a student (about to become a member of the community) had been involved. Does it confirm the assumption of the study about the socialization of young recruits into the profession (admission to the clan)?

Notes	

Interview part 4 – Closed questions	
– What is your current function within the company?	
– How many years of experience do you have in Air Traffic Control?	
– Do you believe in the "clanic" nature of the ATCO profession?	❑ YES ❑ NO
– Were you personally involved in an aviation-related incident or accident?	❑ YES ❑ NO
– Are you involved in the process of selecting and qualifying ATCOs?	❑ YES ❑ NO
– Do you possess an official degree in human factors and system safety?	❑ YES ❑ NO
– Are you interested in receiving a copy of my final study report?	❑ YES ❑ NO

Interview part 5 – Conclusion

❑ Thank the interviewee for his time and effort. ❑ Explain what you are going to do with the information provided. ❑ Ask the interviewee if he would remain at disposal for further clarification. ❑ Ask the interviewee if he has any question before terminating the discussion.
Notes

Preliminary analysis

Remark:

The form presented in this section has been slightly adapted to better fit in the case study report. During the interviews, the original form was used to capture manually the information provided by the interviewee. The same day, notes were consolidated in a new form and scanned for the purpose of feeding the case study information database.

APPENDIX 4 - INCIDENT #01 DESCRIPTION (DE-IDENTIFIED)

Occurrence context

The incident occurred during daytime operations. Runway 23 was in use with ILS approaches active. Weather was cloudy (FEW 2500ft, SCT 3500ft, BKN 25000ft) with good visibility conditions (VIS 9km) and light wind (190°/6kts). The controller was not working in a degraded mode and the traffic situation at the time was not considered exceptional (13 movements within 30 minutes from which 6 departures and 7 arrivals occurred).

Location and horizontal geometry

The following map provides an overview of the occurrence situation. The flight paths have been entered manually and may be, as a consequence, slightly distorted.

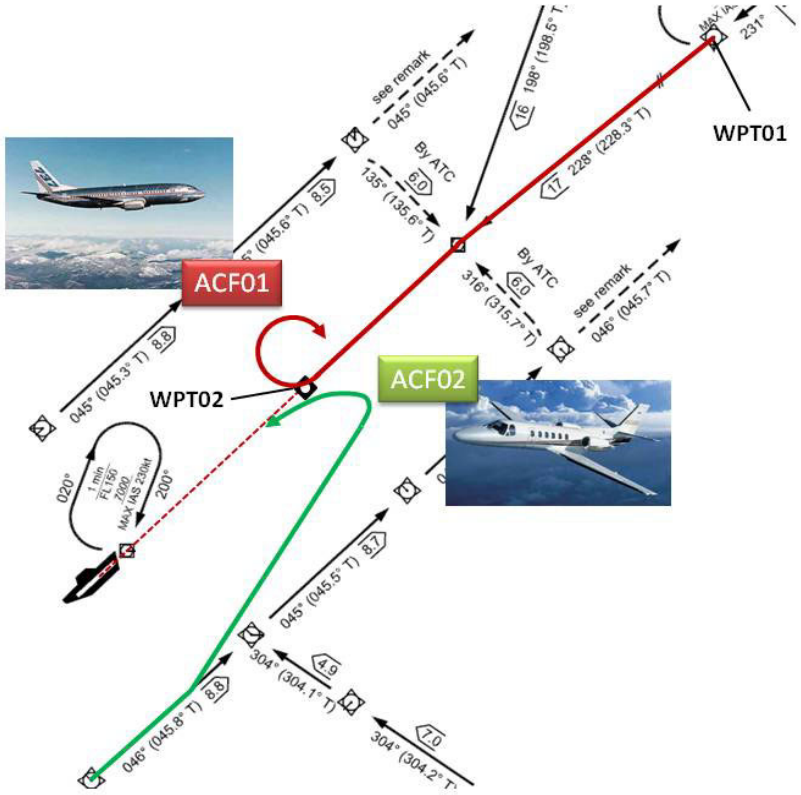

Figure 4 – Incident #01 horizontal geometry

Course of the event

The ATCO planned to turn in ACF02 (a Cessna C550 Citation) in front of ACF01 (a Boeing 737-300). When ACF01 was approaching WPT01, descending through FL100 to FL80, the crew was informed that they can expect a straight-in ILS23 approach and instructed to reduce speed to

220kts. Then ACF02 was radar vectored on a heading of 040, and cleared to descend to 6000ft. Subsequently ACF01 was cleared to descend to 7000ft. When ACF02 was approaching abeam WPT02, the pilot was instructed to turn left heading 260 to intercept ILS23 and to descend to 4000ft. ACF02 acknowledged these instructions and 24 seconds later, the ATCO called back to ask whether they were in the turn, as no such maneuver was visible on the radar. The crew responded by the affirmative and the turn became visible 8 seconds later. The ATCO provided traffic information to both aircraft, instructed ACF02 to increase the turn and cleared ACF01 for final approach with a speed restriction of 160kt. As the plan didn't work out, the ATCO instructed ACF01 to orbit right for repositioning. When ACF02 joined the runway axes, the separation with ACF01 was 1.9NM/0ft.

Findings

The motivation/reason provided by the ATCO to take in ACF02 as number 1 in front of ACF01 was the weight category. Indeed, having the light WTC aircraft in front of the medium allowed the ATCO to reduce the legal separation minima from 5 to 3NM and expedite the arrival procedure for both aircraft. This strategy was found consistent with ICAO regulation which states under specific conditions that *"the approach sequence shall be established in a manner which facilitates arrival of the maximum number of aircraft with the least average delay"* (Doc 4444 – 6.5.6.1.1). Thus, the ATCO strategy made sense but the plan didn't work because the altitude and speed of ACF02 were such that it was difficult to be established on ILS23 over WPT02 if turning immediately when instructed.

Legal context

The strategy applied by the controller resulted in a temporary loss of legal separation minima. Thus, an Operational Improvement Report (OIR) was internally established which resulted in an Air Traffic Incident Report (ATIR) officially transmitted to the National Supervisory Authorities and to the National Aircraft Accident Investigation Board. As a consequence, an official investigation report was established and delivered to those in charge of taking appropriate corrective measures.

APPENDIX 5 - INCIDENT #02 DESCRIPTION (DE-IDENTIFIED)

Occurrence context

The incident occurred during daytime operations. Runway 05 was in use with VOR/DME approaches active. Weather was cloudy (FEW at 3300ft) with good visibility conditions (VIS>10km) and moderate wind (050°/16kts). The controller was not working in a degraded mode and the traffic situation at the time was not considered exceptional (16 movements within 30 minutes from which 9 departures and 7 arrivals occurred).

Location and horizontal geometry

The following map provides an overview of the occurrence situation. The flight paths have been entered manually and may be, as a consequence, slightly distorted.

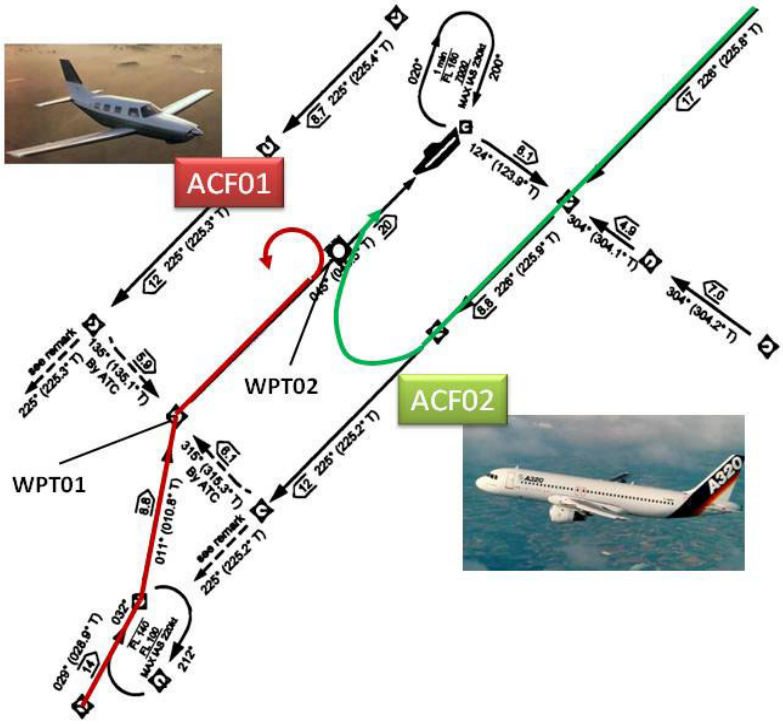

Figure 5 – Incident #02 horizontal geometry

Course of the event

Short after initial contact was established with ACF01, a Piper Malibu arriving from South-West, the ATCO received the first call from ACF02, an Airbus A320 arriving from North-East. Seven minutes later, the ATCO cleared ACF01 for a VOR/DME05 approach and cleared ACF02 to

descend at 7000ft on a downwind leg south of the runway. At the time ACF01 was passing WPT01, the Airbus crew asked with polite but firm insistence for a visual approach towards runway05. The ATCO instructed ACF02 to descend to 6000ft and to standby for visual while providing information about the presence of the Malibu traffic. After having slowed down the Malibu from 180kts to 150kts, the ATCO authorized ACF02 for a visual approach on runway 05 with request to be established before WPT02. It was not before 43 seconds that the visual turn was observed. At this moment, the potential conflict between the two aircraft became apparent and ACF01 was immediately requested by the ATCO to slow down to minimum approach speed (120kts). As the plan didn't work out, the ATCO instructed ACF01 to orbit for repositioning. The direction of turn was not specified by the controller and the pilot initiated a left maneuver towards the mountains. When ACF01 started to orbit left, the separation with ACF02 was 4.3NM/425ft. Legal separation minimums were not infringed but the horizontal distance required with respect to Wake turbulence separation was slightly below requirements (5NM for a light behind a medium WTC aircraft).

Findings

In this area, visual approaches are very common when runway 05 is in use and the weather conditions are good. This practice allows to reduce the ATCO workload and to expedite arrivals so that fuel and time can be saved for the airlines. In the present case, there was no reason to diminish workload. It is therefore possible that the ATCO yielded to the ACF02 visual request in order to provide the best possible quality of service. Another explanation could be that the ATCO wanted to demonstrate his skills and virtuosity in the presence of unusual observers (an instructor and myself).

Legal context

The situation which occurred in that case didn't result in a loss of legal separation minima. As a consequence, no official reporting took place and nobody within and outside the company was informed about what happened. After the occurrence, the situation was retrieved and the case partly documented in cooperation with the internal investigators for the sole purpose of the present research work.

GLOSSARY

AAIB	Aviation Accident Investigation Board
AIRPROX	Air Proximity
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATIR	Air Traffic Incident Report
AWY	Airway
BKN	Broken (in aviation, refers to cloud coverage)
CFMU	Central Flow Management Unit
CTR	Control Terminal Region (or more commonly, control zone)
DME	Distance Measuring Equipment
FEW	Few (in aviation, refers to cloud coverage)
FL	Flight Level
ft	Feet (100ft = 33m)
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
INI	Initial (ATC sector at the boundaries of upper and lower levels)
kt	Knots (1kt = 1.852km/h)
NM	Nautical Miles (1NM=1.852km)
NSA	National Supervisory Authority
OIR	Operational Incident Report
OJT	On the Job Training
RVSM	Reduced Vertical Separation Minima
SCT	Scattered (in aviation, refers to cloud coverage)
SIR	Safety Improvement Report
TMA	Terminal Maneuvering Area
UAC	Upper Area Center
VFR	Visual Flight Rules
VHF	Very High Frequency
VIS	Visibility
VOR	VHF omni-directional range (aviation radio-navigation facility)
WTC	Wake Turbulence Category

Table 3 - Acronyms


SIGILLVM · VNIVERSITATIS · GOTHORVM · CAROLINÆ
AD VTRVMQVE
1666