Characterisation of the Variation in Safety Beliefs across the Aviation Industry

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Abstract. According to the scientific principle of falsification, no knowledge can categorically be proven to be true: science is just a collection of theories which have not (yet) been proven false. This humility must also extend to the social sciences. Some existing aviation human factors and safety 'knowledge' has been falsified based on empirical evidence, yet still this falsified 'knowledge' – or more correctly: these assumptions – seems to persist and in fact actually dominates safety management practices in the commercial air transport industry. This research attempts to clarify some of these disproven yet enduring assumptions, and to map out their prevalence across different aviation domains (e.g. flight operations, maintenance, etc.). The variations in safety perspectives across the industry will be characterised based on a survey and interviews with a cross-section of aviation professionals. This empirical data can be used by researchers and safety management to better understand their target population and ensure their safety models and intervention strategies are appropriate.

1 HARMONY AND DISCORD IN THE AVIATION INDUSTRY

1.1 Commercial Aviation: A Mature and Standardised System

Commercial air transport is frequently heralded as the safest of all public transport modes. This is not by chance. An enormous amount of reflection, resources, and trial and error has gone into building up the modern-day aviation system. It is a system comprised of much more than just (well-trained) pilots flying around in (sophisticated, well-maintained) aircraft. There are many mature layers of organisational infrastructure surrounding the core activity.

This state of maturity and complexity is the result of the combined effort and experience of millions of people world-wide and the knowledge accumulated over decades of operation. Included in this corpus of knowledge are non-technical and human factors principles about the way people design, fly, control, and repair aircraft, as well as how the activity is organised, regulated, and investigated when accidents do occur.

Viewed from the outside and compared to other industries, aviation is a highly standardised industry. There are standards and regulations prescribing in detail the design, certification, manufacture and selection of parts and materials, navigation procedures, and the airport infrastructure, as well as the qualification and training of personnel and the minutiae of daily operations. The jargon used by air traffic controllers, the size and colour of map symbology, the shades of grey of the cockpit dashboards, the number of hours a pilot has to rest – efforts are made to ensure nothing is left to chance.

This level of standardisation offers many obvious advantages, and is clearly a large contributor to the impeccable safety record enjoyed by commercial passenger-carrying operations in the developed world.

1.2 Aviation Safety Models and Methods: Built on Shifting Sands

Just as technical aviation knowledge and methods of inquiry have evolved, so too have the social sciences applied to understanding behaviour, risk, accidents, etc. [Rasmussen, 1997]. Initially, in the development of aviation human factors and safety management principles, the human, social, and organisational elements were added into the equation as 'technical' components, which could be decomposed and studied in isolation. The commercial aviation industry is a sociotechnical system, however, and we are starting to reconsider this technical, positivist approach; the science of understanding and modelling aviation work has become more holistic and refocused towards the social end of the 'sociotechnical' scale in our research topics and our methods.

Despite problems 'proving' and quantifying many non-technical, human factors principles in a scientifically satisfying way, they have accumulated to form a collective common sense within the industry. The fact that these principles are often unproven (or 'proven' based on scientific methods which may not be appropriate) suggests that they should actually be referred to as 'assumptions'. It is therefore our job, as human factors and safety researchers, to continually question and update these assumptions and the associated models and methods derived from them.

Research over the past twenty-five years has indeed shown that some of the common assumptions about aviation safety are either false or do not hold under certain conditions. For examples of the kind of assumptions we are referring to are: 'humans are a liability (and therefore automating the human out of the system makes it categorically safer)' or 'accidents occur as a linear chain of events' or 'following the procedures guarantees safety', etc. Many of the models and methods currently in use are based on these assumptions, and therefore they do not meet the needs of the modern aviation industry – they may in fact prevent further progress [Amalberti, 2001; Dekker, 2005; Hollnagel, 2004; Leveson, 2002].

In his work, Erik Hollnagel characterises many of these problematic assumptions as the

‘Traditional Safety Perspective’, and presents the antithesis ‘Revised Safety Perspective’ as a more realistic way to understand safety and the role of humans in complex sociotechnical systems [Hollnagel, Communication to the IMDR Journée Résilience, Paris, 2008]. Others have published similar ideas about the need to revise our way of thinking about safety issues (e.g. accident analysis, error, responsibility and blame, etc.) in order to make forward progress [e.g. Dekker, 2005; Pariès, 1999; Woods, 2006].

1.3 Disparity in Aviation Safety Perspectives

Most worrying of all is the fact that these assumptions are tacit: they are assumed to be ‘truths’ and are taken for granted without most people even being aware of them or considering them as possible points for debate. An example is the notion that “every accident has a cause”. At first glance such a statement may seem self-evident; however, anyone who has investigated an accident (or seen a presentation by Hollnagel) probably recognises that such assumption cannot be taken at face value.

In spite of many years of promotion and publications by such researchers and their industrial counterparts, it is not uncommon to encounter staunch supporters of the traditional perspective in many walks of aviation life, including human factors and safety researchers. Although it is gradually losing ground, this vision still dominates even in the face of mounting contradictory evidence. The industry as a whole continues to believe in these kinds of assumptions and oversimplifications: they are still taught and promoted and they still form the basis for many of our work practices and regulations[1].

In contrast to the supporters of the traditional vision, there are also those in the industry who have experienced first hand the limitations of the narrow technical perspective and believe in the need for change.

This inconsistency in safety perspectives and human factors beliefs is in sharp contrast to the homogeneity of other aspects of the commercial aviation industry. This disparity is problematic in itself as a potential barrier to communication amongst the various stakeholders, professions, organisations, or even across national boundaries.

In fact we do not know where these differences in opinion lie. Perhaps the variations only exist at an individual level and there is no discernable pattern? Perhaps there is a rift between managers and ‘operators’; a blunt end versus sharp end phenomenon? Perhaps having a broad range of professional experiences or first hand experience with an accident investigation makes a difference? Maybe the variations correspond to the level of human factors training (which varies widely amongst the aviation professions) or post-secondary education. It could be related to national culture, or perhaps it’s simply a matter of age: is this just ‘old school’ versus ‘new school’ thinking?

1.4 What does “The Industry” Believe?

To try to answer these questions, we are conducting a study to map out the differences in safety perspectives across the aviation industry. The objective is to understand who

[1] Of course the reasons for this reluctance are manifold [see for example, Steele & Pariès, 2007], but we will not discuss them here.

subscribes to the traditional safety 'assumptions' and who rejects them. We will compare the safety perspective with demographic data in an attempt to map out any patterns or variations in these beliefs. This will provide empirical data to support (or refute) the literature, as well as more precisely defining the perspectives, allowing safety managers and researchers to more appropriately target their intervention strategies.

2 MAPPING AVIATION SAFETY ASSUMPTIONS

The work is being carried out in four phases: (i) identifying the assumptions from the literature; (ii) conducting initial field work (in the form of interviews) to develop a set of questions and statements for the study; (iii) surveying a cross-section of industry professionals and analysing the results quantitatively; and finally (iv) interviewing a defined sample of industry professionals in order to explain the quantitative findings.

Our main focus is on the four principle aviation activities: aircraft design and manufacturing, airline operations, maintenance operations, and air traffic management. If we have sufficient access to the field, we will also include other aviation-related work in this inquiry, such as accident investigation, regulation, airport operations, etc.

2.1 Identifying the Contested Safety Assumptions

In the first phase of the research, we gathered examples of frequently contested assumptions from the literature (in particular the explicit work of Hollnagel [2004] and Dekker [2005]) which underlie existing safety practices in aviation. This review centred on the different safety paradigms prevalent in aviation human factors, complexity in organisational safety modelling, and the basic tenets of Resilience Engineering. We grouped these assumptions according to themes and identified the core theoretical concepts and operational categories.

The five theoretical concepts are: (i) variability; (ii) linearity and Newtonian proportionality; (iii) causality and determinism; (iv) Cartesian dualism; and (v) normativism. There is considerable overlap between these five concepts, and we observed that they all fall within the framework of complexity theory as applied to organisations [Dugdale & Pavard, 2001; Moulin & Pariès, 2007].

To bridge the gap between these theoretical concepts and concrete, operationally relevant questions we identified what we call 'operational categories' from the same literature sources. These are recognisable, socio-organisational phenomena which embody the aforementioned concepts but which derive directly from operational practice and human factors work, thus lending themselves more easily to direct questioning. The five categories are: (i) errors; (ii) responsibility; (iii) accident models; (iv) safety vision; and (v) inter-organisational relationships. They are not independent of the above theoretical concepts, but rather they serve as examples of them; merely different pieces cut from the same cloth.

2.2 Preliminary Empirical Encounters

Our intention was to build a questionnaire based on these ten concepts and categories to gauge whether "the average" aviation professional subscribes to the simple, traditional safety perspective or the complex, revised safety perspective. In order to facilitate the writing process and to get some initial feedback and see the reactions of operational personnel to the various concepts and categories topics, we decided to conduct some preliminary field work in the form of semi-directed interviews. This also offered us the opportunity to ground the language of our survey in the vocabulary used in the field.

We conducted twenty-one interviews with twenty-one different people. The only criteria for our sample were to have a minimum of four people from each of the four principle domains, who were not specialists in human factors or safety. We expanded our sample size from sixteen to twenty-one to take advantage of the availability of contacts as they opportunities presented themselves. The sample includes five pilots, four engineers, six air traffic controllers, four mechanics, one accident investigator, and one employee at a national regulatory authority. The sample includes people from five different countries in Europe and North America, ranging in age and experience level, and four are women. Four participants are specialists in risk or human factors.

The interviews were confidential (almost all without the knowledge of the participants' employers) and recorded on audio tape. Four of the interviews were conducted over the phone. Some interviews were done entirely or partly in French, the rest in English.

The data was coded, but not analysed at this stage, the objective being to assist writing the questionnaire. It will be analyzed during the final phase of the research project.

2.3 The Questionnaire

The questionnaire is targeted principally to personnel from airlines, aircraft maintenance (MROs), air traffic control (ANSPs), and aircraft and equipment manufacturers.

We customised the questionnaire slightly for the first three types of organisation (e.g. all ANSP employees are asked questions about controllers, all MRO employees are asked the same questions but the word "mechanic" is used rather than "controller", etc.) and everyone else received questions about the behaviour of pilots only. We created slightly different versions of the questionnaire for three types of "operators" (pilots, mechanics, and air traffic controllers) asking direct questions in the form "Do you do this?" rather than indirectly, as in: "Do pilots do this?" This allowed us to compare the perspective of those doing the work (sharp end) versus those removed from the front-line (blunt end).

The web-based questionnaire consisted of 63 - 73 questions about safety (from a pool of 93 total variations) and 19 - 22 demographic questions. In spite of the length, the testing phase revealed that the time required to complete the questionnaire was 15 - 20 minutes, which we considered acceptable. The core questions on safety were available in English, French, or Spanish. The welcome page and demographic questions were in English only.

It was circulated throughout the HILAS (Human Integration into the Lifecycle of Aviation Systems) EU project consortium and using the professional networks of the researchers (initial list of over 600 people) as well as online forums and networking websites, and professional association networks. A "snow-ball" sample (asking respondents to forward on the link) was our objective and, at the time of writing, this seemed to be successful, with a response rate greater than one response per request sent out by the researchers. We hope to receive at least 600 responses. The main area of interest for this study is Europe, however it is being circulated online around the world.

We opted for this dissemination method over a formal sample done within a limited group of companies with management approval because we feel that the nature of the questionnaire is sensitive (e.g. we ask whether respondents agree with the statement "At my organisation safety always comes first") so we wanted to assure confidentiality. We expect that the benefits to the validity of our study (less self-censorship bias and larger sample) will outweigh the drawbacks of not having control over our data sources.

The demographic questions ask about profession, type of company, type of job (operator (pilot, mechanic, controller) or not), country of residence, age, education, human factors training, gender, breadth of experience (any secondary posts or previous aviation job, involvement in an accident, have they ever lived in another country). During the statistical analysis (multiple correlation analysis) we will attempt to identify any variations in safety perspective correlated to these factors.

2.4 Phase 4: Interviews and workshop

Based on the quantitative results, 25 - 40 additional interviews will be carried out with a sample of professionals from the aviation industry. Qualitative analysis will be done together with the data from the twenty-one preliminary interviews. This final phase is needed since the questionnaire only alerts us to the existence of variations in beliefs. Quantitative data alone does not offer insight into the nature of the variations, or why they exist. We will also run a workshop with a panel of industry representatives to discuss the results and the implications for their work practices.

3 CONCLUSIONS

According to David Woods, what organisations really need to do to improve safety is examine their strategies at a meta-level, to question whether their "model of the world matches the world they are in" [Woods, personal communication, 2004]. Continuing to manage the work using inaccurate models based on flawed assumptions (e.g. a normative model assuming that people never deviate from the procedures) only leads to inappropriate decision-making and poorly adapted intervention attempts (e.g. counting deviations rather than understanding why people work around procedures).

A true learning organisation will assume its models are flawed and its ability to respond is imperfect and will actively seek out evidence supporting this, in order to improve [Rochlin, 1999]. As we suggest in the introduction to this paper, the need to take a meta-view extends to the human factors and safety research community as well as, since this is where industry takes many of its cues and also since research provides the models and approaches which form the basis for industry's working methods, tools, and training.

This study proposes an operational characterisation of the concepts defining the traditional and revised safety perspectives in the form of a questionnaire. Quantitative and qualitative data gathered during this research project aims to provide a snapshot of the variation in safety perspectives across the industry world-wide. Empirical data of this nature can be used by researchers and managers to assess the gap between their model and "the world they are in", and more efficiently target their safety efforts.

Resilience Engineering takes the "Revised Safety Perspective" as its starting point and sets out to question and redefine the traditional safety and risk management paradigm. Our study aims to provide theoretical clarity and new empirical data to support this paradigm shift.

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