the centre for analysis
of risk and regulation

centre for analysis
of risk and regulation

# Interrogating the Unknown:
# Risk Analysis and Sensemaking
# in Airline Safety Oversight

**Carl Macrae**

E·S·R·C
ECONOMIC
& SOCIAL
RESEARCH
COUNCIL

LSE
THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE

# Interrogating the Unknown:
# Risk Analysis and Sensemaking in Airline Safety Oversight

**Carl Macrae**

## Contents

Printed and bound by Kube, May 2007

# Interrogating the Unknown:
# Risk Analysis and Sensemaking in Airline Safety Oversight

**Carl Macrae[1]**

**Abstract**

The initial identification of risks in organizations is one of the key challenges of risk management. This research investigates how weak signals of emerging risks are identified and interpreted within airlines. An ethnographic study of airline flight safety investigators was conducted to examine the interpretive work of risk analysis and the sensemaking processes employed to identify risks. The findings suggest that the perception and use of organizational ignorance was central to this work. Risks were identified by constructing and enlarging small moments of doubt, where current knowledge was found to be questionable or suspect in some way. These sensemaking processes were supported by an analytical culture organized around assumptions that organizational knowledge is inherently limited, partial and fallible.

---

[1] Correspondence: Carl Macrae, Centre for Analysis of Risk and Regulation, London School of Economics and Political Science, Houghton Street, London WC2A 2AE. (c.macrae@lse.ac.uk).

**Introduction**

One of the key challenges facing risk managers in organizations is the identification of previously unknown threats. Organizations deploy risk management systems to catalogue, analyze and control threats to their operations. But in modern, complex and hazardous organizations such as airlines, risks are rarely self-evident. They must be actively identified and interpreted, often in a context rich with weak or equivocal signs of potential problems. And many of the most serious and challenging risks typically lie at—or just beyond—the limits of current knowledge. Analyses of major organizational accidents, such as the loss of the space shuttle Challenger (Vaughan, 1996), have revealed how catastrophic organizational breakdowns can result from longstanding issues that were not noticed, recognized or understood as serious risks within the organization before the event (Turner, 1978; Turner and Pidgeon, 1997). It is these unknown, hidden and latent risks that can pose the most insidious threat to organizations (Reason, 1997).

In practice, identifying new and previously unknown risks depends on the professional judgment and expertise of risk managers. Risk managers must interpret information on organizational performance to identify and piece together signs that some previously unknown risk exists—such as a serious procedural flaw, for instance. This work involves an ongoing process of monitoring for previously unexpected and unforeseen risks. Reason (1990, 1997) has argued that unknown, latent risks are inevitable in all organizations and the primary purpose of risk analysis is to find them and "make them visible" (Reason, 1997, p. 37). Wildavsky (1988, p. 93) argues that scanning, probing and "interrogating the unknown" lies at the heart of risk management. However, these initial processes of risk identification are largely ignored in current risk analysis methods. Risk analysis tools typically focus on the measurement and comparison of risks, implying that their initial identification is largely unproblematic (e.g. Cabinet Office, 2002; Institute of Risk Management, 2002). Further, the initial identification of risks in organizations has received little empirical attention. This is perhaps unsurprising. The initial identification of a risk represents the earliest and most tentative stage of risk management (Hutter and Power, 2005). It depends on processes of interpretation that are heavily shaped by both individual knowledge and organizational culture. These interpretive processes are hard to see.

Yet what is interpreted and labeled as a risk at this early stage determines which issues receive further scrutiny, analysis and management—and which do not. It is at this early, tentative stage of risk analysis that consequential judgments are made regarding what to attend to, what to ignore, what to question, and what to take for granted (Weick, 1998a). Understanding the nature of this early interpretive work in risk analysis is therefore crucial to understanding broader issues of risk management in organizations.

The concept of organizational 'sensemaking' (Weick, 1979; 1995) provides a useful theoretical lens through which to examine the early interpretive processes of risk analysis. Sensemaking refers to the processes that people engage in to understand ambiguous situations, interpret uncertain or anomalous data, and literally make sense of confusing events that confront them. Processes of sensemaking unfold when people actively notice and select cues in a situation and relate them to broader

frames of reference in order to create a plausible, meaningful and useful account that can guide and explain action. The failure of sensemaking is strongly implicated in many studies of organizational accidents and disaster (e.g. Turner, 1976; Weick, 1993; Snook, 2000). As such, organizational sensemaking offers a valuable set of ideas that are well-suited to studying the early processes of noticing, identifying and interpreting signs of unknown, latent risks in organizations.

The present research examined the sensemaking processes through which latent risks are identified and interpreted in organizations, and the cultural premises and characteristics that support this activity. It specifically studied how operational risks to flight safety are identified in airlines, drawing on a qualitative, ethnographic study of flight safety investigators. The core work of these investigators was the analysis of minor operational errors and failures as a means of overseeing organizational safety and identifying new, previously unrecognized risks.

This paper is structured as follows. First, the work of airline safety incident analysis is detailed. It is argued that this setting presents an ideal site to study processes of sensemaking in risk analysis and particularly the identification of latent risks. Second, theories of organizational risk and sensemaking are reviewed and connections between them developed. Next, the research approach and methods are outlined. Then the findings and analysis are presented. These focus both on the processes of sensemaking that were employed in risk identification and the underlying assumptions and perspectives on which these processes were based. Finally, the theoretical and practical implications of these findings are discussed.

**Airline safety incidents and risk analysis**

The analysis of flight safety incidents by investigators in airlines is a focused site of risk identification. Incident reporting systems are well established in the airline industry and are widely operated both by airlines and national regulatory agencies (O'Leary and Chappell, 1996; Pidgeon and O'Leary, 2000). Airline personnel are obliged to report any event that may have implications for flight safety to an independent safety oversight unit in the airline—for instance, an equipment failure, a misheard instruction from Air Traffic Control, or an erroneous entry in a technical log. Investigators in these safety units review and analyze incident reports, and recommend and oversee any appropriate risk management action. While these incident reporting systems allow known risks to be monitored, they primarily represent an organizational strategy for capturing previously unknown and unexpected risks. Analyzing incidents allows safety investigators to identify risks that are not otherwise anticipated in the planning and design of operations, nor predicted in prospective risk assessments, nor captured in audit and assurance programmes. The analysis work of investigators is therefore heavily oriented to the identification of previously unrecognized, latent risks.

The work of investigators follows a typical pattern. Once incident reports are submitted they are entered into an electronic information management system. Investigators process each new report by reviewing the brief details and summary provided, judging the risk it represents, assigning a risk rating, and determining what further investigation may be necessary. Reports are then passed to specialists

in relevant areas of the airline, with a request for an opinion or further technical information. Investigators coordinate and oversee these local investigations, which can remain active from a few days to several months, and may involve a single specialist or a large team. In a large airline some hundred or so investigations could be active and ongoing at any one time.

Identifying latent risks by analyzing incident reports is challenging, and represents a typical situation faced by risk managers in many other organizational settings. Investigators are faced with large quantities of data; a team of four or five investigators in a large airline may deal with some 9,000 reported incidents a year. And, while the risks being managed are potentially catastrophic, the reported incidents relate to routine operational events that result in minor, and usually no, adverse consequences: where problems occurred but were effectively caught and contained. As such, the meaning for safety is often ambiguous—something went wrong but was corrected. Further, while incidents may be similar in general type—a communication problem or failure in a technical system—they are typically unique in their detail: what happened, what caused it, and how it was responded to and dealt with. What is more, the information received by investigators is minimal, and often of poor quality. Reports are brief, technical statements—usually "one-liners" to encourage reporting in the first place—and often concern events that reporters only partially observed or understood. Any event that may be of significance therefore needs to be followed up and investigated further.

In light of all this, flight safety investigators work in an environment rich in weak signals, ambiguous signs, and possible warnings of potentially unknown risks. But while signs of potential problems are profligate, attention is limited. Investigators cannot follow up every incident reported to them. They must interpret incidents to identify what constitutes a risk, which issues to prioritize and pursue, and which to set aside.

## Sensemaking and risk in organizations

Organizational sensemaking offers a broad framework within which to understand processes of interpretation and analysis in risk management. This framework draws on a long tradition of organizational and psychological theory, and distils from it a set of key premises. For Weick (1995, p. 14), "sensemaking begins with the basic question, is it still possible to take things for granted? And if the answer is no… then the question becomes, why is this so? And, what next?" In this influential characterization, sensemaking in organizations is occasioned by moments of uncertainty, anomaly, ambiguity, surprise and error (Weick, 1995; Starbuck and Milliken, 1988). These moments are the stuff of risk managers' daily work (Hutter and Power, 2005).

At the core of sensemaking is the ongoing interrelation of concrete cues to broader, more abstract, frames of reference. People bracket and extract specific features of events—such as the location of the damage caused to an aircraft, or the type of bird that struck it—and relate these to socially available knowledge and frames of reference such as rules, stories, norms or models regarding, for instance, previous bird strikes and their operational implications. Through this active interrelating of

cue and frame, people make sense. They build a plausible account or representation of a situation that can guide and explain action (Weick, Sutcliffe and Obstfeld, 2005). Action is central to sensemaking. A key premise here is that people shape and enact the environment they face by acting in and on it (Weick, 1979). Suspecting a problem, people may investigate further, generating more information that changes their view of the problem they face. And sensemaking is guided by peoples' understandings of their goals and identities: their views of what role is being performed, what projects are currently in progress, what objectives and ideals are being strived for. All of this is inherently social (Maitlis, 2005). Sense and organization are produced through social communication and interaction (Weick, Sutcliffe and Obstfeld, 2005), and even when working alone, the frames of reference people draw upon are social products (Berger and Luckman, 1966).

In the literature, facets of sensemaking connect most clearly with risk management at two extremes: disaster and success. On the dark side, a range of theories have sought to explain how risks remain hidden and unknown in organizations, and why signs of these risks go unnoticed or are misunderstood for long periods. Turner (1976; 1978; Turner and Pidgeon, 1997) argued that accidents are preceded by a gradual accumulation of events that are at odds with currently accepted models and beliefs within an organization. This results from a failure to reconsider basic organizational assumptions and beliefs in light of disconfirming events. Simply put, these interpretive failures represent "the management system losing touch with its operational realities" (Turner, 1994, p. 216). Similarly, Vaughan (1990; 1996) has shown how weak signals of anomalies and deviance can quickly become normalized in organizations, through a process in which anomalies become redefined as expected standards of acceptable performance.

On the brighter side, research has sought to explain how high-reliability organizations manage to rapidly identify and resolve emerging problems to maintain near failure-free operations. Weick and Sutcliffe (2001) argue that this is achieved through a distinct approach to organizing that is activated by moments of surprise. Operational anomaly are noticed by personnel who are highly attentive to unexpected deviations and disruptions, and who flexibly organize around these events so as to "enlarge what is known about what was noticed" (Weick, Sutcliffe and Obstfeld, 1999, p. 91), revise flawed expectations, and solve problems while they are still small. Disrupted expectations act as triggers around which personnel interact to interpret and resolve unforeseen problems (Rochlin, 1989).

At the core of both of these bodies of research is how ignorance and the unknown are handled—or mishandled—in organizations (Smithson, 1989; 1990). Accidents have been used to study the creation and inadvertent persistence of pockets of ignorance in organizations. Studies of organizational high-reliability have explored how early signs of the unexpected and surprising are responded to and explored. What these literatures do not address in any detail, however, are the processes of sensemaking that lead to risks being recognized and identified in the first place. Neither has research on sensemaking directly engaged with issues of ignorance and the unknown in organizations. Sensemaking is implicitly assumed to follow disruption or surprise. The interpretive work involved in the initial recognition and construction of these moments of disruption has remained largely invisible.

**Research approach and methods**

This research aimed to examine the processes of sensemaking employed in the early identification of risks, and the underlying cultural assumptions and premises that support these processes. The focus was on risk managers' own beliefs and understandings of risk, and the interpretive and analytical work they engage in to produce these. To study these aspects of risk management a qualitative, ethnographic approach was adopted. The work of risk managers was studied up close in its practical organizational setting, through repeated rounds of in-depth interviews and detailed participant observation. This approach aimed for theory elaboration (Lee, 1999): developing an explanatory account of practice that draws on, contributes to and extends current theory in this area. A constant comparative analytical approach was employed, following the principles of grounded theory (Glaser and Straus, 1967; Turner, 1983; Pidgeon and Henwood, 2003). This provides a systematic process for generating theoretical constructs from qualitative data, is particularly well suited to studying organizational sensemaking (Weick, 1995; Locke, 2001), and has been effectively used in previous studies of organizational risk (Turner, 1976; Snook, 2000).

*Setting and participants*

The research was primarily conducted in the safety oversight department of a large UK airline. This airline operated a well-established incident reporting programme that, at the time of study, received around 9,000 flight safety reports a year. The work of ten safety investigators was studied, three of whom also had senior management responsibilities in the department. These investigators were responsible for the management of the flight safety incident reporting system. They all had lengthy experience in operational roles—as pilots, flight engineers, engineers and cabin crew—along with considerable experience of safety oversight, ranging between two and twenty years. An additional sixteen investigators were interviewed at six other organizations that operated similar flight safety reporting systems. These organizations differed in size and function. This provided the basis for further comparative refinement of the emerging findings. They included two small airlines, a medium sized airline, a large international airline and two national air safety agencies.

*Methods and procedures*

Qualitative data were collected over three years using a multi-method approach. 38 interviews were conducted with investigators, along with some 400 hours of participant observation. The research progressed in six stages in line with an 'emergent' research strategy (Lee, 1999): each stage developed on and was shaped by the findings of the last, as described below. Three rounds of interviews were conducted within the primary airline, followed by three months of participant observation there. Interviews were then conducted at the six comparative organizations, followed by a final round of interviews back at the primary airline.

*Interviews*
First, five unstructured familiarization interviews were conducted to gain an initial view of investigators' analytical work. Having found that participants drew on lengthy experience and professional judgment, the second stage of seven semi-structured interviews explored this further by having each investigator talk through their analysis of a set of ten incidents, following Klein's (Klein, Calderwood and Macgregor, 1989) critical decision method. The third stage consisted of nine semi-structured interviews to review and further explore the emerging findings. The fourth stage of sixteen comparative interviews in the six other organizations examined both specific analytical practices and the issues highlighted previously. The final stage of interviews at the principle airline took the form of two unstructured conversational group interviews with eight investigators to review the key findings.

*Participant observation*
The participant observation study involved three months of close examination of the practical work of risk analysis in the principle airline. This study examined how investigators used and applied notions of risk in their daily work, and the analytical practices employed to identify risk. My place in the field ensured only peripheral involvement in these work activities, which Robson (2002) calls 'marginal' participation. I sat with investigators as they assessed 464 incident reports, asking them to account for their reasoning in each case. I also discussed with them the weekly incident reviews they produced, observed ongoing discussions and conversation, sat in on fortnightly team meetings, and observed three high-level board safety and operational review meetings. Ethnographic field notes were taken overtly and by hand, near-verbatim when required, following Emerson, Fretz and Shaw's (1995) strategies, and later typed up.

*Analysis*
Data analysis was ongoing throughout the research, beginning immediately after the first interview phase. The aim was to gradually move from particular instances and examples of practice to more general theoretical categories and explanations. Initial coding was applied to the transcript and field note data from each study phase: all instances relevant to understanding how risks were being analyzed in practice were highlighted and labelled. These labels aimed to capture, in clear terms, what was going on in that particular instance. They captured, for example, where an investigator recalled some feature of a past accident when reviewing a present incident. So, these labels were low-level categories that captured aspects of sensemaking around risk.

Data analysis cycled from this initial coding to phases of core coding. Here, the emphasis shifted to comparing, integrating and synthesizing these labels into higher-level categories, writing definitions for these categories, and mapping how these categories interrelated and connected with each other. For instance, referring to a past accident became part of a broader category concerning the use of general exemplars of risk. And this category was linked to others relating to the social sources of these risk exemplars. Iterative phases of this integration, comparison, and re-coding allowed key characteristics and patterns of sensemaking to be described and explained in terms heavily grounded in examples of practice. The analysis was

brought to a close once a coherent, sensible and fully elaborated account of the analysis work of investigators was produced.

**Identifying risks: making sense of organizational ignorance**

The risk oversight and analysis work of flight safety investigators was shaped by a distinct analytical culture. At core, this analytical culture was defined by a deep appreciation of the limits to organizational knowledge. Investigators assumed that their knowledge of risk was always partial and incomplete, and that the incident data available was inherently fallible and flawed. Risk assessment was viewed as a means of identifying areas of organizational activity that needed to be re-examined, reviewed and perhaps reshaped. That is, assessments of risk were used to label areas of organizational ignorance: where unknown, latent risks may potentially exist. So, to identify risks, investigators engaged in processes of sensemaking that were directed at creating and enlarging small moments of doubt: a belief that current models of organizational activity were in some way questionable or suspect. These doubts were constructed through four distinct patterns of sensemaking.

*An analytical culture of interpretive vigilance*

Investigators shared a set of assumptions, values and beliefs regarding their role and organizational position as risk managers, the nature of the organizational data being dealt with, and the organizational function and purpose of risk assessment. These shared premises formed a distinct analytical culture that was centred on a deeply ambivalent relationship with ignorance. One of the most fundamental assumptions of investigators was that their knowledge of organizational activity, and its associated risks, was always partial and incomplete. This assumption was continually reinforced by their ongoing experience of investigating and managing risks. This in turn shaped how they understood their role as risk managers and the purpose of risk assessment.

Organizational ignorance was believed to arise from a number sources, and threaten the process of risk management in a number of ways. First, organizational complexity and change were assumed to be sources of fundamental limits to investigators' knowledge. Investigators believed that the sheer complexity of airline operations precluded complete and comprehensive knowledge of all possible problems. They also believed that changes in organizational arrangements and the broader industry continually rendered their knowledge invalid and out of date:

It happens all the time—who supplies the de-icing fluid, who does the de-icing? Things that you take for granted all of a sudden change.
In their experience, countless investigations and accidents had proven this to be the case.

Second, investigators were particularly aware of the limitations to the incident data they depended on, and the flaws and influences it was open to. Primarily, they were concerned about not getting information at all. A 'quiet' week with relatively few incidents reported suggested they were simply not hearing about problems, rather than there being none. Equally, investigators assumed that the incidents reported to them were only a partial sample of those actually occurring—the "tip of the

iceberg". Further, the content and accuracy of the reports were considered questionable as they were written from the limited perspective of a single observer:

> Where we fail is getting information early enough… Even sometimes from the individual [reports], it doesn't come out. You will get the report saying we had a fire warning in the cargo bay. Then you find out that it happened outside the cargo bay but the detectors inside detected it. Then you think this is serious, because we have a process to protect fires in the cargo bay—fireproofing and extinguishers. But this is outside, so you have a problem there, and the process escalates and you realize how much more important it is as you get more information. So the end result, [is that] we get the information, but it is very difficult to get that information early on.

Incident data were viewed as inherently inaccurate—and often entirely wrong. A stark poster to this effect hung in one of their offices.

Third, investigators assumed that their own analyses and assessments could easily be flawed. They viewed assessments of risk as a fallible product of their current knowledge, the information available and their ability to piece this together effectively. Investigators believed that risk assessments were "only as good as the people doing the analysis", and that this analysis could easily be performed poorly—missing important points, dismissing relevant information or misconstruing evidence.

This broad concern with the limits of knowledge, information and analysis was based on investigators' ongoing experience of risk management. They cited countless examples of interpretive failures—where beliefs, data and assessments had been proven incomplete or entirely wrong, often by some adverse event. Major accidents were seen as the most vivid and incontrovertible evidence of this, demonstrating where risks had not been foreseen or fully understood:

> We always thought [this event] was back here in the chain… We didn't think that this would happen first, that would break down, and then that can happen. But if we could do that we would all be geniuses, and the thing with accidents is that they prove that we are not geniuses. They are where we have got it wrong and we need to learn.

Equally, investigators believed that the daily work of reviewing and investigating incidents continually revealed where they had previously been unaware of risks. Stories of how people had been caught out in the past, and missed signs of impending disaster, were commonly told. For instance, discussing an incident in which an engineer had misdiagnosed the cause of a fault, two investigators retold a story of an infamous accident that another airline had suffered several years ago, where part of the top of the aircraft ripped off during flight with the loss of a flight attendant:

> *First investigator:* It was loads of human factors that went into that. I was over in engineering then, and the millions that were spent on looking into that, looking at all this non-destructive testing to find cracks… But a guy who knew all about it reckoned the crack had to be like that [demonstrating several millimetres wide and several centimetres long]. It was up by the door, left number one, upper right side. You don't need tools to see that.
> *Second investigator:* Just a mark one eyeball… And it was on a real high cycle aircraft, it should have been one of their basic checks, they were a really high risk group.
> *Researcher:* With all the island hopping?
> *Second investigator:* That's it. Up and down, up and down, it's like a test, expanding

and contracting it all the time… So they should have been checking it, and when they looked there was a history of pressurization problems, leaky seals and things.
*First investigator:* And one of the passengers reported seeing the crack, either on that flight or on one before.
*Second investigator:* And there would have been sounds, but being close to the door people would just have said, yup, it's the door—leaky seal, that explains it.
*First investigator:* That's right, if it had been right between the two doors people might have paid a little more attention to it. That's a good point, I like that.

Interpretive failure, missed warnings, and ignored or unrecognized signs of risk were a central preoccupation of investigators and defined this culture of analysis. Investigators viewed their risk management role as one of maintaining a high degree of sensitivity and attentiveness to weak signs of potential risks. Their relationship to organizational ignorance was therefore deeply ambivalent. While there was an expectation and acceptance that knowledge was inevitably limited in some way, there was also a strong belief that moments of surprise—of being caught out by events—were moments of failure. For investigators, to be surprised was to have failed, implying they had allowed a prolonged and considerable disjuncture to develop between their understanding of the organization and actual events:

When we trip over it, that's where the intolerable occurs… it means that our systems not only have fallen down, but it has obviously been wrong for a long period of time. So if something comes up like that, that is intolerable. It means we have been derelict.

Another typical comment was:

You've not done your job by flagging this back earlier… if you get something that warrants action and soon, it surprises you. Horrify might be a better word.

Accordingly, the primary aim of investigators was to remain informed and aware of the risks facing operations. They viewed the purpose of their analytical work as identifying where their current understanding of organizational activities may be outdated, incomplete or wrong, and using this as a basis for learning and advancing organizational knowledge of risks:

You couldn't look at last year's data and say, that was how the risk was scored then, that was how it's scored now, so there is an inconsistency. There isn't, because your knowledge has moved—and hopefully expanded.

As such, the purpose of risk assessment was seen as a process of identifying gaps or inconsistencies in their knowledge of risk, "to recognize where your problems are", and to label these for further attention and investigation. Investigators used assessments of risk to direct and focus organizational attention onto previously taken-for-granted aspects of operations, to "get people thinking", to "prompt discussion" and to "spark action". Risk assessments were used to indicate that some aspect of organizational activity required re-examining and perhaps redesigning. Determining that an incident represented a risk was a way of signalling and prioritizing the need for renewed sensemaking within the organization.

This approach to risk analysis, and the assumptions and beliefs that underpinned it, can be characterized as a culture of *interpretive vigilance*. Based on their assumptions about organizational ignorance and their role as risk managers, investigators aspired to a high level of sensitivity to weak signs of potential problems. They sought to remain vigilantly attentive to the early signals of emerging risks, in the form of gaps and inconsistencies in their own knowledge. Moreover, they attempted to approach incident data—and their own interpretations

of risk—with a high degree of scepticism, humility and caution. Investigators were constantly concerned with where they may have "got things wrong", how they may be "deluding themselves" and that they "could easily fool ourselves". In practice, this wariness and unease translated into distinctive patterns of sensemaking around incidents, through which investigators attempted to find where their current beliefs and knowledge were questionable or open to doubt.

*Ways of identifying risk: constructing and enlarging doubt*

Investigators identified risks by focusing on and enlarging small moments of doubt: a sense that current knowledge of organizational activity was in some way questionable or suspect. Doubts were fleeting signs of organizational ignorance—a space where the organization was poorly understood and latent risks may be hidden. These moments of doubt emerged when incidents could be construed as challenging or problematic in terms of currently accepted beliefs and models of operational safety.

For the most part, incidents were considered unremarkable. Many events were considered to be "all part of normal operations" and were not dwelt on. They were deemed well-understood and dealt with relatively automatically:

> Most of [the incidents], you know enough to just fly through. [You] check and can say okay, it is not a problem… you're just flying through and they are standard. But as soon as you get into the contentious ones, you start talking about it.

The incidents that attracted the attention of investigators were those that in some way disturbed or unsettled their view that all was adequately understood and under control in an area of the organization. These were events that were "contentious" or "troubling" in some way, and so provoked closer examination and investigation.

Incidents were interpreted as contentious or troubling through four interrelated patterns of sensemaking. These four patterns of sensemaking were the processes through which weak signs of potential risk were recognized and pieced together. They involved:

- making connections, between features of an incident and past accidents or major risk issues;
- identifying patterns of failure, where incidents appeared to share some underlying common factor;
- sensing discrepancy, where there appeared to be inconsistencies in organizational activities or their knowledge of them; and
- noticing novelty, where aspects of an event had not been seen before.

Broadly, the first two sensemaking processes were based on judgments of similarity—constructing patterns, making relations and matching like with like (e.g. Weick, 1995). The second two processes were based on judgments of difference—finding gaps, disjunctions and dissimilarity (e.g. Weick and Sutcliffe, 2001). These processes were highly interrelated, triggering one another. For instance, once a pattern of failure had been constructed it may become categorized as a widespread issue, leading to connections being drawn between that issue and other more disparate and diverse events. Or, noticing a novel or apparently new form of failure

could provoke a review of past events, revealing a previously unidentified pattern. Each of these sensemaking processes are examined in turn.

*Drawing connections*
Seeing a connection, no matter how weak, between an incident and a broader safety issue or past major accident led investigators to doubt safety in the operational area concerned. Past accidents and broader safety issues—such as industry-wide problems identified by safety agencies, or ongoing safety investigations—provided frames of reference that investigators used to interpret incidents with otherwise minor or inconsequential outcomes. References to past accidents while assessing incidents were profligate. An incident could be "like Taipei", or was "Tenerife all over again", or "stinks of Milan"—all references to past major air accidents. These connections were made on the basis of any perceived similarity between features of the incident and factors implicated in the accident or broader concern.

For instance, in one incident a crew reported that nearly the full length of the runway was used on landing. It had been raining and, as a result of being distracted by a suspected failure of one set of windscreen wipers, the autothrottle had been inadvertently left engaged. The investigator immediately deemed this "a bit of a QF1"—referring to the flight code of another airline's aircraft that had overrun a runway in a heavy rain storm due, amongst other things, to a distracted crew—and flagged it for closer examination.

Relating incidents such as this to the broader frame provided by a past major event led investigators to question aspects of operations more broadly, and more seriously, than the incidents on their own would have justified. Connecting an event of limited or no consequences with a past accident or major issue was one way that investigators enlarged their concerns beyond the immediate incident reported— even though these connections were acknowledged to be "tenuous links". Tenuous though they were, drawing these connections was a key basis for identifying where the safety of organizational activities was open to doubt. It was a process for creating and enlarging areas of ignorance.

*Making patterns*
Investigators doubted the safety of operations if they could make some sort of pattern that related reported incidents. Such patterns suggested a common, underlying problem of which they were currently unaware. Patterns were occasionally easy to make, particularly the repeated occurrence of similar events. Such repetition was taken as a strong indication of a problem, and brought the adequacy of risk management processes in that area into doubt. "Repeaters" clearly demonstrated to investigators that risk management in the area had not adequately addressed the issue.

However, patterns were not always so easy to make. In many cases, investigators had to more creatively piece together possible relationships between incidents. For instance, investigators received a report describing how a crew had been slow to disconnect the autothrottle during cruise, resulting in a relatively insignificant eight knot speed exceedence for the flap setting they were on. The investigator reviewing this incident felt that it was similar to three other recent events that were, superficially at least, entirely different—one where a crew had slightly rolled over a

stop line that lead onto a live runway, another where a crew had briefly forgotten to change the altimeter mode after take-off, and a third where a crew belatedly realized they had been flying a manoeuvre too slowly for the flap setting. These were all interpreted as "distraction-type ones", leading the investigator to question, "is it part of a big picture, are we building up a risk?"

The underlying links that investigators made between apparently diverse incidents were often subtle. Whether an event seemed to be part of a 'bigger picture' was rarely self-evident in the reports themselves. The patterns made were based on small numbers of events. Investigators were liberal with the terms 'trend' and 'spate', because they wanted to find and fix problems early. Two events could make a trend, three or four a spate. Here, creating a doubt depended on investigators actively *building* the big picture they suspected it might then fit into. Making patterns—and so identifying risks—was therefore an interpretive rather than a statistical exercise.

*Sensing discrepancy*
Investigators suspected that their organizational knowledge may be inadequate when they identified any apparent inconsistency in organizational processes, or their understanding of them—where things didn't seem to properly match up or fit together. Sometimes these discrepancies were clear. Other times they were more subtle, "little niggling things" where it seemed that "something's not quite right" but it wasn't clear exactly what. A simple example, for instance, concerned a report that described an apparent mismatch between the ECAM (Electronic Centralised Aircraft Monitoring) warning drill and the MEL (Mandatory Equipment List) procedures for dealing with a fuel pump pressure warning prior to take-off:

> Anytime we see a disagreement between ECAM and MEL it's very worrying, as the manufacturers write both. And generally the crew follow the ECAM. So we definitely need to understand this.

Such discrepancies worried investigators, and signalled an area that they needed to understand. More subtly, investigators became suspicious when they perceived any slight discrepancy between what they would have expected to happen and what was reported in incidents (e.g. Weick and Sutcliffe, 2001). On one occasion, for instance, an investigator reviewed an incident in which a take-off had been aborted at low speed due to an engine overspeed warning—signalling that one of the compressor fans in the engine was spinning too fast, reducing thrust. The flight crew were advised by engineering control to check the engine with two stationary engine runs and, as those were clear, to depart as planned. While this sequence was a typical one, the investigator was unsure about the advice given to the flight crew. He was not entirely certain, but "thought they would have done other checks before restarting" with this type of warning. Having "a dig around" and making some telephone calls, he found out that the powerplant engineers "weren't happy" either, and believed that further maintenance checks may have been appropriate before the aircraft was dispatched. Picking up on small discrepancies between the way investigators believed things should be and the way they occurred in incidents was one way in which they produced and enlarged small moments of doubt to identify underlying risks.

*Perceiving novelty*
Investigators developed doubts about the adequacy of operational knowledge if an event was perceived to suggest some new or previously unrecognized facet of failure. Recognizing new ways that organizational activity might break down was a simple and direct indicator of potential ignorance. It involved perceiving signs of new and previously unheard of forms of organizational weakness—either by seeing new forms of failure, or by seeing new implications of known failures, such as novel ways that they might occur and develop.

> It could be either a new kind of condition or a condition you have had for a while, but you will suddenly see it as a major link in a chain… a new link in a chain that gives us an unease.

Signs of novelty were typically both subtle and specific, relating to some slightly different or new facet of operational failure. One example concerned incidents of momentary 'sticking' or stiffness of flight controls once cruise altitude had been reached. On investigation this turned out to have resulted from de-icing fluid dehydrating and accumulating in crevices of the aircraft, re-hydrating on warm, humid days and then freezing at high altitude—later discovered to be an industry-wide problem (Wastnage, 2005).

Recognizing novelty was a clear way of exposing the limits of current knowledge. Where making patterns, drawing connections and sensing discrepancy involved relating incidents to some broader frame or bigger picture, perceiving novelty involved identifying where there was *no* picture. Signs of novelty signalled to investigators a pressing gap in organizational knowledge that needed to be addressed.


**Conclusion**

This research aimed to investigate and characterize the early sensemaking processes involved in the identification of organizational risks. A key challenge in risk analysis is recognizing and perceiving signs of previously unknown, latent or taken for granted organizational conditions (Reason, 1997; Weick and Sutcliffe, 2001). Examining the interpretive processes that underlie practices of risk analysis in airline safety oversight suggests, perhaps counter intuitively, that risk identification involves the organizational *production* of ignorance. Identifying risks involved actively calling into question that which was currently taken for granted, and working to bring current beliefs and assumptions into doubt. In this sense, risk analysis routinized Weick's (1995) organizational sensemaking recipe; is it still possible to take things for granted—and if not, why? In practice, risk identification was a process of interrogating and probing the limits of current knowledge by constructing and enlarging small moments of doubt. These doubts were produced through patterns of sensemaking that interrelated organizational incidents with broader frames of reference in ways that made weak signals meaningful, relevant and worthy of further attention.

These findings hold three implications for theory, practice and future research. First, this research demonstrates the importance of the knowledge, beliefs and frames of reference that are used in risk analysis. How knowledge is drawn on and

related to new information is as important in risk analysis as the data available. This knowledge can take a variety of forms. Here, detailed practical knowledge of organizational processes and goals, previous problems and past accidents was of particular importance. This was particularly the case given that the information available to investigators early on was so limited, ambiguous and imprecise—as can be reasonably expected in many other risk management situations. Identifying risks early and as soon as possible was therefore an interpretive rather than a statistical exercise, and a range of interpretive tactics and sensemaking processes supported this. One implication for practice is therefore that the importance of these broader frames of knowledge—that are often developed and shared through stories about past accidents and events (e.g. Orr, 1996; Weick, 1987)—should be acknowledged, and their use more explicitly encouraged and developed in risk management.

Second, the research suggests the importance of ignorance in risk analysis, and elaborates some of the ways that ignorance is produced and used. Risk identification was a process of recognizing where current organizational knowledge may be limited or inadequate. Small moments of doubt were used to identify areas of ignorance, where current knowledge of the organization needed to be reviewed, developed or remade. In practice, drawing connections, making patterns, sensing discrepancies and noticing novelty all provided ways of interrogating the unknown (Wildavsky, 1988), exposing the limits of assumptions (Turner, 1978; Turner and Pidgeon, 1997) and violating expectations (Weick and Sutcliffe, 2001). Investigators engaged in these processes of sensemaking to tackle ignorance before it tackled them. These findings also emphasize the variety of forms that ignorance can take in organizations (e.g. Smithson, 1989; Weick, 1998b), beyond traditional concepts of probabilistic uncertainty. Another implication for practice is therefore the importance of acknowledging this, and establishing analytical cultures in which scepticism, doubts, suspicions and queries can be voiced and are acted upon.

Third, this research holds a range of implications for future work in this area. The analysis demonstrates that the theoretical framework of organizational sensemaking, and an ethnographic and grounded research methodology, provide suitable approaches to studying the early stages of risk analysis. Clear patterns of sensemaking were identified, along with the cultural premises that support these in this specific organizational setting. The particular setting studied here is, of course, relatively unique in terms of the experts and technology involved, the risks managed and the specific tasks conducted. However, the risk analysis challenges faced here—in terms of poor quality initial information, organizational data on mainly routine and minor failures, and weak signs of large numbers of potential problems—are relatively common across a wide range of organizational risk management settings (Vaughan, 1996; Reason, 1997; Turner and Pidgeon, 1997). Moreover, in this research approach, generalizability is aimed for in terms of the applicability and explanatory power of the conceptual account that is developed. The cultural premises of ignorance that underlie risk management practice, the use of doubts and suspicions as early indicators of potential risk, and the distinct patterns of sensemaking conceptualized here may offer useful theoretical tools that allow us to better understand how risk managers identify previously unknown threats in a range of organizational and regulatory settings.

**References**

Berger, P., and Luckmann, T. (1966). The social construction of reality: A treatise in the sociology of knowledge. London: Penguin.

Cabinet Office. (2002). Risk: Improving government's capability to handle risk and uncertainty. London: Cabinet Office Strategy Unit.

Emerson, R. M., Fretz, R. I., and Shaw, L. L. (1995). Writing ethnographic fieldnotes. London: University of Chicago Press.

Glaser, B. G., and Strauss, A. L. (1967). The discovery of grounded theory. Chicago: Aldine.

Hutter, B., and Power, M. (Ed.). (2005). Organizational encounters with risk. Cambridge: Cambridge University Press.

Institute of Risk Management. (2002). A risk management standard. London: IRM, ALARM and AIRMIC.

Klein, G. A., Calderwood, R., and Macgregor, D. (1989). Critical decision method for eliciting knowledge. *IEEE Transaction on Systems, Man, and Cybernetics*, 19(3), 462-472.

Lee, T. W. (1999). Using qualitative methods in organizational research. London: Sage.

Locke, K. (2001). Grounded theory in management research. London: Sage.

Maitlis, S. (2005). The social processes of organizational sensemaking. *Academy of Management Journal*, 48(1), 21-49.

O'Leary, M., and Chappell, S. L. (1996). Confidential incident reporting systems create vital awareness of safety problems. *International Civil Aviation Organization Journal*, 51, 11-13.

Orr, J. (1996). Talking about machines: An ethnography of a modern job. London: Cornell University Press.

Pidgeon, N., and Henwood, K. (2003). Grounded theory. In M. Hardy, and Bryman, A. (Eds.), Handbook of data analysis. London: Sage.

Pidgeon, N., and O'Leary, M. (2000). Man-made disasters: Why technology and organizations (sometimes) fail. *Safety Science*, 34, 15-30.

Reason, J. (1990). Human error. Cambridge: Cambridge University Press.

Reason, J. (1997). Managing the risks of organisational accidents. Aldershot: Ashgate.

Robson, C. (2002). Real world research: A resource for social scientists and practitioner-researchers. Oxford: Blackwell Publishers.

Rochlin, G. I. (1989). Informal organizational networking as a crisis-avoidance strategy: US Naval flight operations as a case study. *Industrial Crisis Quarterly*, 3, 159-176.

Smithson, M. (1989). Ignorance and uncertainty: Emerging paradigms. London: Springer-Verlag.

Smithson, M. (1990). Ignorance and disasters. *International Journal of Mass Emergencies and Disasters*, 8(3), 207-235.

Snook, S. A. (2000). Friendly fire: The accidental shootdown of US Black Hawks over Northern Iraq. Oxford: Princeton University Press.

Starbuck, W. H., and Milliken, F. J. (1988). Executives' perceptual filters: What they notice and how they make sense. In D. C. Hambrick (Ed.), The executive effect: Concepts and methods for studying top managers. London: JAI Press.

Turner, B. (1976). The organizational and interorganizational development of disasters. *Administrative Science Quarterly*, 21(378-397).

Turner, B. (1978). Man-made disasters. London: Wykeham.

Turner, B. (1983). The use of grounded theory for the qualitative analysis of organizational behaviour. *Journal of Management Studies*, 20(3), 333-348.

Turner, B. (1994). Causes of disaster: Sloppy management. *British Journal of Management*, 5, 215-219.

Turner, B., and Pidgeon, N. (1997). Man-made disasters (2nd ed.). Oxford: Butterworth-Heinemann.

Vaughan, D. (1990). Autonomy, interdependence, and social control: NASA and the space shuttle Challenger. *Administrative Science Quarterly*, 35, 225-257.

Vaughan, D. (1996). The challenger launch decision: Risky technology, culture and deviance at NASA. London: Chicago University Press.

Wastnage, J. (2005). Airlines get new ice alert. *Flight International*, 25-31 October, 12.

Weick, K. E. (1979). The social psychology of organizing (2nd ed.). London: McGraw-Hill.

Weick, K. E. (1987). Organizational culture as a source of high reliability. *California Management Review*, 29(2), 112-127.

Weick, K. E. (1993). The collapse of sensemaking in organizations: The Mann Gulch disaster. *Administration and Society*, 38(4), 628-652.

Weick, K. E. (1995). Sensemaking in organizations. London: Sage.

Weick, K. E. (1998a). Foresights of failure: An appreciation of Barry Turner. Journal of Contingencies and Crisis Management, *6*(2), 72-75.

Weick, K. E. (1998b). The attitude of wisdom: Ambivalence as the optimal compromise. In S. Srivastva, and Cooperidge, D. L. (Eds.), Organizational wisdom and executive courage. San Francisco, CA.: Lexington.

Weick, K. E., and Sutcliffe, K. M. (2001). Managing the unexpected: Assuring high performance in an age of complexity. San Francisco: Jossey Bass.

Weick, K. E., Sutcliffe, K. M. and Obstfeld, D. (1999). Organizing for high reliability: Processes of collective mindfulness. *Organizational Behaviour*, 21, 81-123.

Weick, K.E., Sutcliffe, K.M., & Obstfeld, D. (2005). Sensemaking and organizing. 2005. *Organization Science*, 16(4), 409-421.

Wildavsky, A. (1988). Searching for safety. Oxford: Transaction Publishers.