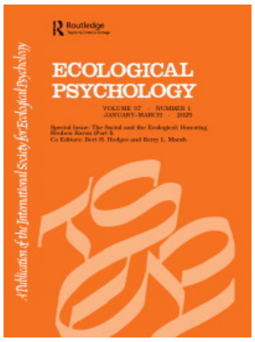

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The Ecological Social Psychology of Aviation Disasters

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ABSTRACT

Reuben Baron's primary contribution to ecological psychology was in promoting the idea that we perceive other humans and animals in our environment in much the same way as we perceive inanimate objects, namely, by actively detecting information. Here, we explore how this insight can lead to a deeper understanding of real-world behavior. We look specifically at three case studies from the history of commercial aviation disasters. In our analysis we combine Baron's direct social perception strategy with the theoretical principles of the distributed cognition approach to functional group activity. We suggest that these approaches are deeply compatible, and that future work is needed to ground cognitive study of team activities in the analysis of the perceptual information available to the actors.

Introduction

Reuben Baron was a pioneer in exploring how James J. Gibson's ecological theory of perceptual information (Gibson, 1966, 1979) might be extended further into the social realm. This is a challenging task because the animate objects of our environment—the other people and animals—generate information that is of a higher order of complexity compared with the information generated by the inanimate features of the environment. You can walk around a rock or a bucket of water and the surfaces will stay just where they were at the beginning. Try to walk around a cat, however, and the same outcome is far from guaranteed. Other animals do not merely passively reflect light, they also shape light in a creative way by moving their bodies.

Hodges and Baron (2007) offered a memorable phrase to identify their method of pursuing this difficult project. They recommended that we should seek to make 'social psychology more ecological and ecological psychology more social'. One way to do this is to focus on laboratory-based experimental activities. In comments prepared in 2021, for instance, Baron wrote: 'I want to set up experiments that ask questions in [social] situations where direct perception is the dominant epistemic mode' (Szokolszky et al., 2023, p. 268). Making laboratory activities more ecological is a valuable and worthwhile strategy.

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In this text, however, we focus on a complementary strategy, namely on cognitive ethnography (Ball & Ormerod, 2000; Hollan et al., 2000; Hutchins, 1995a). Cognitive ethnography offers a functionalist approach to the observation of behavior in the wild (Baggs & Sanches de Oliveira, in press). Specifically, we will look in some detail at three cases of real-world social interaction that took place in commercial airline cockpits in the moments leading up to a crash. At the end we will discuss how this kind of analysis of real-world data can contribute to the further development of an ecological approach to social psychology. First, though, we discuss Reuben Baron's project of pursuing a social psychology grounded in an analysis of the information available for direct perception.

Reuben Baron's ecological social psychology: Direct perception of social properties

An important intuition driving Baron's work on the topic of social perception was the intuition that information about other people can be obtained in much the same way that information is obtained about the inanimate features of the environment—namely, through active exploration on the part of the observer.[1]

This is an important insight, because it immediately draws into question the suitability of some of the most widely used methods in social psychology. Laboratory-based social psychology experiments often deliberately prevent participants from exploring their social environment. For instance, many social psychology experiments rely on presenting the participant with impoverished information in the form of static pictures or lists of words. As Baron pointed out, such conditions are likely to yield errors of perception.

> [I]n the social realm we expect more 'incorrect' social judgments to occur when a person is given a list of adjectives to learn and integrate than when impressions are based on face-to-face and extended social interactions. Errors in such artificial situations arise because the person is (a) deprived of crucial information regarding how his or her actions affect the other person, (b) processing limits are more likely to occur for data which is arbitrarily imposed as opposed to spontaneously elicited by reciprocal behaviors. (Baron, 1980, p. 598)

From this observation alone, we may be persuaded that social psychology must be made more ecological (Hodges & Baron, 2007). The difficult question is: How might this be achieved? One answer that Baron advocated was to focus on the stimulus information underlying the perception of the properties of other people. For instance, McArthur and Baron (1983) invoke Albert Michotte's work on the perceptual information specifying causality in collisions between inanimate objects (Michotte, 1963). They suggest that similar work is needed for causation in the social domain:

> The ecological approach suggests that such research must allow perceivers to watch, listen to, and/or interact with the people for whom they will be making causal attributions. In this manner, one can ascertain what information in the extensional properties of a person or persons is sufficient for making a given attribution. And, one can thus begin to describe the stimulus invariants that give rise to the perception of social causality just as Michotte described the stimulus invariants that give rise to the perception of physical causality. (McArthur & Baron, 1983, p. 229)

In advocating that social psychologists should focus on the underlying stimulus information, Baron is actually advocating a return to an approach to social psychology that was widely accepted in the middle part of the twentieth century: 'Arguably, the three most seminal historical figures in social knowing, Fritz Heider, Albert Michotte, and Solomon Asch, were all committed to a realist, direct perception view of social knowing' (Baron & Misovich, 1993, p. 542).

It is certainly true that Heider understood the phenomenology (if not necessarily the causality) of interacting with others to be a matter of direct, unmediated engagement:

> It has often been stressed, especially by phenomenologists, that the person feels that he is in direct contact with things and persons in his environment. He sees objects directly, just by focusing his eyes upon them. He acts on objects directly by touching them and lifting them. The same is true of person perception. He not only perceives people as having certain spatial and physical properties, but also can grasp even such intangibles as their wishes, needs, and emotions by some form of immediate apprehension. (Heider, 1958, p. 22)

On the following page, Heider quotes a passage from Asch, along similar lines:

> To naive experience the fact of being 'in touch with' other persons is most direct and unmediated by intervening events. We experience direct communication with others: emotion clashing with emotion, desire meeting desire, thought speaking to thought. Often there is virtually no lag between the psychological event in one person and its grasp in the other. We may even anticipate the thought and feelings of those we know, and it would appear that we are as directly connected with others as with our own psychological processes. It seems sufficient for the actions and purposes of others to be there to make them visible and comprehensible; the process appears entirely translucent. (Asch, 1952, p. 142; quoted in Heider, 1958, p. 23)

Interestingly, James J. Gibson, in the 1950s, expressed the opinion that social psychology ought to take as its starting point the identification of stimulus information underlying the accurate perception of other people:

> How do we perceive, for instance, that one person is being kind to another, bearing in mind that we do this with some accuracy? How do we perceive the intentions and abilities of a political candidate, taking it for granted that he does not fool *all* of us all the time? In other words, what do we discriminate and identify in these complex stimulus-situations which, when conditions are favorable, yields a correct perception? This ought to be the primary line of inquiry, but instead it is almost completely neglected. (Gibson, 1951, p. 95–96; quoted in Heider, 1958, p. 41)

Some progress has been made along these lines in the intervening years (Hodges & Baron, 2007; Szokolszky et al., 2023), especially in the domain of interpersonal motor coordination (Nalepka et al., 2017; Richardson et al., 2007). However, researchers still face the challenge identified by Baron in 1980: laboratory-based methods for investigating social cognition are inherently limited because participants in laboratory situations are necessarily constrained in their ability to generate new information about others. In comments that he wrote in 2021, Baron suggests that social psychology is less amenable to a purely laboratory-based mode of investigation than is the motor control work carried out by other Gibsonians including Michael Turvey: 'if you study complex phenomena, you cannot be a purist. To understand social phenomena, I need to be a mixed-mode theorist. We should not deal only with selected problems that fit the ecological approach. Rather, we should not be afraid to attack important and often messy mainstream problems and then apply the ecological approach' (Szokolszky et al., 2023, p. 268).

We agree with this. In the rest of this paper, we discuss a complementary approach within the broader field of ecological social psychology, namely the distributed cognition approach, along with its methodological toolkit including cognitive ethnography and cognitive event analysis. The distributed cognition approach largely eschews laboratory-based work in favor of field-based study of cognition in the wild (Baggs & Sanches de Oliveira, in press).

Distributed cognition and the ecological approach

The distributed cognition approach arose out of work conducted by cognitive scientists working primarily in Southern California in the 1980s and 1990s. This work was particularly focused around the design of human-computer interfaces (Hutchins et al., 1985). The distributed cognition researchers found that the individualistic focus of the then-dominant cognitivist approach was overly constraining, because it assumes that cognition takes place exclusively in the brain and ignores the details of how we interact with things outside our bodies. Hollan et al. (2000) identify three ways that a cognitive task can in fact be distributed across the systems made up of individual actors in an environment:

1. A cognitive task can be distributed among members of a team.
2. A cognitive task can be distributed across space, involving environmental and biological resources.
3. A cognitive task can be distributed across time: earlier events can constrain later events.

The classical text in the distributed cognition tradition is Ed Hutchins's study of maritime navigation on board a U.S. Navy aircraft carrier (Hutchins, 1995a). Hutchins adopted an observational method which he called 'cognitive ethnography' (Hutchins, 1995a, p. 371).[2] Hutchins describes how a navigation team is able to coordinate its activity so as to repeatedly plot the position of the ship on a paper naval chart. The navigation team, along with the instruments and the wider environment, constitute a complex system that is distributed in all three of the ways identified above. The system is socially distributed because it involves six team members working in close coordination. The system is spatially distributed in that, to take one example, some members of the team are inside the navigation room, while others are outside peering through instruments to measure bearings with reference to landmarks on the shore. The system is temporally distributed because it unfolds over the course of minutes and hours, and also because it requires a period of specialist training on the part of the team members, and because it relies on pre-compiled naval charts and other pieces of navigation equipment developed over centuries.

A more everyday example of a distributed cognitive system is a coffee shop. Kirsh (2006) describes two different systems for remembering customers' orders in chain coffee shops. One system uses a computer to queue the orders and display them on a screen, while another system uses paper cups on which the baristas write the customers' names. Both systems use environmental resources as a means of remembering the sequence of coffee orders, and coordinating subsequent behavior among the workers.

Work from our research group has expanded upon the distributed cognition tradition. We have looked in particular at real-world problem-solving behavior in organizational contexts. This led to the development of a methodology called cognitive event analysis, which typically uses video data to allow the researcher to reconstruct the fine-grained events involved in an episode of problem-solving activity, including through linguistic behavior (Steffensen, 2013, 2016; Steffensen et al., 2016; Trasmundi, 2020; Trasmundi & Steffensen, 2016).

The distributed cognition approach lends itself well to integration with the Gibsonian ecological approach (Heft, 2001). Elsewhere we have combined the two approaches to explore the perceptual component of individual problem-solving activity, for example in the drawing of diagrams to help with understanding mathematical concepts (Baggs & Steffensen, 2023).[3] In what follows, we extend the argument into the domain of social interaction, specifically in the constrained context of commercial aviation.

Three aviation disasters

We here consider three case studies. The first two, both of which occurred in the 1970s, are classic cases that led to important advancements in aviation safety. Both have been used extensively as teaching cases in organizational psychology. The third case occurred in 2015. It shows that organizational and social psychological factors remain relevant sources of potential system failure, even after several decades of commercial aviation experience. The three cases are summarized in Table 1. In each case, it is possible to identify multiple factors that contributed to the disaster. The table highlights a selection of the social, perceptual, and technical factors. As can be seen from this overview, aviation safety relies not only on engineering, but also, at least implicitly, on

Table 1. Overview of the three case studies.

Case	Social factors	Perceptual factors	Technical factors
Eastern Airlines Flight 401	Dual task conditions absorb crew resources Stressful atmosphere inhibits functional problem solving	Dark night: no information about aircraft approaching the ground Inattentional blindness to safety warning	Blown lightbulb leads to initial uncertainty and launches secondary problem-solving task Autopilot unintentionally disengaged
Tenerife airport disaster	Bomb at Gran Canaria causes increased traffic at Los Rodeos airport, Tenerife Understaffed air traffic control at Los Rodeos KLM crew reluctance to contradict senior captain?	Fog: no visual information about second aircraft on the runway Interference in radio transmission as ground control and PanAm transmit simultaneously, causes loss of crucial auditory information	No ground radar system at Los Rodeos Refueling of KLM aircraft possibly makes it too heavy to take off before colliding with the PanAm aircraft
TransAsia Flight 235	Organizational failure in promoting captain above level of competence Insufficient training for aircraft model	Incorrect perceptual action selection: captain shuts off the functional number-1 engine	Faulty wiring incorrectly leads to warning of number-2 engine failure

organizational expectations about pilots' perceptual abilities, and about the social behavior and social skills of the crew members (Maurino et al., 1995). Both perceptual and social psychology are therefore highly relevant to avoiding future disasters.

Case study 1: Eastern Airlines flight 401

The following narrative is drawn from a useful summary compiled by O'Brien and Bull Schaefer (2020) and from the official report published by the National Transportation Safety Board (1973). Figure 2 shows a timeline of events.

Overview

Eastern Airlines flight 401 was the first crash involving a commercial jumbo jet. The crash occurred shortly before midnight on December 29, 1972, when the aircraft, a Lockheed L-1011 TriStar, collided with the ground. The flight had originated in New York City, and was approaching its destination airport of Miami with its landing gear already deployed when the crew discovered a problem. One of the instrument panel indicator lights, specifically the light that was supposed to indicate that the front landing gear was correctly locked in place, was not illuminated. This could mean either that there was a problem with the landing gear, or that there was a problem with the light bulb, or both. The crew radioed air traffic control to request to fly in a circle path around the airport while they attempted to solve the problem (see the flight path in Figure 1). This request was granted. The crew then tried retracting and

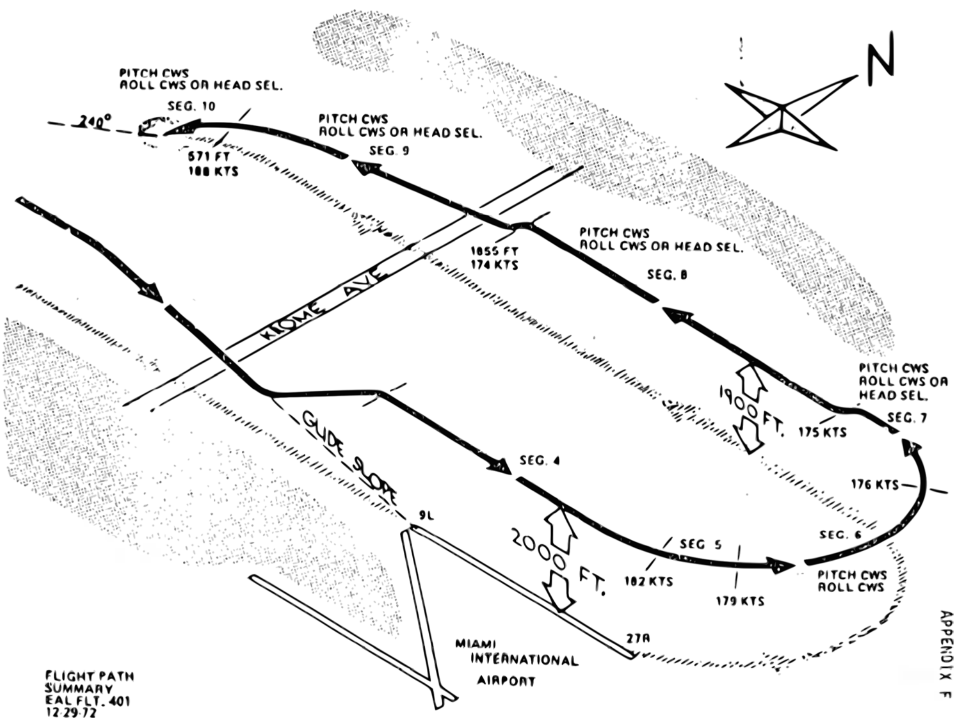

Figure 1. Flight path of Eastern Airlines flight 401. Source: National Transportation Safety Board (1973).

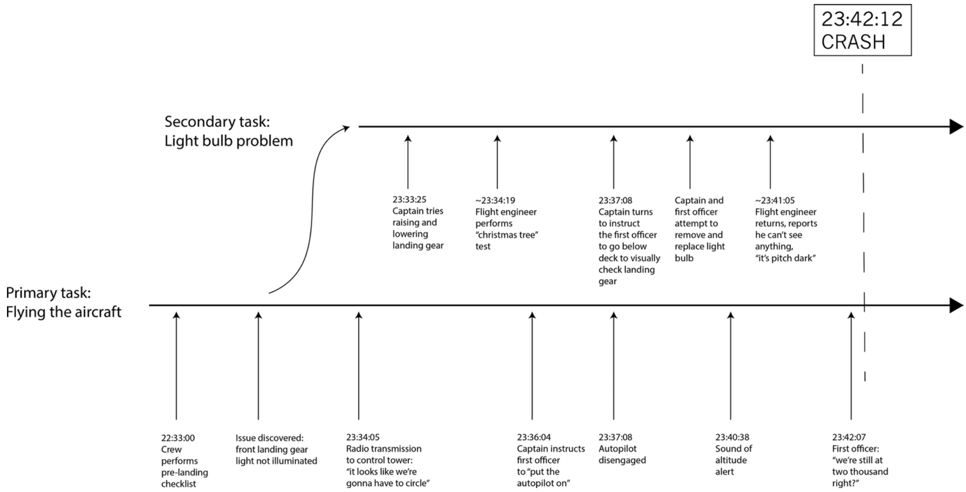

Figure 2. Timeline of events leading up to the crash, based on the cockpit voice recorder data.

redeploying the landing gear, and they then performed a test known as the 'christmas tree', which lights up all of the instrument panel's lights at once, allowing the crew to check for blown light bulbs. The indicator for the front landing gear still failed to illuminate.

At 23:36:04 the captain instructed the first officer to set the autopilot to keep the plane flying at 2000 feet. After this, the crew continued to make occasional manual adjustments to heading to maintain the orbital path. Meanwhile, all three members of the flight crew, including the flight engineer, continued to work on solving the problem with the light bulb. The captain and first officer tried to remove the instrument panel button and replace it, while the flight engineer went below deck to try to peer through an optical instrument to visually confirm that the landing gear was locked in place, albeit unsuccessfully; the engineer reported that he could not see anything through the optical instrument. This problem-solving activity continued for several minutes. The flight data recorder shows that the autopilot was disengaged at 23:37:08, just over a minute after it had been set, and without any member of the crew being aware that it had been disengaged. The plane subsequently entered a glide path, slowly drifting toward the ground (see Figure 1). None of the flight crew noticed that the plane had lost altitude until a few seconds before impact, when the following exchange is recorded:

23:42:05	First officer	We did something to the altitude
	Captain	What?
23:42:07	First officer	We're still at two thousand right?
23:42:09	Captain	Hey, what's happening here?

The impact is heard around three seconds later. In all, 101 people died, including the three flight crew. There were 75 survivors.

Discussion

Perceptual factors contributed to the Eastern 401 disaster. The collision occurred at night, over the swamp terrain of the Florida Everglades. This meant that there was no optical information about the approaching ground terrain available to the flight crew by glancing out of the windows (Gibson, 1950). The crew might have detected the relevant information by noticing structures on the horizon (Sedgwick, 2021), but their capacity to attend to this information was impaired by their being absorbed in the problem with the light bulb.

The crew's failure to notice the loss of altitude is an instance of inattentional blindness (Neisser & Becklen, 1975; Simons & Chabris, 1999). Inattentional blindness also prevented the crew from noticing a warning alert. At 23:40:38 a chime sound is heard on the cockpit voice recording. This is an alert to indicate that the plane had fallen more than 250 feet below its intended altitude, and was therefore now flying at an altitude of less than 1750 feet above the ground. This alert sound came from the engineer's console, however this occurred while the engineer himself was below deck, trying to peer through the optical sighting instrument to see the landing gear. Neither the captain nor the first officer noticed the chime sound. Since the chime only played once, the alarm was time-sensitive. Nobody noticed the sound at the time, and therefore the information that the plane had lost altitude simply went undetected within the cockpit. This is an instance of inattentional blindness occurring at the scale of the socially-distributed system; i.e. the cockpit failed to notice its loss of altitude (cf. Hutchins, 1995b).

The official report lists 17 conclusions, the last of which is that 'The captain failed to assure that a pilot was monitoring the progress of the aircraft at all times' (National Transportation Safety Board, 1973, p. 23). The problem with the light bulb meant that there were two tasks competing for the attention of the three crew members: flying the plane, and solving the light bulb problem (see Figure 2). The secondary problem with the light bulb was crucial to being able to land the aircraft safely, but meanwhile the plane still had to be kept in the air. However, the captain had largely delegated this task to the autopilot system. The autopilot was apparently disengaged unintentionally, probably because the captain nudged the steering console while turning to address the flight engineer (O'Brien & Bull Schaefer, 2020, p. 353). Again, none of the crew noticed that the autopilot had been disengaged. Subsequent testimony from other pilots indicated that on this model of aircraft it was relatively easy to accidentally disengage the autopilot (O'Brien & Bull Schaefer, 2020, p. 353).

The official report includes three technical recommendations (National Transportation Safety Board, 1973, p. 40). It recommends the installation of a light switch next to the optical sighting instrument for checking the landing gear, and the installation of an adjacent placard with directions for using the instrument, and it also recommends that a flashing light should be introduced in the cockpit to indicate when the altitude has deviated ±250 feet from intended altitude, in addition to the auditory alert chime. This change aims to address the time-sensitiveness problem with the single alarm sound.

A more lasting consequence of the Eastern 401 crash, however, was that it contributed to new methods for training flight crews (O'Brien & Bull Schaefer, 2020), including the introduction of crew resource management training (Cooper et al., 1980). A central concern of this training is that a person should at all times be in control of the primary task of flying the aircraft.

Case study 2: Tenerife airport disaster

In the following, we draw primarily on a 1979 human factors report commissioned by the Air Line Pilots Association (ALPA), which includes transcripts of the two cockpit voice recordings (Roitsch et al., 1979), and we also draw on the discussion in Weick (1990).

Overview

The deadliest disaster in the history of commercial aviation occurred at Los Rodeos airport on the island of Tenerife on March 27, 1977. Two Boeing 747s, one operated by the Dutch airline KLM and the other operated by the U.S. airline Pan Am, collided on the runway, resulting in 583 deaths. Both planes had been diverted to Los Rodeos following a bomb explosion at their original destination airport on nearby Gran Canaria. The planes were forced to wait on the tarmac at Tenerife until the airport at Gran Canaria could be reopened. Following the reopening of the airport at Gran Canaria, the two air traffic control (ATC) operators at Los Rodeos were faced with the difficult logistical task of maneuvering the two 747s, along with a number of other smaller planes, into position for takeoff. The air traffic controllers directed the captain of the KLM to taxi down the entire length of the main runway, turn around 180°, then await instruction to take off. The Pan Am captain was then instructed to follow the KLM plane, but to turn off the main runway at the 'third exit'. While the Pan Am plane was still taxiing down the runway, the KLM had reached the end and turned around. The KLM crew radioed to request ATC clearance, which was granted.

While the KLM first officer was reading back the ATC clearance the captain released the brakes and began accelerating for takeoff. At this moment, the Pan Am plane was still taxiing on the runway, having overshot exit C3, and was moving toward exit C4 (see Figure 3). The Pan Am plane was in a patch of thick cloud with low visibility. At 17:06:17 local time the KLM ended a transmission with words that can ambiguously be heard from the cockpit recordings as 'we are now at takeoff' or as 'we are now eh taking off'. One second later, the air traffic controller radioed to say 'Okay, stand by for takeoff, I will call you'. At the same moment, the Pan Am crew radioed to say 'And we're still taxiing down the runway'. Interference between these simultaneous

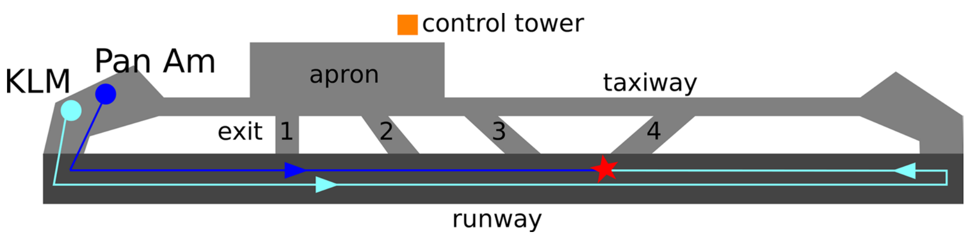

Figure 3. Schematic diagram of the Tenerife disaster, showing the movement of the two aircraft. The collision site is marked with a star. Source: Wikimedia Commons.

transmissions caused a squeal that can be heard in the flight recording from the KLM cockpit. At 17:06:32 one of the KLM's crew members is heard in the cockpit asking 'Is he not clear then?' to which the KLM captain responds emphatically 'Oh yes'. Thirteen seconds later the collision occurs, causing the deaths of all 248 people on board the KLM, and all but 61 of the 396 on the Pan Am plane.

Discussion

Multiple contributing factors led to the Tenerife collision, only some of which are mentioned in the above summary and in Table 1. Several investigations were carried out in the years after the incident (Roitsch et al., 1979). In the subsequent organizational psychology literature, however, much focus has been placed on the cockpit communications in the KLM plane (McCreary et al., 1998; Weick, 1990).

The captain of the KLM plane, Jacob Veldhuyzen van Zanten, was a senior figure within the organization, and the head of the company's flight training department. Moreover, he had personally trained the first officer for his 747 qualification just two months earlier (Weick, 1990, p. 579). The first officer was thus inexperienced in flying this particular type of plane. In his influential analysis of the disaster, the organizational theorist Karl Weick suggests that the social status of the captain caused his crewmates to be reluctant to challenge him, after the captain had decided to initiate the takeoff: 'Perhaps influenced by his [the captain's] great prestige, making it difficult to imagine an error of this magnitude on the part of such an expert pilot, both the copilot and flight engineer made no further objections' (Weick, 1990, p. 574).

The first officer is, however, heard on the cockpit recording challenging the captain. The captain had in fact prematurely started to initiate the takeoff procedure immediately after completing a technical checklist, leading to the following exchange:

17:05:36	First officer	body gear disarmed landing lights on check list completed
[captain moves to initiate takeoff roll]		
17:05:41.5	First officer	Wait a minute we do not have an ATC clearance
17:05:42.8	Captain	No I know that, go ahead ask

Weick (1990) suggests that the captain's actions were caused by stress, leading to a reversion to an overlearned sequence of actions that he had become habituated to using during his frequent training simulations. In training simulations it is not necessary to communicate with air traffic controllers before initiating takeoff. Nevertheless, the captain failed to acknowledge his mistake. Instead he reacted by hurrying to once again initiate the takeoff roll while the first officer was still reading back the ATC clearance. The captain's next utterance occurs at 17:06:12:85, 31 s after the first officer challenged him. The captain is heard saying 'we go', shortly followed by the sound of the engines starting to spin up.

Weick (1990), in the passage quoted above, reads the failure to correct the pilot for a second time as being due to deference on the part of the first officer and engineer. An alternative reading is that the captain, in re-initiating the takeoff, effectively performs a conversational move in which he overrules his crewmates. On this alternative reading, the captain is assertively doubling down on his initial mistaken decision to initiate the takeoff movement. In acting as he does, the captain is presenting information to his crewmates to the effect that: I've made my decision and we are going. His behavior appears to be driven by emotion more than rational deliberation. It is, perhaps, an instance of social incompetence, in the sense outlined by Baron and Boudreau (1987):

> Social incompetence may also reside in an inability to effectively communicate social affordances. This failure may, in turn, be viewed at two levels. The simplest level of this argument is that socially incompetent people are deficient in their ability to display social affordance information. There is evidence supporting this position if we assume that giving appropriate emotional information is a key aspect of many spontaneous communications of social affordances. That is, emotions may be the first signal system for communicating social affordances. (Baron & Boudreau, 1987, p. 1224)[4]

Nevertheless, the captain's petulant reaction would not have led to disaster were it not for the confluence of other factors distributed across the wider control system of the airport, including: low visibility preventing each of the two flight crews from seeing the other aircraft; the fact that the airport lacked a ground radar system; misunderstanding on the part of the Pan Am crew over which exit they were supposed to take; possible language issues stemming from the air traffic control operators' having to communicate in English, a second language (Weick, 1990); and the fact that the KLM captain had earlier decided to refuel his aircraft while it was waiting on the tarmac. This last decision caused the aircraft to be heavier than it would otherwise have been, and also caused the plane's wreckage to become an inferno.

The Tenerife disaster contributed further to studies of human factors in flight crews (Roitsch et al., 1979), and to new training interventions including communication training and stress training (McCreary et al., 1998). After several decades of experience with human factors engineering, however, errors still occasionally occur (Kharoufah et al., 2018).

Case study 3: TransAsia flight 235

In the following we draw on the official report (Aviation Safety Council, 2016) and on the summary in Kharoufah et al. (2018). We also consulted a YouTube video published on the channel MentourPilot ('A Horrible Chain of Mistakes! TransAsia Airways flight 235' https://youtu.be/xU0E-w-43Fc, uploaded February 12, 2022). The incident is also discussed by Roth (2018).

Overview

On February 4, 2015, TransAsia flight 235 took off from Taipei Songshan Airport. This was a short domestic flight destined for the island of Kinmen. Less than four minutes into its flight the aircraft, an ATR72-600, crashed into the Keelung river. The crash was precipitated by a technical problem with the number 2 engine. As the aircraft was about 1200 feet into its ascent the number 2 engine's propeller shut down and a warning was displayed in the cockpit indicating engine number 2 had flamed out. In response to this, the captain is heard at 10:53:06 saying 'pull back number one', referring to the still-functioning number 1 engine. The captain proceeds to retard the number 1 engine. With the only remaining functional engine now retarded, the aircraft loses speed and the aircraft's stall protection system is deployed, causing an alarm sound in the cockpit and causing the stick shaker mechanism to operate. In the confusion, amid attempts to engage the autopilot and to communicate with Taipei's control tower, the captain then fully shuts off the number 1 engine while advancing the throttle for the dead engine number 2.

At 10:54:07 the first officer is heard saying 'engine flameout we lost both sides'. The captain's response is to call to 'restart the engines' which he says eight times. At 10:54:27 the captain acknowledges his mistake: 'wow… pulled back the wrong side throttle'. Around 9 s later the recording ends. A moment immediately prior to the crash was captured in automobile dashcam footage as the aircraft swung over a highway near the river, its wingtip colliding with a taxi. In the final moments of the flight the aircraft rolled around its longitudinal axis, entering the river in an inverted position. Of the 58 people on board 43 were killed, including the three flight crew. The subsequent investigation suggested that the technical problem with engine 2 was caused by a faulty soldering connection.

Discussion

The electronic fault affected the aircraft's automatic takeoff power control system (ATPCS). This is an electronic control system that is designed to monitor the power output of the two engines during takeoff, and to compensate for discrepancies between the two. The faulty soldering connection meant that the ATPCS system on TransAsia 235 was functioning only intermittently. The first officer noticed during the takeoff roll that the ATPCS system was not armed, i.e. that the indicator light was not illuminated. According to company policy, the captain should have aborted the takeoff at this point. The first officer appears to suggest doing this. He is heard on the cockpit recording saying 'take off inhibit', which the captain repeats, however the captain then immediately decides to continue the takeoff. A few seconds later the first officer is heard confirming that the ATPCS light has illuminated.

10:51:43	First officer	no a-t-p-c-s armed
10:51:44	Captain	really
10:51:46	First officer	okay take off inhibit
10:51:47	Captain	take off inhibit
10:51:48.4	First officer	okay
10:51:48.7	Captain	ok continue to take off
		[…]
10:51:51	First officer	oh there it is… a-t-p-c-s armed
		[…]
10:52:32	First officer	it came back after we advanced the throttle… uh maybe
10:52:33	Captain	yes

The official report entertains the possibility that the reason the captain did not abort the takeoff is that he was following the procedure that was appropriate for an earlier model of the same aircraft, the ATR72-500. On the earlier model, the captain was allowed to continue the takeoff without the ATPCS system being armed. The report concludes, however, that the mistake was likely caused by inadequate communication within the company: 'the absence of a formal, documented company policy that was enforced and consistent with the reported ATPCS training on the [ATR72]-600 created an opportunity for misunderstanding' (Aviation Safety Council, 2016, p. 153).

Another mystery is the question of why the captain shut down the only functioning engine. In fact, inappropriate responses in emergency situations have long been a known risk, particularly in turboprop planes such as the ATR72. A major report in the 1990s concluded that 'Particularly in the turboprop arena, pilots are failing to properly control the airplane after a propulsion system malfunction which should have been within their capabilities to handle' (Sallee & Gibbons, 1999, p. 3). That report recommended that 'the industry needs to effect cockpit/aircrew changes to decrease the likelihood of a too-eager crewmember shutting down the wrong engine' (Sallee & Gibbons, 1999, p. 29).

On TransAsia 235, a further factor was that the crew failed to follow the correct procedure for an engine-out situation: 'Following the uncommanded autofeather of engine number 2, the flight crew failed to perform the documented failure identification procedure before executing any actions. That resulted in pilot flying's confusion regarding the identification and nature of the actual propulsion system malfunction and he reduced power on the operative engine number 1' (Aviation Safety Council, 2016, p. 176).

We can only speculate as to the actual cause of the captain's inappropriate action selection, but it is plausible that the design of the warning system played a role. The captain had no means to directly perceive which engine had malfunctioned, but was forced to rely on symbolic information relayed through the instruments. At the moment of malfunction, the console displayed a warning: 'ENG 2 FLAMEOUT AT TAKE OFF' (Aviation Safety Council, 2016, p. 149). If the captain had been able to see the malfunctioning engine itself, it is hard to imagine that he would have shut down the wrong engine. But in fact the captain was faced with two near-identical levers: one on the left and one on the right. In these circumstances, it is easy to imagine selecting the wrong lever. Everyone is familiar with the experience of confusing left and right.[5] In design terms, the labels 'number 1 engine' and 'number 2 engine' lack a natural mapping to the devices being controlled (Baggs & Steffensen, 2023; Norman, 2013).

The two control levers for the two engines are a good example of a principle of distributed cognition, namely that 'artefacts are implicit psychological hypotheses that are tested through subsequent empirical evaluation' (Ball & Ormerod, 2000, p. 148). The design of the two levers is based on an implicit hypothesis on the part of the aircraft designers that, in an emergency, the captain will remember the difference between left and right. On TransAsia 235, this hypothesis appears to have failed.

Cognitive ethnography as a contribution to ecological social psychology

Commercial aviation disasters are an interesting arena of potential application for the psychological toolkit that Reuben Baron sought to develop, namely an ecological approach to social psychology. The airplane cockpit is an inherently distributed system, with control being distributed in each of the three ways identified by Hollan et al. (2000). The control system is socially distributed across the members of the flight crew as well as the air traffic control operators and potentially the crews of other aircraft. It is spatially distributed across cockpit instruments, runways, the weather, and so on. And it is temporally distributed: decisions made by aircraft designers, by runway designers, by training personnel, and by the individuals within the system themselves at some earlier time T_1 often tend to constrain events at a later time T_2.

Aviation disasters are an unusual form of real-world event in that they routinely leave a detailed behavioral trace. In many cases, fine-grained behavioral data is preserved in the form of the cockpit voice recorder and the flight data recorder. This data enables airline authorities to compile their official reports, but it can also serve as behavioral data for developing an ecological theory of social cognition.

Furthermore, in the case of aviation, the control task is functionally constrained in a useful way (Hutchins, 1995b). It is always clear what the primary cognitive task is, namely flying the plane safely from the departure airport to the destination airport. This is essentially the same task that Gibson studied during the second world war when he developed a theory of the visual information available to pilots (Gibson, 1950). The fact that the task environment is constrained is important because it simplifies the analyst's job: it is easier to reconstruct the behavior if you already know what the actors are trying to do, as opposed to the case in which you are observing a non-well-defined task domain where it is unclear, perhaps even to the actors themselves, what the goal state should be (Trasmundi et al., 2024).

Gibson (1950) was primarily interested in information in optic flow originating from inanimate features outside the aircraft, such as the ground and the horizon. Our case studies show that in modern commercial aviation it is also important to understand the information specifying social properties of the environment both inside the cockpit and, *via* radio communications as well as visual information, in the wider social system of the airport. As such, our article is a contribution to Hodges and Baron (2007) ambition of making ecological psychology more social.

Both Gibson's and Hutchins's approaches begin with an observation of how the task of flying the plane is achieved under normal circumstances. This is a valuable approach. In the real world, most cognition functions effectively most of the time. In the case of aviation, however, it is crucial to also understand the errors that do take place. If aviation industry players wish to avoid the same errors re-occurring, they must first diagnose precisely what went wrong. What is called for here is an ecological psychology of particular events (Steffensen, 2016). Roth (2018) refers to the cognitive analysis of aviation disasters as an instance of 'forensic cognitive science'.

In our analyses above we have employed the methods of cognitive event analysis (Steffensen, 2013, 2016). This method builds on multimodal interaction analysis (Goodwin, 2000) and on distributed cognition (Hollan et al., 2000), as well on Chemero's Chemero (2000) ecological definition of events as 'changes in the layout of affordances'. The method has proved useful in analyzing one-off events occurring in everyday settings including office settings (Steffensen, 2013), healthcare settings (Simonsen & Steffensen, 2021; Trasmundi, 2020; Trasmundi & Steffensen, 2016), and educational settings (Trasmundi et al., 2024), as well as in laboratory settings such as during insight problem-solving tasks (Baggs & Steffensen, 2023; Steffensen et al., 2016).

A project for future research is to ground the method of cognitive event analysis, and the more general field of cognitive ethnography, more thoroughly in an analysis of perceptual information. One of Reuben Baron's key insights was that our behavior in social situations is organized partly with respect to information that is generated by other actors (Baron & Misovich, 1993; McArthur & Baron, 1983). It would seem necessary that an ecological approach to social psychology should be based on a thorough analysis of this information. In terms of the perceptual information that they generate, other people and animals are among the most complex things in our environment. It is therefore unsurprising that the ecological approach to social psychology remains in its infancy (Baggs, 2021). Constrained team-based activities in real-world contexts, such as the airline cockpit, offer a promising arena for developing the approach.

Notes

1. Baron and Misovich (1993) refer to such exploratory actions as "event-activity tests" that we perform on other people.
2. Cognitive ethnography is the principal methodological tool employed within the distributed cognition approach (Ball & Ormerod, 2000; Hollan et al., 2000). It consists in observing people carrying out some more-or-less well-defined task in a real-world setting, and in describing the environment in which the task is carried out (Trasmundi et al., 2024). Introducing the term, Hutchins writes: 'I call this description of the cognitive task world a "cognitive ethnography." One might have assumed that cognitive anthropology would have made this sort of work its centerpiece. It has not.' (Hutchins, 1995a, p. 371). Since cognitive ethnography is explicitly task-oriented, we can say that it belongs in the family of functionalist approaches to studying behavior and reasoning.
3. Mathematical diagrams, of the kind that are used in classical Euclidean geometry, are interesting objects because they instantiate a mathematical idea and make that idea available to the visual system (Sherry, 2009). This demonstrates that even abstract reasoning can have a direct perception component, and is therefore in principle open to empirical observation, including ethnographic observation (Baggs & Steffensen, 2023).
4. The term "social affordance" is somewhat misleading, as it conflates the perspective of the analyst with that of the actor (Baggs, 2021). From the actor's perspective, the world is not carved up a priori into inherently social and inherently non-social components. From the actor's perspective, there is just an environment (Baggs & Chemero, 2020). A more appropriate term here might be "information about social properties of the environment" or simply "information.".
5. Social psychologists will also be familiar with the experience of being unable to remember which one is a type-1 and which one is a type-2 error.

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References

Asch, S. E. (1952). *Social psychology*. Prentice-Hall.

Aviation Safety Council. (2016). *Aviation occurrence report: 4 February, 2015, TransAsia Airways Flight GE235 ATR72-212A, loss of control and crashed into Keelung River three nautical miles east of Songshan Airport*. Aviation Safety Council.

Baggs, E. (2021). All affordances are social: Foundations of a Gibsonian social ontology. *Ecological Psychology*, *33*(3-4), 257–278. https://doi.org/10.1080/10407413.2021.1965477

Baggs, E., & Chemero, A. (2020). The third sense of environment. In J. B. Wagman, & J. J. C. Blau (Eds.), *Perception as information detection: Reflections on Gibson's Ecological approach to visual perception* (pp. 5–20). Routledge.

Baggs, E., & Sanches de Oliveira, G. (in press). Rewilding psychology. *Philosophical Transactions of the Royal Society B: Biological Sciences*. https://doi.org/10.1098/rstb.2023.0287

Baggs, E., & Steffensen, S. V. (2023). Perception and problem solving. In M. Segundo-Ortin, M. Heras-Escribano, and V. Raja (Eds.), *Places, sociality, and ecological psychology: Essays in honor of Harry Heft* (pp. 45–58) Routledge.

Ball, L. J., & Ormerod, T. C. (2000). Putting cognitive ethnography to work: The case for a cognitive ethnography of design. *International Journal of Human-Computer Studies*, *53*(1), 147–168. https://doi.org/10.1006/ijhc.2000.0372

Baron, R. M. (1980). Contrasting approaches to social knowing: An ecological perspective. *Personality and Social Psychology Bulletin*, *6*(4), 591–600. https://doi.org/10.1177/014616728064011

Baron, R. M., & Boudreau, L. A. (1987). An ecological perspective on integrating personality and social psychology. *Journal of Personality and Social Psychology*, *53*(6), 1222–1228. https://doi.org/10.1037/0022-3514.53.6.1222

Baron, R. M., & Misovich, S. J. (1993). Dispositional knowing from an ecological perspective. *Personality and Social Psychology Bulletin*, *19*(5), 541–552. https://doi.org/10.1177/0146167293195006

Chemero, A. (2000). What events are. *Ecological Psychology*, *12*(1), 37–42. https://doi.org/10.1207/S15326969ECO1201_3

Cooper, G. E., White, M. D., and Lauber, J. K., eds. (1980). *Resource management on the flight deck: Proceedings of a Nasa/industry workshop held at San Francisco*. *June 26–28, 1979*. National Aeronautics and Space Administration (NASA).

Gibson, J. J. (1950). *The perception of the visual world*. The Riverside Press.

Gibson, J. J. (1951). Theories of perception. In W. Dennis (ed.). *Current trends in psychological theory* (pp. 85–110) University of Pittsburgh Press.

Gibson, J. J. (1966). *The senses considered as perceptual systems*. Houghton-Mifflin.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Houghton-Mifflin.

Goodwin, C. (2000). Action and embodiment within situated human interaction. *Journal of Pragmatics*, *32*(10), 1489–1522. https://doi.org/10.1016/S0378-2166(99)00096-X

Heft, H. (2001). *Ecological psychology in context: James Gibson, Roger Barker, and the legacy of William James's radical empiricism*. Lawrence Erlbaum Associates.

Heider, F. (1958). *The psychology of interpersonal relations*. John Wiley & Sons.

Hodges, B. H., & Baron, R. M. (2007). On making social psychology more ecological and ecological psychology more social. *Ecological Psychology*, *19*(2), 79–84. https://doi.org/10.1080/10407410701331918

Hollan, J., Hutchins, E., & Kirsh, D. (2000). Distributed cognition: Toward a new foundation for human-computer interaction research. *ACM Transactions on Computer-Human Interaction*, *7*(2), 174–196. https://doi.org/10.1145/353485.353487

Hutchins, E. (1995a). *Cognition in the wild*. MIT Press.

Hutchins, E. (1995b). How a cockpit remembers its speeds. *Cognitive Science*, *19*(3), 265–288. https://doi.org/10.1016/0364-0213(95)90020-9

Hutchins, E., Hollan, J. D., & Norman, D. A. (1985). Direct manipulation interfaces. *Human–Computer Interaction*, *1*(4), 311–338. https://doi.org/10.1207/s15327051hci0104_2

Kharoufah, H., Murray, J., Baxter, G., & Wild, G. (2018). A review of human factors causations in commercial air transport accidents and incidents: From to 2000–2016. *Progress in Aerospace Sciences*, *99*, 1–13. https://doi.org/10.1016/j.paerosci.2018.03.002

Kirsh, D. (2006). Distributed cognition: A methodological note. *Pragmatics & Cognition*, *14*(2), 249–262. https://doi.org/10.1075/pc.14.2.06kir

Maurino, D. E., Reason, J., Johnston, N., & Lee, R. B. (1995). *Beyond aviation human factors: Safety in high technology systems*. Routledge. https://doi.org/10.4324/9781315261652
McArthur, L. Z., & Baron, R. M. (1983). Toward an ecological theory of social perception. *Psychological Review*, *90*(3), 215–238. https://doi.org/10.1037/0033-295X.90.3.215
McCreary, J., Pollard, M., Stevenson, K., & Wilson, M. B. (1998). Human factors: Tenerife revisited. *Journal of Air Transportation World Wide*, *3*(1), 23–31.
Michotte, A. (1963). *The perception of causality*. Basic Books.
Nalepka, P., Kallen, R. W., Chemero, A., Saltzman, E., & Richardson, M. J. (2017). Herd those sheep: Emergent multiagent coordination and behavioral-mode switching. *Psychological Science*, *28*(5), 630–650. https://doi.org/10.1177/0956797617692107
National Transportation Safety Board (1973). *Aircraft accident report: Eastern Airlines, Inc. L-1011, N310EA*. *December 29, 1972* National Transportation Safety Board (NTSB).
Neisser, U., & Becklen, R. (1975). Selective looking: Attending to visually specified events. *Cognitive Psychology*, *7*(4), 480–494. https://doi.org/10.1016/0010-0285(75)90019-5
Norman, D. A. (2013). *The design of everyday things*. MIT Press.
O'Brien, J., & Bull Schaefer, R. A. (2020). Deadly distraction—Eastern Air 401: The accident that changed aviation forever. *The CASE Journal*, *16*(3), 345–368. https://doi.org/10.1108/TCJ-10-2019-0095
Richardson, M. J., Marsh, K. L., & Baron, R. M. (2007). Judging and actualizing intrapersonal and interpersonal affordances. *Journal of Experimental Psychology. Human Perception and Performance*, *33*(4), 845–859. https://doi.org/10.1037/0096-1523.33.4.845
Roitsch, P. A., Babcock, G. L., & Edmunds, W. W. (1979). *Human factors report on the Tenerife accident*. Air Line Pilots Association (ALPA).
Roth, W.-M. (2018). Autopsy of an airplane crash: A transactional approach to forensic cognitive science. *Cognition, Technology & Work*, *20*(2), 267–287. https://doi.org/10.1007/s10111-018-0465-3
Sallee, G. P., & Gibbons, D. M. (1999). Propulsion system malfunction plus inappropriate crew response (PSM + ICR). *Flight Safety Digest*, *18*(11–12), 1–193.
Sedgwick, H. A. (2021). J. J. Gibson's "ground theory of space perception. *i-Perception*, *12*(3), 20416695211021111. https://doi.org/10.1177/20416695211021111
Sherry, D. (2009). The role of diagrams in mathematical arguments. *Foundations of Science*, *14*(1-2), 59–74. https://doi.org/10.1007/s10699-008-9147-6
Simons, D. J., & Chabris, C. F. (1999). Gorillas in our midst: Sustained inattentional blindness for dynamic events. *Perception*, *28*(9), 1059–1074. https://doi.org/10.1068/p281059
Simonsen, L. M., & Steffensen, S. V. (2021). Hybrid cognition in medical discharges. *International Journal of Organization Theory & Behavior*, *24*(3), 251–272. https://doi.org/10.1108/IJOTB-05-2020-0080
Steffensen, S. V. (2013). Human interactivity: Problem-solving, solution-probing and verbal patterns in the wild. In S. J. Cowley & F. Vallée-Tourangeau (Eds.), *Cognition beyond the brain* (pp. 195–221) Springer.
Steffensen, S. V. (2016). Cognitive probatonics: Towards an ecological psychology of cognitive particulars. *New Ideas in Psychology*, *42*, 29–38. https://doi.org/10.1016/j.newideapsych.2015.07.003
Steffensen, S. V., Vallée-Tourangeau, F., & Vallée-Tourangeau, G. (2016). Cognitive events in a problem-solving task: A qualitative method for investigating interactivity in the 17 animals problem. *Journal of Cognitive Psychology*, *28*(1), 79–105. https://doi.org/10.1080/20445911.2015.1095193
Szokolszky, A., Baron, R. M., Read, C., & Palatinus, Z. (2023). Reuben M. Baron—Interview and reflection. In A. Szokolszky, C. Read, & Z. Palatinus (Eds.), *Intellectual journeys in ecological psychology* (pp. 250–272) Routledge.
Trasmundi, S. B. (2020). *Errors and interaction: A cognitive ethnography of emergency medicine*. Benjamins.
Trasmundi, S. B., & Steffensen, S. V. (2016). Meaning emergence in the ecology of dialogical systems. *Psychology of Language and Communication*, *20*(2), 154–181. https://doi.org/10.1515/plc-2016-0009
Trasmundi, S. B., Baggs, E., Toro, J., & Steffensen, S. V. (2024). Expertise in non-well-defined task domains: The case of reading. *Social Epistemology*, *38*(1), 13–27. https://doi.org/10.1080/02691728.2023.2266690
Weick, K. E. (1990). The vulnerable system: An analysis of the Tenerife air disaster. *Journal of Management*, *16*(3), 571–593. https://doi.org/10.1177/014920639001600304