Chapter 2

Motivations for Incident Reporting

This chapter explains why many organisations develop incident reporting systems. The intention is often to identify potential failures before an accident occurs. The higher frequency of less critical mishaps and near-miss events also supports statistical analysis that cannot reliably be performed on relatively infrequent accidents. Data and lessons from one system can be shared with the operators of other similar applications. The following pages also identify limitations that are often forgotten by the proponents of incident reporting systems. Many submissions do little more than remind their operators of hazards that are well understood but are difficult to avoid. The resources used by a reporting system might alternatively fund safety improvements. Managers of successful reporting systems can be overwhelmed by a mass of data about relatively trivial mishaps. Later sections go on to review issues of confidentiality and scope that help to determine whether the claimed benefits outweigh the perceived costs of operating these systems.

2.1 The Strengths of Incident Reporting

The US Academy of Science recommended that a nationwide mandatory reporting system should be established to improve patient safety [452]. They argued that this system should initially be based around hospitals but that eventually other ‘care settings’ should be included. The International Civil Aviation Organisation has published detailed guidance on the manner in which reporting systems must be implemented within signatory states [384].

> “(The assembly) urges contracting states to undertake every effort to enhance accident prevention measures, particularly in the areas of personnel training, information feedback and analysis and to implement voluntary and non-punitive reporting systems, so as to meet the new challenges in managing flight safety, posed by the anticipated growth and complexity of civil aviation”.
> (Resolution A31-10: Improving accident prevention in civil aviation)
>
> “(The assembly) urges all Contracting States to ensure that their aircraft operators, providers of air navigation services and equipment, and maintenance organisations have the necessary procedures and policies for voluntary reporting of events that could affect aviation safety” (ICAO Resolution A32-15: ICAO Global Aviation Safety Plan)

The US Coast Guard and the Maritime Administration have helped to establish a voluntary international maritime information safety system. This is intended to receive, analyse, and disseminate information about unsafe occurrences. They argue that these ‘non-accidents’ or ‘problem events’ provide an untapped source of data. They can be used as indicators of safety-levels in the maritime community and provide the information necessary to prevent accidents before they happen [831]. The goals of the system are to reduce the frequency of marine casualties, to reduce the extent of injuries and property damage (including environmental damage), and to create a safer and more efficient shipping transportation system and mariner work environment.

The Council of the European Union had similar concerns when it drafted the 1996 directive on the control of major accident hazards. This has become more widely known as the Sveso II directive; it was named after the town in Italy where 2,000 people had to be treated following a release of tetrachlorodibenzoparadioxin (Dioxin) in 1976:

> "Whereas, in order to provide for an information exchange and to prevent future accidents of a similar nature, Member States should forward information to the Commission regarding major accidents occurring in their territory, so that the Commission can analyse the hazards involved, and operate a system for the distribution of information concerning, in particular, major accidents and the lessons learned from them; whereas this information exchange should also cover 'near misses' which Member States regard as being of particular technical interest for preventing major accidents and limiting their consequences." [187]

The Transportation Safety Board of Canada [623] identified a number of reasons to justify the creation of its own confidential incident reporting system. They argued that incident data will support the Board's studies on a wide range of safety-related matters including operating procedures, training, human performance and equipment suitability. The analysis of incident reports can also help to identify widespread safety deficiencies that might not have been detected from individual reports submitted to regional centres. Greater insights into national and international transportation safety issues can be gained by collating accident/incident reports and by comparing it with data from other agencies.

These individual initiatives across a range of industries illustrate the increasing importance of incident reporting within safety management systems [443]. They can also be used to identify common arguments that justify the development and maintenance of incident reporting systems:

1. Incident reports help to find out why accidents DONT occur. Many incident reporting forms identify the barriers that prevent adverse situations from developing into a major accident. These insights help analysts to strengthen those safeguards that have already proven to be effective barriers in 'near miss' incidents.

2. The higher frequency of incidents permits quantitative analysis. It can be argued that many accidents stem from atypical situations. They, therefore, provide relatively little information about the nature of future failures. In contrast, the higher frequency of incidents provides greater insights into the relative proportions of particular classes of human 'error', systems 'failure', regulatory 'weakness' etc.

3. They provide a reminder of hazards. Incident reports provide a means of monitoring potential problems as they recur during the lifetime of an application. The documentation of these problems increases the likelihood that recurrent failures will be noticed and acted upon.

4. Feedback keeps staff 'in the loop'. Incident reporting schemes provide a means of encouraging staff participation in safety improvement. In a well-run system, they can see that their concerns are treated seriously and are acted upon by the organisation. Many reporting systems also produce newsletters that can be used to increase awareness about regional and national safety issues.

5. Data (and lessons) can be shared. Incident reporting systems provide the raw data for comparisons both within and between industries. If common causes of incidents can be observed then, it is argued, common solutions can be found. However, in practice, the lack of national and international standards for incident reporting prevents designers and managers from gaining a clear view of the relative priorities of such safety improvements.

6. Incident reporting schemes are cheaper than the costs of an accident. The relatively low costs of managing an incident reporting scheme should be offset against the costs of failing to prevent an accident. This is a persuasive argument. However, there is also a concern that punitive damages may be levied if an organisation fails to act upon the causes of an incident that subsequently contribute towards an accident.

7. May be required to do it. The final argument in favour of incident reporting is that these schemes are increasingly being required by regulatory agencies as evidence of an appropriate safety culture. This point is illustrated by the ICAO resolutions A31-10 and A32-15 and by the EC Seveso II directive that were cited on previous pages.

Many of these arguments require little additional explanation. For example, it it sufficient to cite the relevant ICAO resolutions to demonstrate that member states should implement incident reporting systems. However, some of these apparent justifications for incident reporting are more controversial. For example, we have argued that the higher number of incidents can be used to drive statistical analyses of the problems that lead to a far smaller number of accidents. Heinrich's [340] pioneering studies in occupational health and safety suggested an approximate ratio of one accident to thirty occurrences involving major injuries to three hundred 'near-miss' incidents. More recently, Bird [84] proposed a ratio of one accident, involving serious or disabling injuries, to ten minor injuries to 30 incidents involving property damage to six hundred incidents resulting in no visible damage. He based this on a statistical analysis of 1.5 million reported incidents. The work of Heinrich, Bird and their colleagues have led to the 'Iceberg' model of incident data. Any accident is the pinnacle, or more properly the nadir, of a far larger number of incidents. The consequences of this form of analysis seem clear. Incident reports provide a far richer data sources for organisational learning and the 'control' of major accidents.

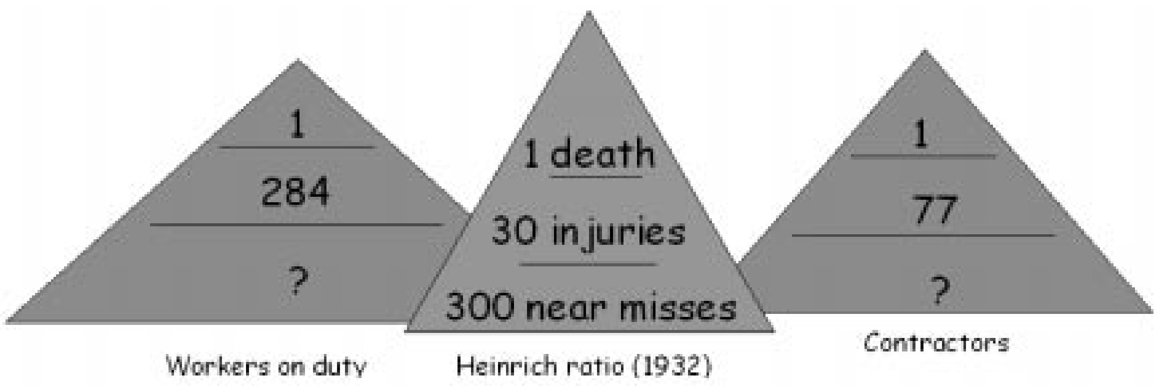

Figure 2.1: Federal Railroad Administration Safety Iceberg

Figure 2.1 illustrates a number of caveats that can be made about the Iceberg model. The central pyramid represents the results of Heinrich's initial study. On either side, the diagram presents the proportion of fatal to non-fatal injuries reported for different groups of workers in the US rail system based on Federal Railway Administration data from 1997 to 2000. Direct railroad employees or 'workers on duty' suffered a total of 119 fatalities and 33,738 injuries. Contractors experienced 31 fatalities and 1,466 injuries in the same period. The first problem is that the FRA has no reliable means of calculating the number of 'near miss' incidents over this period. As a result, it is only possible to examine the relationship between fatal work related deaths and injuries. Workers had a Heinrich ratio of one fatality for every two hundred and eighty-four injuries. The ratio for contractors was one fatality to seventy-seven injuries.

Further problems arise when we interpret these ratios. They might show that contractors are less likely to be injured than 'workers on duty'. An alternate way of expressing this is to say that contract staff are more likely to be killed than injured when compared to other employees. However, these ratios provide a very impoverished measure of probability. They do not capture the comparative risk exposure of either group. For example, the smaller number of fatal accidents to contractors may stem from a proportionately smaller number of workers. Contract workers are more likely than full-time, direct staff to be involved in high-severity incidents [875]. Alternatively, it can be argued that contractors are more reluctant to report work-related injuries than 'directly' employed staff.

This line of analysis is important because it questions the reliability of the data that can be obtained to calculate Heinrich ratios.

The argument that statistical data about incidents can be used to predict potential accidents is based on the premise that incidents are accidents in the making. It is assumed that incidents share the same root causes as more serious occurrences Van der Schaaf [844, 841] provides preliminary data from the Dutch chemical industry to confirm this premise. Glauz, Bauer and Migletz [291] also found a correlation between traffic conflicts and accidents. Other have exploited a more qualitative approach by looking for common contributory factors in both incidents and accidents. For instance, Helmreich, Butler, Taggart, and Wilhelm [341] have attempted to show that poor Crew Resource Management (CRM) causes both incidents and accidents. They then use this analysis to propose a predictive Cockpit Management Attitudes Questionnaire that can assess individual attitudes towards crew communication, coordination, and leadership issues.

A great deal of safety-related research rests on the assumption that incidents are good predictors of potential accidents. Wright has recently challenged this view in her statistical analysis of Scottish railways Confidential Incident Reporting and Analysis System (CIRAS) [875]. This confidential system elicits information about less 'critical' incidents. All accidents must, in contrast, be reported to a specialist unit within the UK Health and Safety Executive. Her work, therefore, focuses on 'near misses' and unsafe acts near the base of the Iceberg model. A near-miss has the potential to lead to a more serious occurrence, for example:

> "A Driver overshot a station platform by one and a half coach lengths. The Driver experiences wheelslip which may have been due to rail contamination. This did not result in any damage or injury" [875]

An unsafe act occurs when operator intervention actively undermines the safety of their system:

> "A Driver stated that when requested by the Signaller to do a controlled stop to assess railhead conditions he carries out this procedure assuming exceptional conditions i.e., reduced speed rather than normal speed. A controlled stop test carried out in this manner would not indicate the braking capacity in normal conditions and lead to an incorrect assumption that normal working may be resumed" [875]

Wright was able to conduct follow-up interviews with the staff who had submitted a confidential form from a total collection of 165 reports. A causal analysis was conducted using guidelines in the systems classification handbook and was validated by inter-rater reliability trials [197]. Occurrences were first assessed to identify technical and human factors issues. If a human factors 'failure' was identified then it was categorised as either proximal, distal or intermediate. Proximal factors include a range of human failures at the 'sharp end'. Intermediate factors relate to training or communications failures between high-level management and front-line staff. Distal factors relate to organisational and managerial issues that are remote from the workplace. Table 2.1 provides a comparison of the high-level causes of the 'near misses' and unsafe acts. The discrepancy between the number of reports and the total number of causal factors in this table can be explained by the fact that an incident can involve one or more causal factors.

Category	Near Miss (total 155)	Unsafe Acts (total 223)
Technical	20.7% (32)	1.3% (3)
Proximal	27.7% (43)	23.3% (52)
Intermediate	21.9% (34)	21.2% (47)
Distal	29.7% (46)	54.3% (121)

Table 2.1: Causal Comparison of CIRAS Incidents and Unsafe Acts

As can be seen, technical faults and failures seem to occur more frequently in near miss events than in unsafe acts. Conversely, distal factors such as organisation and managerial problems seem to occur more frequently as causal factors in unsafe acts. From this it follows that any analysis of 'near miss' events might fail to predict probable causes of actual incidents at the lower levels of the Iceberg model. These results can be explained in terms of the particular application area that Wright was studying. For example, near misses typically involved a failure to halt a train within the specified distance from a particular signal. These were often attributed to technical problems such as contaminated railheads. Unsafe acts were, in contrast, associated with the violations of company rules and procedures that govern driver behaviour on the UK railways. More work is required to confirm Wright's more general hypothesis that adverse events at the lower levels of the Iceberg model may provide poor predictors of accidents at the higher levels.

2.2 The Weaknesses of Incident Reporting

The most obvious limitation of incident reporting systems is that they can be expensive both to set up and to maintain. For instance, Leape notes that the Aviation Safety Reporting System spends about $3 million annually to analyse approximately 30,000 reports. This equates to about $100 (£66) per case.

> "These 'near miss' situations are far simpler to analyse than actual accidents, thorough investigation of which would almost certainly cost far more. It would be interesting to know, for example, the cost per case of investigations reported to the confidential enquiries. However, if we applied the figure from the Aviation Safety Reporting System to the 850,000 adverse events that are estimated to occur annually in the UK National Health Service, the cost of investigation would be £50 million annually." [479]

For comparison, it has been estimated that the cost of clinical negligence to health authorities and NHS Trusts was approximately £200 million in 1995-1996. The NHS summarised accounts for 1996-2001 include provision totalling £80 million with contingent liabilities of £1.6 billion [89]. Even when incident reporting systems are successfully established and maintained, a number of problems can limit their effectiveness. For instance, there is in reality very little sharing of incident data. For example, the European Confidential Aviation Safety Reporting Network ran between 1992 and 1999 with funding from the European Community. The network was intended to improve safety by passing on incident information to the aviation community. However, it was forced to close through lack of support from some sectors of the European aviation industry.

Further problems limit the transfer of incident information between organisations within an industry. For instance, Boeing operate an extensive system for collecting information about maintenance problems in their aircraft. They have successfully encouraged the exchange of data with airline operators. Unfortunately, however, there has been little coordination between airlines and groups of airlines about the format that this data should take. These formats are proprietary in the sense that they have been tailored to meet the specific needs of the operating companies. As a result when Boeing attempt to collate the data that is being shared they must face the considerable task of translating between each of these different formats. Any conclusions that are drawn from this data must also account for the different reporting cultures and reporting practices that exist within different operating groups [471].

Incident reporting systems may also fail to keep staff 'in the loop'. Occasionally these systems develop into grandiose initiatives that fulfill the organisational ambitions of their proponents rather than directly addressing key safety issues. There is also a danger that incident reporting systems degenerate into reminders of failures that everyone knows exists but few people have the political or organisational incentives to address [409]. Similarly, they may recommend short-term fixes or expedients that fail to address the underlying causes of incidents. This is illustrated by the following report from NASA's Aviation Safety Reporting System (ASRS):

> "Problem: on landing, gear was unlocked but up. Contributing factors: busy cockpit. [I] did not notice the gear down-and-locked light was not on. Discovered: Gear up was discovered on landing. Corrective action: [I] was unable to hear gear warning horn because of new noise cancelling headsets. I recommend removal of one ear-piece in

> landing phase of flight to audible warning devices to be heard by pilot. The noise-cancelling headsets were tested by three people on the ground and all three noted that with the headsets active that the gear warning horn was completely masked by the headsets." [62]

This illustrates the strengths and weaknesses of many incident report schemes. They provide first-hand insights into operational problems. They can also provide pragmatic remedies to the challenges that poorly designed equipment creates. However, there is also a danger that immediate remedies to individual incidents will fail to address the root cause of a problem. The noise-correcting headphones were clearly not fit for purpose. The proposed remedy of removing one headphone provides a short-term fix for individual pilots. However, it does little to address the underlying problems for future product development.

Further problems limit the ways in which data can be shared between incident reporting schemes. Although some organisations have successfully exchanged information about the frequency of particular occurrences, there have been few attempts to ensure any consistency in their response to those incidents. This creates particular problems for the maritime and aviation industries where operators may read of different recommendations being made in different countries. The following excerpt comes from the Confidential Human Factors Incident Reporting Programme (CHIRP). CHIRP is the UK equivalent of the ASRS that was cited in the previous quotation. This excerpt offers a slightly different perspective on the problems of ambient noise in the cockpit:

> "Fortunately, I have no incident to report. I would like, however, to highlight a common practice by some airlines, including my employer, which I feel is a significant risk to flight safety: namely the practice of not using flight deck intercom systems in favour of half wearing a headset over one ear for VHF comms, whilst using the other ear, unaided, for cockpit communications. And all this in what are often not so quiet flight decks.
>
> I cannot believe that we do not hear much better with two ears than with one, and many are the times when I, and other colleagues of mine, have had to ask for the other crew member to repeat things because of aircraft noise in one ear, and ATC in the other with the volume turned high enough not to miss a call. Not the best answer in a busy terminal area after a long flight, and an unnecessary increase in stress factors. Myself and others have raised this point several times to our training and safety departments, all of which has fallen, pardon the pun, onto deaf ears. The stock answer is that there is no written down SOP on intercoms, and common agreed practice rules. In reality, the guy in the right hand seat has no influence without things getting silly.
>
> As even single ear-piece headsets are not incompatible with intercoms, I would have thought a compromise would be mandatory use of full headset and intercom at the busy times, say below a given flight level, with the option for personal preferences in the cruise. Volumes for different communication channels could be adjusted to suit, and surrounding noise significantly reduced. This would preclude the need to speak louder than usual to be heard, to ask for repetitions, and general ly improve the working environment. After all, if the CAA and other agencies have made intercoms mandatory in transport aircraft, it will be for a reason.
>
> CHIRP Comment: The use of headsets for the purpose of effective reception of RTF/intercom messages between flight crew members is not mandated. The certification requirement for an intercom system is to provide communication between all crew members in an emergency. The partial/full use of a headset in normal operations should be dependent on the ambient noise level on the flight deck. For this reason, some operators specify the headset policy by aircraft type and phase of flight, as the reporter suggests. [175]"

The US ASRS article, cited above, argues that only one headset should be used during landing in order to help the crew hear cockpit warnings. In contrast, the CHIRP report condemns this practice as a threat to flight safety. This apparent contradiction is resolved by the second report, which argues that the partial or full use of headsets should be determined by the level of ambient noise. However, this distinction is not made explicit in the first report. Such differences illustrate the inconsistencies that can arise between national incident reporting systems. They are also indicative of a need to improve communication between these systems if we are to achieve the benefits that are claimed for the exchange of incident data. The ASRS and CHIRP systems are run by 'not for profit' organisations. The problems of data exchange are many times worse when companies may yield competitive advantage through the disclosure of incident information.

Incident reporting systems can provide important reminders about potential hazards. However, in extreme cases these reminders can seem more like glib repetitions of training procedures rather than pro-active safety recommendations. This problem is compounded by the tendency to simply remind staff of their failures rather than to address the root causes, such as poor design or 'error inducing environments' [362]. Over time the continued repetition of these reminder statements from incident reporting systems is symptomatic of deeper problems in the systems that users must operate:

> "On pre-flight check I loaded the Flight Management Computer (FMC), with longitude WEST instead of EAST. Somehow the FMC accepted it (it should have refused it three times). During taxi I noticed that something was wrong, as I could not see the initial route and runway on the navigation map display, but I got distracted by ATC. After we were airborne, the senior cabin attendant came to the flight deck to tell us the cabin monitor (which shows the route on a screen to passengers) showed us in the Canaries instead of the Western Mediterranean! We continued the flight on raw data only to find out that the Heading was wrong by about 30-40 degrees. With a ceiling of 1,000 ft at our destination I could not wait to be on 'terra firma'. Now I always check the Latitude/Longitude three times on initialisation!"
>
> (Editorial note) A simple but effective safeguard against 'finger trouble' of the type described is for the pilot who does not enter the data to confirm that the information that he/she sees displayed is that which he/she would expect. Then, and only then, should the 'Execute' function button be pressed." [176]

The CHIRP feedback is well intended. It also reiterates recommended practices that have formed part of Crew/Cockpit Resource Management (CRM) training for almost twenty years [410]. UK Aeronautical Information Circular (AIC) 143/1993 (Pink) states that all crew must have completed an approved CRM course before January 1995. Joint Airworthiness Requirement Operational Requirements (JAR OPS) sub-part N, 1.945(a)(10) and 1.955(b)(6) and 1.965(e) extended similar requirements to all signatory states during 1998. There is a considerable body of human factors research that points to the dangers of any reliance on such reminders [700]. Effectiveness declines with each repetition that is made. It is depressing, therefore, that such data-entry problems continue to be a frequent topic in aviation reporting systems. These incidents are seldom the result of deliberate violations or aircrew negligence. They illustrate the usability problems that persist within Commercial Aviation and which cannot simply be 'fixed' by training in cockpit coordination [410].

Incident reporting systems must go beyond repeated reminders to be 'careful' if they are to preserve the confidence of those who contribute to them. The US ASRS recognise this by issuing two different forms of feedback in response to the reports that they receive. The Callback bulletin describes short-term fixes to immediate problems. In contrast, the DirectLine journal addresses more systemic causes of adverse events and 'near miss' incidents even if it has a more limited audience than its sister publication. For instance, the following excerpt is taken from a DirectLine analysis of the causes of several mishaps involving Pre-Departure Clearances:

> "The type of confusion experienced by this flight crew over their (Pre-Departure Clearance) PDC routing is potentially hazardous, as noted by a controller reporter to ASRS: 'It has been my experience ... that several times per shift aircraft which have received PDCs with amended routings, have not picked up the amendment ... I have myself on numerous occasions had to have those aircraft make some very big turns to achieve sep-

aration.' (ACN # 233622). The sources consulted by ASRS suggested several potential solutions to this problem:

- Standardise PDC formats, so that pilots will know where to look for routing information and revisions.
- Show only one clearance line in a PDC, and insert any revisions into the clearance line. Make the revision section more visible by tagging it ('REVISION') or highlighting with asterisks or other eye -catching notation (*****).
- Provide flight crews with training in how to recognise PDC revisions." [56]

There are limits to the safety improvements that can be triggered through initiatives in publications such as DirectLine. Some mishaps can only be addressed through industry cooperation and regulatory intervention. Others require international agreements. For example, reporting systems have had a limited impact on workload in aviation. Similarly, usability problems continue to affect new generations of computer systems for airline operations. Data entry in flight management systems continues to be error prone many years after the problem was first identified. These 'wicked problems' must be considered when ambitious proposals are made to extend aviation reporting into healthcare and other transportation modes.

2.3 Different Forms of Reporting Systems

There are several different types of reporting system. This section explains why concerns over retribution have led to anonymous and confidential schemes. It also explains how both national and local systems have been set up to ensure that recommendations do not simply degenerate into reminders about known problems.

2.3.1 Open, Confidential or Anonymous?

The FAA launched the Global Aviation Information Network (GAIN) initiative as an attempt to encourage national and commercial organisations to exchange occurrence data. The Office of System Safety that drove the GAIN proposal within the FAA identified four main barriers to the success of such a system. These can be summarised as follows:

> "1. Punishment/Enforcement. First, potential information providers may be concerned that company management and/or regulatory authorities might use the information for punitive or enforcement purposes. In the US, significant progress has been made on this issue. Following the example of the UK, the FAA issued a policy statement in 1998 to the effect that information collected by airlines in their Flight Operations Quality Assurance (FOQA) programs, in which flight data recorder information is collected routinely, will not ordinarily be used against the airlines or pilots for enforcement purposes. In January 2000, the US President announced the creation of the Aviation Safety Action Programme (ASAP), in which airlines will collect reports from pilots, mechanics, dispatchers, and others about potential safety concerns, and made a commitment analogous to the FOQA commitment not to use the information for enforcement purposes. In April 2000, Congress enacted legislation that requires the FAA to issue a rule to develop procedures to protect air carriers and their employees from enforcement actions for violations that are discovered from voluntary reporting programs, such as FOQA and ASAP programs.
>
> 2. Public Access. Another problem in some countries is public access, including media access, to information that is held by government agencies in certain countries. This problem does not affect the ability of the aviation community to create GAIN, but it could affect the ability of government agencies in some countries to receive information from GAIN. Thus, in 1996 the FAA obtained legislation that requires the agency to protect voluntarily supplied aviation safety information from public disclosure. This

> will not deprive the public of any information to which it would otherwise have access, because the agency would not otherwise receive the information; but on the other hand, there is a significant public benefit for the FAA to have the information because it helps the FAA prevent accidents and incidents. The FAA is now developing regulations to implement that legislation...
>
> 3. Criminal Sanctions. A problem in some countries is the fear of criminal prosecution for regulatory infractions. Such a fear would be an obvious obstacle to the flow of aviation safety information. This has not historically been a major problem in the U.S., but the trend from some recent accidents is troubling.
>
> 4. Civil Litigation. Probably the most significant problem, certainly in the U.S., is the concern that the information will be used against the reporter in accident litigation. Some have suggested that, as was done in relation to the public disclosure issue, the FAA should seek legislation from Congress to protect aviation safety information from disclosure in litigation. In comparison with the public disclosure issue, however, the chances of obtaining such legislation are probably very remote; and a failed attempt to obtain such legislation could exacerbate the situation further because these disclosure issues are now determined in court, case by case, and a judge who is considering this issue might conclude that a court should not give protection that Congress refused to give." [308]

Incident reporting systems have addressed these concerns in a number of different ways. For instance, it is possible to identify three different disclosure policies. Anonymous systems enable contributors to entirely hide their identity. Confidential systems allow the limited disclosure of identity but only to trusted parties. Finally, open systems reveal the identity of all contributors. The impact of the distinctions between open, confidential and anonymous systems cannot be under-emphasised. In anonymous systems, contributors may have greater confidence in their submission; safe in the knowledge that they can avoid potential 'retribution'. However there is a danger that spurious reports will be filed. This problem is exacerbated by the fact that it is difficult to substantiate anonymous reports to determine whether they really did occur in the manner described. Investigators cannot simply ask about an incident within a workgroup without the possibility of implicating the contributor. This would remove the protection of confidentiality and could destroy the trust that is fundamental to the success of such systems. The distinctions between open, anonymous and confidential systems are also blurred in many existing applications. For example, the Swedish Air Traffic Control organisation (Luftfartsverket Flygtrafikjänsten) encourages the open contribution of incident reports. However, normal reporting procedures direct submissions through line supervisors. There is a danger that this might dissuade contributions about the performance of these supervisors. As a result, procedures exist for the confidential submission of incident reports via more senior personnel.

Trust and Technological Innovation

Distinctions between confidential, anonymous and open systems are intended to sustain the confidence and *trust* of potential participants. In a confidential system, contributors trust that only 'responsible' parties will receive identification information. The implications of this for the operation of any reporting system are illustrated by the approach taken with the CIRAS system that covers UK railways. This receives paper-based forms from train drivers, maintenance engineers and other rail staff. A limited number of investigators are responsible for processing these forms. They will conduct follow-up interviews in-person or over the telephone. These calls are not made to the contributor's workplace for obvious reasons. The original report form is then returned to the employee. No copies are made. Investigators type up a record of the incident and conduct a preliminary analysis. However, all identifying information is removed from the report before it is submitted for further analysis. From this point it is impossible to link a particular report to a particular employee. The records are held on a non-networked and 'protected' data base. This data itself is not revealed to industry management. However, anonymized reports are provided to managers every three months.

Incident reporting systems increasingly rely on computer-based applications . The Swedish Air Traffic Control system, mentioned above, is an example of this. Controllers in airfields in the more remote areas of Northern Sweden can receive rapid feedback on a report using this technology. However, electronic submission creates a number of novel and complex challenges for systems that attempt to preserve anonymity. These concerns are illustrated by the assurances that are provided to contributors on the Swiss Anaesthesia Critical Incident Reporting System. These include a commitment that they 'will NOT save any technical data on the individual reports: no E-mail address and no IP-number (a number that accompanies each submitted document on the net)' [756]. The use of computer-based technology not only raises security problems in the maintenance of trust during the transmission and storage of electronic documents, it also offers new and more flexible ways of maintaining incident reporting systems. For example, the US Department of Energy's Computerised Accident/Incident Reporting System (CAIRS) exploits an access control mechanism to tailor the level of confidentiality that is afforded to particular readers of particular incident reports. The CAIRS database is used to collect and analyse reports of injuries, illnesses, and other accidents that are submitted to the Department of Energy by their staff or contractors. The following paragraphs provide a brief overview of the innovative way in which the confidentiality of information is tied to particular access rights.

> "When you are granted access to CAIRS, you will be assigned an organisational jurisdiction. This jurisdiction may be for a specific organisation or for a complete contractor, area office, or field office. This jurisdiction assignment will determine the records that will be selected when the default organisation selection is utilised in many of the reports and logs. The default can be over-ridden by entering the desired organisation codes in the appropriate input boxes.
>
> CAIRS reports contain personal identifiers (names and social security numbers) and information regarding personal injury or illness. In order to prevent an unwarranted invasion of personal privacy, all personal identifiers are masked from the view of general users whenever any logs or reports are generated.
>
> The default registration for CAIRS does not provide access to any privacy information. If you require access to privacy information in order to perform your job function, you may apply for access to that information." [656]

It can be difficult to communicate the implications of such computer-based security measures to non-computer literate employees. There is a natural reluctance to believe in the integrity of such safeguards given continuing press coverage about the vulnerability of 'secure' systems [1]. The ability to access this data over the web might compound such misgivings.

Workplace Retribution and Legal Sanction

At least two different classes of problems exist in more open systems. Later paragraphs will address the issues that arise when trying to integrate a pro-active safety culture into a punitive legal system. There is a natural reluctance to implicate oneself or one's colleagues when subsequent investigations might directly threaten their livelihood and wellbeing. The second set of problems arise from a justified fear of persecution from colleagues or employers. These fears are natural if, for example, the subject of a report is a person in a position of authority or if the report reflects badly upon such a person. These individuals are likely to have a strong influence upon the career prospects and promotion opportunities of their more junior colleagues. The long term consequences of any actual or implied criticism can be extremely serious. Such concerns have long been apparent in the 'cockpit gradient'; co-pilots have extreme difficulty in challenging even minor mistakes made by a Captain. Co-Pilots have been known to remain silent even when their colleague's behaviour threatened the lives of everyone on board [734].

There are other reasons why individuals can be reluctant to contribute to incident reporting systems. There may be a fatalism that such an individual or group will suppress the report. If the report focuses less on higher management and more on their colleagues then the contributor may have concerns about appearing to be disloyal. In all of these cases, a natural reluctance can be compounded by a feeling of self-doubt. It may not be clear to the reporter that an adverse event has occurred. Those involved in an incident may seek to excuse or cover up their behaviour. Junior staff can also be reluctant to appear 'stupid' by raising concerns over unfamiliar equipment or procedures. As a result, they can remain silent about important safety concerns.

Many of the issues described above are illustrated by the events leading to the UK Bristol Royal Infirmary Inquiry. This focused on the procedures that were used to gain parental approval for child organ retention after autopsy. Concerns about these procedures were first identified following complaints that several complex cardiac surgical procedures continued to be conducted in spite of an unusually low recovery rate. The inquiry heard how Steve Bolsin, a member of staff within the unit, had attempted to draw attention to these problems by conducting a personal clinical audit. The following quotation comes from the hearings of this inquiry. The questions, labelled Q, were posed by the leagl team to the Chief Executive of the United Bristol Healthcare NHS Trust. His answers are labelled with an A.

> "Q. There was, was there, personal difficulty for a number of people in his overall conclusions being accepted?
>
> A. That certainly seems to be the case from all the records that I have seen, yes.
>
> Q. To what extent was that a reflection, would you say, of the absence of an institutionalised system of audit the absence of an institutionalised system of audit properly monitored, and to what extent did you consider that was part of a club culture where someone who rocked the boat, in whatever capacity, might be, as it were, going against the 'club'?
>
> A. They could both be contributory factors. Clearly, if there was no thorough-going structure in place along the lines we have discussed, then that is not going to lead to a climate whereby individuals doing audit and then presenting it is necessarily going to be received positively. Also, of course, if data is produced that appears to be critical of certain individuals and has not been collected with their knowledge and they do not subscribe to the methodology, then it would be surprising if they did not feel a degree of resentment and rejection of what was put in front of them. And it is possible that if this was undertaken by someone relatively new to the organisation who was challenging senior figures in the organisation, that, yes, indeed, it may have cut across some of the cultural boundaries within the Trust." [434]

In the subsequent investigations, Steve Bolsin's intervention was widely praised. However, things become more complex if an individual's actions can be interpreted as either 'whistler blowing' or 'trouble making' depending on ones' perspective. This dichotomy is illustrated by Mary Schiavo's criticisms of the FAA. She held the post of Inspector General in the US Department of Transportation. Following the Valujet crash, she told an American House of Representatives panel that she had made regular complaints to the FAA about what she felt were lax inspection practices in monitoring rapidly expanding airlines. Her comments and criticisms were widely reported in the media. However, her 'whistle blowing' was, in turn, heavily criticised by the US Congress. They attacked her by asking why she had not first passed her concerns to the Congress before publicly airing her criticisms. Under federal law, inspectors general are required to pass on to Congress within seven days any problems requiring immediate attention. She chose to resign from her post and subsequently published an account of her criticisms [730].

This dichotomy between constructive 'whistle blowing' and destructive criticism of an employer can also be seen in the Paul van Buitenen case. He voiced concerns about fraud and mismanagement in the European Commission's £60 billion budget. When these criticisms were made public, the veracity of his claims and his motivation for making them were, in turn, heavily criticised by individuals within the Commission. Although this incident did not have direct safety implications, his statements in a BBC interview provide a powerful illustration of the psychological pressures that affect such individuals:

> "I did not realise the full consequences of what would happen. I did not even know the word whistle-blower - I did not know this phenomenon existed... It was completely strange for me to see the commission tackle me on my personality and my credibility and not on the contents of what was disclosed. Sometimes I had difficulty keeping the tears inside when I discovered what machinery was brought against me... I am withdrawing as of April 1st, I want to be an anonymous official again. I want to show I can still be loyal, I want to do a normal standard budget management job. I want to have a quiet family life and be a husband and a father to my children who still have to do three years at secondary school, and I cannot carry on carrying this on my own." [103]

A UK National Audit Office enquiry headed by Sir John Bourn subsequently found errors totalling about £3 billion in European pay-outs during 1998. van Buitenen concerns are occasionally echoed in safety-related incident reporting systems: The provision of a reporting system is no guarantee of an appropriate safety culture in the companies that operate within an industry:

> "At the start of the Winter heavy maintenance programme, the company railroaded into place a computerised maintenance and integrated engineering and stores, planning and labour recording system. No training was given on the operational system only on a unit under test. Consequently we do not look at planes any more just VDU screens, filling in fault report forms, trying to order parts the system does not recognise, as the stores system was not programmed with (aircraft type) components (the company wanted to build a data base as equipment was needed)... The record had numerous faults, parts not recorded as being fitted, parts removed with no replacements, parts been fitted two or three times, parts removed by non-engineering staff, scheduled tasks not called-up by planning, incorrect trades doing scheduled tasks and certifying, and worst of all the record had been altered by none certifying staff after the CRS signatories had closed the work. Quality Airworthiness Department were advised of these deficiencies and shown actual examples. We were advised by the management that these problems are being addressed but they are not, we still have exactly the same problems today. What am I to do without losing my job and career. In a closed community like aviation, troublemakers and stirrers do not keep jobs and the word is spread around...' [174].

The comments that aviation is a "closed community" and that "troublemakers and stirrers do not keep jobs" provide an important 'reality-check' against some assertions about the benefits of incident reporting. These schemes have little impact on the underlying safety culture of many companies and organisations. O'Leary and Chappell argue that confidential incident reporting systems create a 'vital awareness of safety problems' [661]. The key point is not, perhaps, that O'Leary and Chappell are wrong but that the beneficial effects of these systems are constrained by the managerial culture in which they operate.

Media Disclosure

Issues of confidentiality and disclosure do not simply reflect the need to protect an individual's identity from their co-workers. They can also stem from concerns about media intrusion. For example, recent amendments have been proposed for ICAO Annex 13 on Accident and Incident Investigation and Prevention. The revisions would provide pilots with automatic confidentiality in accident and incident investigations. They would also limit the disclosure of information following an incident or accident. These amendments are significant in two ways. Firstly, they would ensure that the media had no right to cockpit voice recordings. This is an important issue given public and professional reactions to the broadcasting of such recordings after fatal accidents. Secondly, it would increase the level of civil protection available to pilots. The intention is to encourage a 'no-blame' approach to incident reporting. The concept is currently being tested in New Zealand civil courts.

If the ICAO adopts these amendments, it is likely that they will be ratified by all ICAO signatory nations as international law.

Accident and incident investigators often have a complex relationship with the media [419]. Public disclosure of sensitive information can jeopardise an enquiry and can dissuade contributions about potential hazards. Media interest can also play a powerful role in establishing reporting systems and in encouraging investment in safety initiatives. Peter Majgrd Nørbjerg's account of the new Danish Air Traffic Management reporting system reveals these two aspects of media involvement:

> "Then, in 2000, in order to push for a change the Chairman of the Danish Air Traffic Controllers Association decided to be entirely open about the then current obstacles against reporting. During an interview on national television, she described frankly how the then current system was discouraging controllers from reporting. The journalist interviewing the ATCO chairman had picked up observations made by safety researchers that, as described above, Denmark had a much smaller number of occurrence reports than neighbouring Sweden. Responding to the interviewer's query why this was so, the ATCO chairman proclaimed that separation losses between aircraft went unreported simply due to the fact that controllers - for good reasons - feared for retribution and disclosure. Moreover, she pointed out, flight safety was suffering as a consequence of this! These statements, broadcasted on a prime time news program, had the immediate effect that the Transportation Subcommittee of the Danish Parliament asked representatives from the Danish Air Traffic Controllers Association to explain their case to the Committee. Following this work, the Committee spent several of their 2000-01 sessions exploring various pieces of international legislation on reporting and investigation of aviation incidents and accidents. As a result of this, in 2001 the Danish government proposed a law that would make non-punitive, strictly confidential reporting possible." [677]

The irony in this account is obvious. The media played a key role in motivating political intervention to establish the reporting system. One of the first acts in establishing the new scheme was to create a legislative framework that effectively protected contributors from media exposure.

Proportionate Blame...

Potential contributors often have a justified fear of retribution. They may be dissuaded from participating in a reporting system if they feel that their colleagues and managers will perceive them to be 'whistle blowers'. Contributors can also be concerned about the legal consequences of submitting an incident report [83]. Leape points out that this reluctance is exacerbated by apparent inequities in the degree of blame that is associated with some adverse events. He also identifies a spectrum of blame that can lead from peer disapproval through to legal sanctions:

> "...these punishments are usually calibrated to the gravity of the injury, not the gravity of the error. The nurse who administers a tenfold overdose of morphine that is fatal will be severely punished, but the same dosing error with a harmless drug may barely be noted. For a severe injury, loss of the right to practise or a malpractice suit may result. Moderate injuries may result in a reprimand or some restriction in practice. Punishment for less serious infractions are more varied: retraining, reassignment, or sometimes just shunning or other subtle forms of disapproval." [479]

This fear of retribution has been addressed by number of regulatory organisations who have sought to ensure that any enforcement actions are guided by principles that are intended to protect individuals and companies. For example, the UK Health and Safety Executive is responsible for initiating prosecutions that relate to violations of health and safety law. These action are often taken in response to the accidents and injuries that are reported under the RIDDOR scheme, introduced in Chapter 1. The Health and Safety Commission requires that individual HSE inspectors inform their actions by the principle of proportionality; the enforcement action must reflect the degree of risk. They must also endeavour for consistency in their enforcement actions; they must adopt a similar approach in similar circumstances to achieve similar ends. A further HSE principle concerns the targeting of enforcement. Actions are focused on the people who are responsible for the risk and who are best placed to control it. Finally, there is a requirement that any legal or other enforcement actions should be transparent; the justifications and reasons for any decision to prosecute must be open to inspection. These guiding principles clearly distinguish regulatory actions from the informal retribution that often dissuades potential contributors from 'whistle-blowing'. In order to achieve these principles, Health and Safety inspectors will exploit a range of enforcement actions:

> "Enforcing authorities must seek to secure compliance with the law. Most of their dealings with those on whom the law places duties (employers, the self employed, employees and others) are informal - inspectors offer information, advice and support, both face to face and in writing. They may also use formal enforcement mechanisms, as set out in health and safety law, including improvement notices where a contravention needs to be remedied; prohibition notices where there is a risk of serious personal injury; withdrawal of approvals; variations of licences or conditions, or of exemptions; or ultimately prosecution. This statement applies to all dealings, formal or informal, between inspectors and duty holders - all contribute to securing compliance." [315]

The legal position of incident reporting systems is inevitably complicated by differences between different national systems. The effects of this can be seen from the differing reporting practices in European air traffic control. Some service provides are compelled to report all incidents to the national police force or to state prosecutors who will launch an investigation if they believe that an offence has been committed. However, there is a concern in the European coordinating organisation, EUROCONTROL, that controllers and pilots will significantly downgrade the severity of the incidents that they report in such potentially punitive environments. Concerns over litigation can also prevent reports from being filed. Other states have reached agreements between air traffic management organisations and state prosecutors to protect staff who actively participate in the investigation of an occurrence. The Swedish experience of operating an open reporting system is that very few controllers have lost their licenses as a result of filing an incident report within the last decade. The Luftfartsverket Flygtrafikjänsten personnel who operate the system stress the need to protect the controller's trust in the non-punitive nature of the system. The overall safety improvements from the information that is gathered by a non-punitive system are believed to outweigh the disciplinary impact of punitive sanctions. These arguments have also motivated the Danish system, mentioned earlier in this chapter [677]. It is interesting to note that the same personnel who expect a non-punitive approach to protect their submissions often also expect more punitive actions to be taken against others who are perceived to have made mistakes, especially pilots.

Most companies and regulators operate 'proportionate blame' systems. Annex 13 to the International Civil Aviation Organisation's International Standards and Recommended Practices provides the framework for accident and incident reporting in world aviation. This advocates a non-punitive approach to accident and incident reporting. It might, therefore, seem strange that some countries continue to operate systems that directly inform the actions of state prosecutors. There is, however, a tension between the desire to ensure the trust of potential contributors and the need to avoid a system that is somehow 'outside the law'. Ethical as well as judicial considerations clearly prevent any reporting system from being entirely non-punitive. For instance, action must be taken when reports describe drug or alcohol abuse. As a result most systems reserve the right to pass on information about criminal acts to the relevant authorities. This is illustrated by the immunity caveats that are published for NASA and the FAA's Aviation Safety Reporting System (ASRS). Section 5 covers the 'prohibition against the use of reports for enforcement purposes':

- "a. Section 91.25 of the Federal Aviation Regulations (FAR) (14 CFR 91.25) prohibits the use of any reports submitted to NASA under the ASRS (or information derived therefrom) in any disciplinary action, except information concerning criminal offences or accidents which are covered under paragraphs 7a(l) and 7a(2).

- b. When violation of the FAR comes to the attention of the FAA from a source other than a report filed with NASA under the ASRS, appropriate action will be taken. See paragraph 9.
- c. The NASA ASRS security system is designed and operated by NASA to ensure confidentiality and anonymity of the reporter and all other parties involved in a reported occurrence or incident. The FAA will not seek, and NASA will not release or make available to the FAA, any report filed with NASA under the ASRS or any other information that might reveal the identity of any party involved in an occurrence or incident reported under the ASRS. There has been no breach of confidentiality in more than 20 years of the ASRS under NASA management." [59]

Section 7 of the regulations governing the ASRS describes the procedure for processing incident reports. Again, this process explicitly describes the way in which legal issues are considered before reports are anonymized:

- a. "NASA procedures for processing Aviation Safety Reports ensure that the reports are initially screened for:
  1. Information concerning criminal offences, which will be referred promptly to the Department of Justice and the FAA;
  2. information concerning accidents, which will be referred promptly to the National Transportation Safety Board (NTSB) and the FAA; and Note: Reports discussing criminal activities or accidents are not de-identified prior to their referral to the agencies outlined above.
  3. time-critical information which, after de-identification, will be promptly referred to the FAA and other interested parties.
- b.Each Aviation Safety Report has a tear-off portion which contains the information that identifies the person submitting the report. This tear-off portion will be removed by NASA, time-stamped, and returned to the reporter as a receipt. This will provide the reporter with proof that he/she filed a report on a specific incident or occurrence. The identification strip section of the ASRS report form provides NASA program personnel with the means by which the reporter can be contacted in case additional information is sought in order to understand more completely the report's content. Except in the case of reports describing accidents or criminal activities, no copy of an ASRS form's identification strip is created or retained for ASRS files. Prompt return of identification strips is a primary element of the ASRS program's report de-identification process and ensures the reporter's anonymity." [59]

These quotations show that incident reporting systems must define their position with respect to the surrounding legislative and regulatory environment. They also illustrate the care that many organisations take to publish their position so that potential contributors understand the protection they are afforded. This does not necessarily imply that they respect the intention behind such protection. For instance, ASRS reporting forms are often colloquially referred to as 'get out of gaol free cards' by some US pilots.

The protection offered by confidential reporting systems has both positive and negative effects. 'No blame' reporting is intended to encourage participation in the system. Protection from prosecution can, however, introduce bias if it has greater value for particular contributors. This can be illustrated by the Heinrich ratios for US Commercial and General Aviation. The bottom tier of the Iceberg can be assessed through contributions to NASA's ASRS. Table 2.2 shows that General Aviation and air traffic management personnel submitted less voluntary incident reports than the crews of commercial air carriers in 1997 and 2000. These years were chosen because the ASRS provide complete month by month submission statistics. Administrative problems have led to submission data being merged for some months in other years. Others, including cabin crew, mechanics and military personnel provide very few submissions. The relatively high level of commercial aircrew contributions can be explained in terms of the protection offered by ASRS submissions. Submission to the system turns an adverse event into a learning opportunity In contrast, General Aviation pilots typically do not, typically, risk their livelihoods if their licences are revoked after an adverse event. There may also be less concern that others will witness and report an adverse event in General Aviation. They may, therefore, be less likely to submit information about adverse events they have been involved in. There is always the possibility in Commercial Aviation that other members of the flight crew or air traffic managers will file a report even if you do not.

	Air Carrier		General Aviation		Air Traffic Managers		Others	
	1997	2000	1997	2000	1997	2000	1997	2000
January	1,888	2,451	612	597	59	76	42	162
February	1,681	2,217	677	608	55	52	29	188
March	1,884	2,503	779	582	69	85	42	191
April	1,894	2,677	776	727	82	72	31	194
May	1,798	2,112	701	718	69	54	38	192
June	1,952	2,232	718	729	88	81	66	193
July	2,051	2,536	762	829	113	72	64	168
August	1,944	2,663	650	774	105	95	56	188
September	1,974	1,719	759	619	84	37	63	139
October	1,988	1,897	724	857	119	46	50	102
November	1,837	1,721	589	850	68	30	68	103
December	2,017	1,895	637	611	54	28	69	80
Total	22,908	26,623	8,384	8,501	965	728	618	1,900

Table 2.2: ASRS Contribution Rates 1997 and 2001

Table 2.3 presents NTSB data for accidents involving Commercial and General Aviation. In theory, this information can be used to calculate the Heinrich ratios that in turn illustrate the effects of 'no blame' reporting on participation rates. Unfortunately, the ASRS and NTSB use different classification schemes. The NTSB classify Commercial operations using the 14 CFR 121 and 14 CFR 135 regulations. In broad terms, 14 CFR 135 refers to aviation operations conducted by commuter airlines. 14 CFR 121 refers to larger air carriers and cargo handlers. The 14 CFR 135 statistics are further divided into scheduled and unscheduled services. Table 2.3, prsents the NTSB accident data for scheduled services. The 14 CFR 135 figures in parentheses also include accidents involving on-demand unscheduled services, such as air taxis. In calculating the Heinrich ratios, we have taken the figures for both scheduled and unscheduled services.

	14 CFR 135		14 CFR 121		General Aviation	
	All	Fatal	All	Fatal	All	Fatal
1997	16 (98)	5 (20)	49	4	1,845	350
1998	8 (85)	0 (17)	50	1	1,904	364
1999	13 (86)	5 (17)	51	2	1,906	340
2000	12 (92)	1 (23)	56	3	1,837	344
2001	7 (79)	2 (20)	45	6	1,726	325
2002	8 (66)	0 (17)	41	0	1,714	343

Table 2.3: NTSB Fatal and Non-Fatal Accident Totals

Figure 2.2 illustrates the Heinrich ratios for US Commercial and General Aviation in 1997 and 2000. The ratios were based on the number of incident submissions from Table 2.2. Table 2.3 provided the total number of fatal accidents. The number of non-fatal accidents was derived by subtracting the number of fatal incidents from the NTSB totals for all accidents. The General

Aviation classification is used in both the ASRS and NTSB statistical sources. The frequency of fatal commercial accidents was derived from the sum of incidents associated with 14 CFR 121 and 135 operations in the NTSB datasets. The figures in parentheses represent the total incident frequencies used in calculating the ratios.

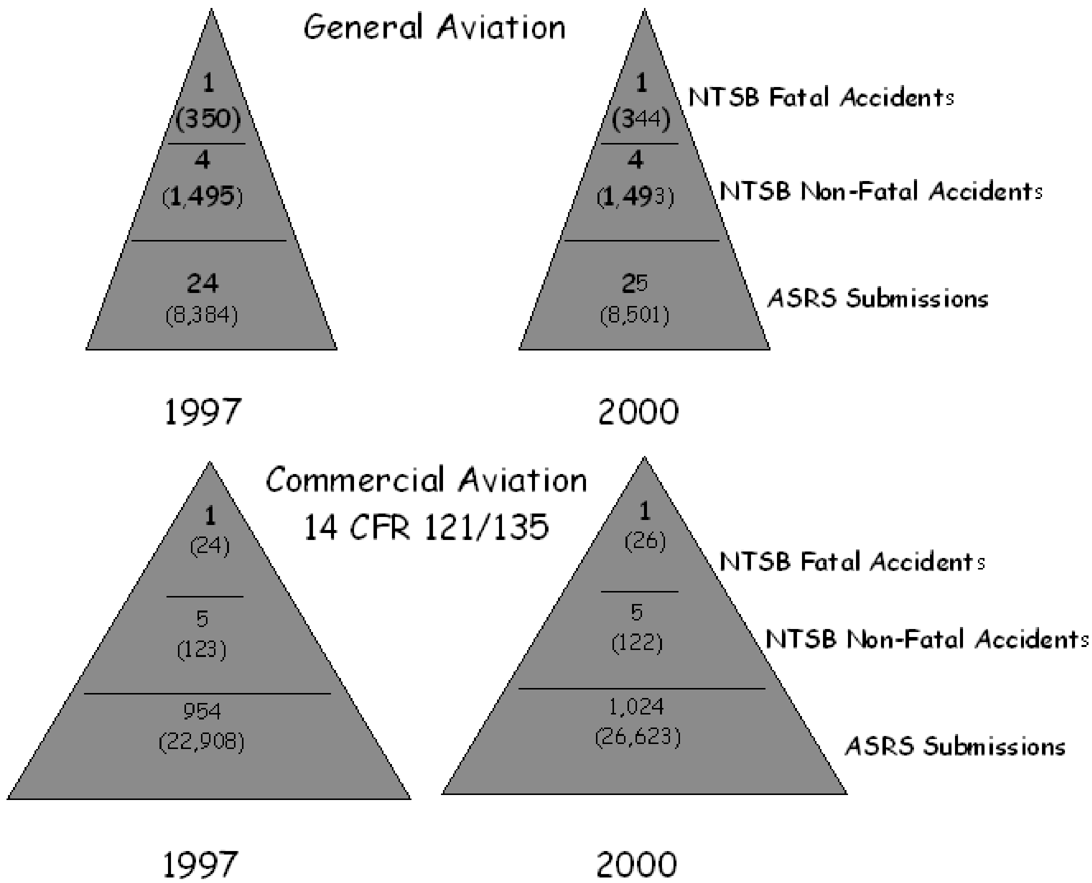

Figure 2.2: Heinrich Ratios for US Aviation (NTSB and ASRS Data)

The proportion of injuries to deaths in Figure 2.2 is lower for both General and Commercial Aviation than would be expected from Heinrich's ratio of one death to thirty injuries. In the case of General Aviation there is one fatal accident for every four non-fatal accidents. In Commercial Aviation, the ratio is one to five. This is deceptive. The ratios in Figure 2.2 cannot be directly compared to Heinrich's results. The NTSB and ASRS data refers to accidents rather than the number of injuries. The difference between Heinrich's ratio and our data arises because a single accident in the NTSB data can yield multiple fatalities or injuries. The NTSB do, however, present fatality and injury numbers for 14 CFR 121 operations. From this we can derive ratios of 1(2) : 10(21) : 13,311(26,623) in 1997 and 1(83) : 0.1(9) : 276(22,908) in 2000. The numbers in parentheses are the total frequencies for fatalities, minor injuries and incident reports. Further caveats can also be raised about these revised 14 CFR 121 ratios because the ASRS submission statistics combine 14 CFR 121 and 135 operations. These anomalies illustrate the practical difficulties that are often ignored by proponents of the Heinrich ratio as a tool for Safety Management. They also illustrate a recurrent observation in this book; incident and accident statistics are often presented in incompatible formats. This makes it difficult to trace the relative frequency of adverse events and their outcomes over time. It is apparent, however, that the revised 14 CFR 121 ratios are very different from Heinrich's figures. In particular the ratio of 1 death to 0.1 injuries seems at odds with the one to thirty ratio cited above. Fatal accidents are relatively rare in Commercial Aviation. Those that do occur often result in significant loss of life. Relatively few passengers and crew survive with minor injuries. These particular characteristics help to explain the apparent anomaly in the 1:0.1:276 ratio in 2000 for 14 CFR 121.

Heinrich's original work mixed outcome frequencies in terms of fatalities and injuries with event frequencies, based on observations of near misses. He did not attempt to estimate likely outcomes for near miss incidents. It can, therefore, be argued that the ratios in Figure 2.2 are more informative because they are based entirely on event frequencies. They do not include outcome information. Figure 2.2 can be used to identify patterns in ASRS submission data. In General Aviation, there was 1 fatal incident for every 24 submissions in 1997 and one fatal accidet for every 25 submissions in 2000. In Commercial Aviation, there were 954 ASRS submissions in 1997 and 1,024 in 2000 for each fatal incident. There are a number of possible explanations for these ratios. We can argue that there is a higher proportion of fatal accidents in General Aviation than in Commercial Aviation. This hypothesis is supported by the lower standards of training and equipment in General Aviation [82].

The higher rate of incident reports from Commercial Aviation in Figure 2.2 might be explained if these pilots had a greater incident exposure than in General Aviation. This is contradicted by the observation that General Aviation pilots accumulate significantly more flying hours than 14 CRF 121 and 14 CFR 135 operations combined. Table 2.4 presents NTSB statistics for flying hours and also accident rates per 100,000 hours in both Commercial and General Aviation [201]. To simplify the calculation of these rates we have excluded non-scheduled on-demand air taxis under 14 CFR 135. This is justified by the relatively low number of flying hours and incidents in this category.

	14 CFR 135		14 CFR 121		General Aviation	
	Accident Rate	Flying Hours	Accident Rate	Flying Hours	Accident Rate	Flying Hours
1997	1.628	982,764	0.309	15,838,109	7.19	25,591,000
1998	2.262	353,670	0.297	16,816,555	7.44	25,518,000
1999	3.793	342,731	0.291	17,555,208	6.4	29,713,000
2000	3.247	369,535	0.306	18,299,257	6.3	29,057,000
2001	2.330	300,432	0.231	17,752,447	6.28	27,451,000
2002	2.595	308,300	0.228	18,011,700	6.56	26,078,000

Table 2.4: NTSB Fatal and Non-Fatal Accident Rate Per 100,000 Flight Hours

The ratios in Figure 2.2 can also be explained in terms of a lower proportion of ASRS submissions from General Aviation than Commercial Aviation. Commercial pilots have more to lose from adverse events. The additional protection provided by the 'no blame' environment of the ASRS approach encourages them to submit a report. This attitude partly arises from the professional and personal consequences of losing a license that is essential to that person's job. Interviews with pilots have revealed that they are more likely to submit an ASRS report if they believed that someone else had also witnessed the incident. Given the NASA/FAA statement protection, cited above, there is perhaps a tendency to use the ASRS as a form of confessional in which contribution implies repentance. Arguably this has reached the point where many ASRS incidents are of a relatively trivial nature and provide few safety-related insights. With less to lose, General Aviation pilots may be less inclined to contribute to the system.

The difficulty in interpreting Heinrich ratios for US Commercial and General Aviation illustrates the confounding factors that must be considered when analysing reporting patterns. It seems likely that immunity policies affect contribution rates but little work has been conducted to determine how they interact with risk exposure, with individual attitudes to risk etc. The lack of such information is a primary motivation in writing this book. Major policy decisions have been made and continue to be made on the basis of data supplied by national and international reporting systems. There are, however, many open questions about the reliability, or biases, that affect these information sources.

2.3.2 Scope and Level

There are many different types of reporting system. Local schemes may record incident information supplied by a few staff in a particular department. International systems have been developed by groups such as the International Maritime Organisation to support the exchange of information between many different multinational companies [387]. These differences in the coverage of a reporting system can be explained in terms of their scope and level. The level of a reporting system is used to distinguish between local, national and international initiatives. The scope of a system defines the groups who are expected to participate in the scheme. The concept of coverage is a complex one. It is possible to distinguish between the theoretical and actual scope of a system. Although a system is intended to cover several different groups, such as medical and nursing staff, it may in practice only receive contributions from some subset of those groups. Similarly, a national system may be biased towards contributions from a particular geographical area.

There are important differences between national and regional reporting systems. For example, it can be easier to guarantee anonymity in national systems. Reports that are submitted to local systems often contain sufficient details for others to infer the identity of individuals who are involved in an adverse event. National systems are more likely to be protected by legal guarantees of confidentiality. They are also more likely to have the resources to finance technology protection for contributors, such as that offered by the Department of Energy's CAIRS system [656]. They can also finance dedicate personnel to process reports. Key individuals, such as the 'Gatekeepers' in the Swedish Air Traffic Control system, can be given the task of anonymizing information so that identities are hidden during any subsequent analysis. Steps may even be taken, as in the case of CIRAS, to ensure that these individuals are also prevented from retrieving identity information after the analysis is completed. All of these protection mechanisms are easier to sustain at a national level where resources of time, money and personnel can be deployed to address the logistical problems that often threaten locally-based systems.

A host of problems threaten anonymity in local reporting systems. For instance, the individuals who are responsible for setting up and running such a system can have some difficulty in convincing staff that they will not divulge confidential information to management or to other members of staff. One common means of avoiding this problem is to operate completely anonymous systems in which no identification information is requested. This creates the opportunity for malicious reporting in which one person implicates another. It also creates difficulties in both analysing and interpreting the causes and effects of particular incidents.

One of the longest running medical incident reporting systems was established in the Intensive Care Unit of an Edinburgh hospital. This scheme can be used to illustrate the difficulty of preserving anonymity and confidentiality in local reporting systems. The unit has eight beds [121]. There are approximately three medical staff, one consultant, and up to eight nurses per shift on the ward. Given the relatively close-knit working environment of an intensive care unit, it is possible for other members of staff to narrow down those individuals who might have submitted a report about a particular procedure or task that they were involved in. A key issue here is the trust that is placed in the person who is responsible for operating the system. The Edinburgh system was set up by David Wright, a consultant anaesthetist, who was heavily influenced by the earlier Australian Incident Monitoring Study (AIMS) [867]. This local system is heavily dependent upon his reputation and enthusiasm. He receives the reports and analyses them with the help of a senior nurse. The extent of his role is indicated by the fact that very few reports are submitted when he is not personally running the scheme.

The Paradox of Anonymity

There is a paradox in the affect that anonymity has on the value of a report at the local, national or international level. As part of the initiative to establish common guidelines for incident reporting in Air Traffic Control, interviews were conducted with controllers and other personnel in several European countries [422]. During these sessions, several contributors stressed the importance of anonymity. However, they also stressed the importance of knowing the context in which an incident occurred. This included both the location, which airport and which runway, as well as the time of day, the operator's shift pattern etc. Without this information, they argued that the report would have little or no value to other operators. With that information, however, it would be relatively easy to narrow the potential contributor down to a few individuals. The paradox here is that anonymity is often essential to encourage the continued submission of incident reports. However, anonymity jeopardises the usefulness of a report for those who may benefit most from the lessons that it contains.

In international schemes this paradox raises a number of deeper questions. A large number of local factors will influence the way in which an occurrence is dealt with. These include differences in national operating practices, in equipment, in workload. However, if a report were to be anonymized then much of this information would have to be omitted. It is not clear how much information about all of these issues ought to be provided and how much can be assumed about the readers knowledge of regional and national differences. In aviation, this has been addressed by ICAO Annex 13, mentioned above. This specifies the minimum content for accident and incident reports. However, these guidelines are not always adhered to. Similar provisions do not currently exist to support the sharing of data in the medical domain or in, for instance, rail transportation.

In local schemes, the context is already well established. The staff in the Edinburgh ICU system know that all reports refer to occurrences within that unit. As a result, much of the identifying information about that ICU can be reatined in the reports. Much of this detail would have to be removed in a confidential national systems in order to protect the individual hospital department. At the same time, however, there is an increased likelihood that those running local systems may be able to infer who contributed an anonymous report from their knowledge of the unit. The managers of the reporting system must ensure that similar inferences cannot easily be made by the co-workers who receive the recommendations that are generated from each contribution. This again leads to the danger that necessary information will be omitted.

'Targeting the Doable"

Local incident reporting systems must typically select their recommendations from a more limited set of remedial actions than national or international systems. For example, the FAA/NASA's ASRS is widely recognised to have a profound influence not just on US but also on global aviation policy. The same cannot be said for more local systems where it may only be possible to influence the unit in which it is being run. This is reflected in the more limited definition of an incident in some of these schemes. For example, the staff of the Yorkhill Hospital for Sick Children recently established an incident reporting system for incidents in a Neonatal Intensive Care Unit. This local system borrowed heavily from the existing schemes in Edinburgh and at various places in Australia [122, 121]. The agreed definition of an incident that fell within the scope of the system was printed on each of the forms:

> "A critical incident is an occurrence that might have led (or did lead) if not discovered in time - to an undesirable outcome. Certain requirements need to be fulfilled:
>
> 1. It was caused by an error made by a member of staff, or by a failure of equipment;
> 2. It can be described in detail by a person who was involved in or who observed the incident;
> 3. It occurred while the patient was under our care;
> 4. It was clearly preventable.
>
> Complications that occur despite normal management are not critical incidents. But if in doubt, fill in a form." [122]

The penultimate sentence illustrates a key point about local systems. Local schemes depend upon the good will, or at worst the passive acceptance, of higher levels of management. Such support can be jeopardised if the system is seen to move beyond constructive criticism.

Many of the incidents reported to local schemes can only be avoided or mitigated through cooperation with other, external organisations. For example, van Vuuren's study of incident reporting in a UK Accident and Emergency unit found that forty-five per cent of the causes (42 out of a total of

93) of the 19 incidents that were studies had organisational causes. Of these, thirteen causes were external to the Department itself. This is due to the way in which an Accident and Emergency department depends on the specialist services of other departments, including radiology, biochemistry etc:

> "Because the external factors are beyond the control of the investigated department, it is difficult to assess their real causes. It is of little use to hypothesise in detail about their origins and accompanying corrective actions of root causes in other departments... However, the majority of the external factors relate to the priorities of hospital management. The consequences of these priorities influence day to day practice in the A&E department, revolving mainly around staffing problems (not enough senior staff) and bed problems (lack of beds for A&E patients due to the continuous closing of beds on the wards), Although these external factors are beyond the control of the investigated department, their reporting is important to enable informal discussion between departments and to stimulate other departments to assess their own performance and its impact." [845]

There are clear differences between van Vuuren's emphasis on collecting data, even if it cannot immediately be used to affect other departments, and the previous definition of an incident which 'targets the doable'. The previous definition of a critical incident, arguably, illustrates the pragmatic approach that must be adopted during the establishment of an incident reporting system. Before the value of such a scheme has been widely accepted, it can provide difficult to get other groups to accept that their actions may lead to failures in the unit operating the system. Van Vuuren's argument that incident data can be used to enable informal discussions about common concerns will only be effective if other groups are willing to participate.

National and international systems can often make recommendations that have a much wider impact than local systems. For instance, the recommendations that are obtained from the UK's Royal College of Anaesthetists systems can be passed directly to other college's for further consideration[716]. Similarly, the GAIN system is intended to support the dissemination of 'best practice' across the World's airline operators and manufacturers [308]. It is also intended to support the dissemination of recommendations to air traffic service providers, airport managers etc. A number of limitations affect these large scale systems. It can be difficult to encourage the active participation of all regions within a system. These systems can also become victims of their own success if it becomes difficult to identify common patterns of failure amongst a large number of submissions.

Local, national and international systems provide different insights. For example, Section 2.1 described the potential benefits of incident reporting. These included the fact the they provide a reminder of hazards and that lessons can be shared. In a local system, these reminders may have greater local relevance than in a national scheme. In a national system, feedback often retains local features that were observed in the initial incident report. These features may not be appropriate for all participants. Alternatively, the incident must be abstracted to derive a generic account of the failure. In this case, the recipients must interpret the implications of the generic lesson in the context of their department or organisation. This can lead to a strongly negative reaction to the system if the lessons seem to be inappropriate [408]. There is also a danger of ambiguity; the implications of a generic lesson can be misinterpreted. The following list reviews a number of further differences:

- *local systems* can react relatively quickly to any report of an incident. As mentioned, the overheads of analysing and investigating a mishap can be substantially reduced because the individuals who run the system will have a good understanding of the context in which any failure occurred. These systems may only have a limited scope within a particular level of an organisation. Partly as a consequence of this, they often exploit ad hoc solutions to more serious problems. For instance, many hospital systems train their staff how to 'make do and mend' with poorly designed equipment [418]. National and international systems typically have the greater influence necessary to change procedures and prohibit the use of particular devices.

- *national systems* have correspondingly greater coverage. As a result, more reports may be received and better statistical data can be derived from them. This enables a closer relationship to be created between incident reporting and the subsequent risk assessments that drive future development and operational decision making. The ability to collate national data makes it more likely that such systems will be able to identify trends of common failures across many different sites. This is important because they can recognise the significance of what would otherwise appear as isolated failures. For instance, the lack of any effective central monitoring system has been identified as a reason why repeated problems with radiotherapy systems were not corrected sooner [486]. However, these systems introduce new problems of scale. There are considerable information processing challenges in identifying common trends in the 500,000 reports currently held by the ASRS . It can also be difficult to respond promptly when analysts must communicate with regional centres to establish the detailed causes of an adverse occurrence. Finally, it can be hard to ensure that local and regional agencies exploit consistent reporting procedures. This implies that similar incidents must be reported in a similar manner and that local or regional biases must be identified.

- *international systems* enable states to share information about relatively rare mishaps. They can also be used to exchange insights into the success or failure of recommendations for common problems. For example, Germany Air Traffic Control (Deutschen Flugsicherung GmbH) currently operates several parallel approach runways. The increasing use of these configurations has encouraged them to share data with other organisations which operate similar approaches, such as the UK's National Air Traffic Services operation at Heathrow. International reporting systems enable states to identify potential problems before they introduce systems that are currently operated in other countries. It can, however, be difficult to ensure the active participation of several different countries. Individual states must trust other countries both to investigate and report on their incidents. Cultural and organisational problems also affect the successful operation of international systems. For example, there is often a reluctance to adopt forms and procedures that were not developed within a national system. Occasionally, there is a belief that some of the incidents which are covered by national systems simply 'could not happen here' [422].

Large scale systems often attract political criticism if they are perceived to threaten other national and international organisations. It is for this reason that recent attempts to develop medical incident reporting systems in the United States are at pains to consider the relationship between federal and state bodies:

> "Congress should:
>
> - designate the Forum for Health Care Quality Measurement and Reporting as the entity responsible for promulgating and maintaining a core set of reporting standards to be used by states, including a nomenclature and taxonomy for reporting;
> - require all health care organisations to report standardised information on a defined list of adverse events;
> - provide funds and technical expertise for state governments to establish or adapt their current error reporting systems to collect the standardised information, analyse it and conduct follow-up action as needed with health care organisations.
>
> Should a state choose not to implement the mandatory reporting system, the Department of Health and Human Services should be designated as the responsible entity; and designate the Center for Patient Safety to:
>
> 1. convene states to share information and expertise, and to evaluate alternative approaches taken for implementing reporting programs, identify best practices for implementation and assess the impact of state programs; and
> 2. receive and analyse aggregate reports from States to identify persistent safety issues that require more intensive analysis and/or a broader-based response (e.g., designing prototype systems or requesting a response by agencies, manufacturers or others)."

[452]

The distinctions between local, national and international schemes often become blurred under systems such as that proposed by the US Institute of Medicine. Local initiatives report to State organisations that may then contribute to a Federal database. Such an integration will, however, change the nature of local systems. For instance, the need to ensure consistency in the information that is gathered nationally will force changes on the forms and procedures that are used locally. Recommendations that are issued from a national level may not easily be implemented under local conditions. For instance, recommendations relating to the use of more advanced equipment that has not yet been installed in all regions can serve to remind teams of what they are missing rather than forewarn them about the potential problems of equipment that they might receive in the future [409]. Similar comments can be made about initiatives to integrate national and international reporting systems [422]. The need to convert between national reporting formats and consistent international standards can lead to considerable tension. For instance, some European Air Traffic reporting systems operate a national system of severity assessment that must then be translated into categories proposed by EUROCONTROL's ESARR 2 document [718]. This translation process must be transparent if all of the member states are to trust the reliability of the statistics produced from international initiatives.

2.4 Summary

This chapter has summarised the reasons why a range of government and commercial organisations have established these systems in the military, in transportation, in healthcare, in power generation etc. These initiatives have been justified in terms of the learning opportunities that can be derived from incident data ideally before an accident takes place.

This chapter has also looked at some of the problems associated with incident reporting. These include the difficult of encouraging participation from a broad spectrum of contributors. For instance, we have calculated Heinrich ratios for fatal and minor accidents affecting US personnel. This reveals that contract staff may report fewer minor injuries than directly employed staff. The FRA have, therefore, encouraged greater monitoring of incidents involving contract workers.

'No blame' reporting systems encourage greater participation. However, the Heinrich ratios for General and Commercial Aviation suggest that the protection offered to contributors can introduce biases. In particular, pilots are more likely to report an adverse event if their livelihood is at risk or if they are concerned that their actions may be reported by colleagues and co-workers.

This book addresses the problems identified in this chapter. The aim is to present techniques that will help to realise the benefits that are claimed for incident reporting systems. Issues of anonymity, of legal disclosure, of retribution and blame, of scope and context must all be considered when developing an effective reporting scheme. It is also important to consider the sources of human error, system failure and managerial weakness that contribute to the incidents that are reported. This is the topic of the next chapter.