Divergence and Convergence, Trends in Accident Investigations

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Abstract

Transport Safety Boards have seen an incremental development over the past decades, evolving from disciplinary courts and governmental investigation committees into independent safety agencies. New missions, roles and responsibilities have caused a shift in focus in accident investigation, which may lead to a divergence in forms and procedures across such investigations. Simultaneously, a convergence takes place with respect to the establishment of independent safety boards, necessitating the development of a specific methodology. In this methodology, a combination of initiating investigations, fact-finding, safety analysis, drafting recommendations and initiating systems change takes place, defining these agencies as problem providers for safety management and engineering designers.

This contribution discusses methodological issues involved in this evolution in accident investigation from a perspective of Transportation Safety Boards.

Introduction

Maritime accident investigation courts were established by the second half of the 19th century in most of the sea-going trade nations. A judicial approach enabled disciplinary action against the misconduct of a captain and officers endangering vessels, cargo and passengers. The role of the government was exclusive: the findings of the boards were addressed to the ministry, which held jurisdiction over the issue. In most cases this was the ministry of transportation. The inspectorates of the ministries, which also issued the reports on which boards could base their decisions, conducted the investigative efforts. Similar administrative investigation agencies were established in the railways in may countries, although the disciplinary aspect was less prominent or even abandoned for the benefit of learning. Developments in aviation were slightly different from the maritime and railway sector. Accident investigation into major air crashes was established mandatory as an international obligation of a state by ICAO under Annex 13 in 1951. Initially, the focus was on the technical reliability of the aircraft, the performance of the pilot and compliance with regulations.

In the sixties of the previous century, the concept of independent and permanent investigation boards was adopted in other modes of transportation as well, leading to establishing multi-modal transportation safety boards throughout the world [1], [2], [3].

Over the past decade, several major events have occurred across Europe dealing with infrastructure related disasters. Public and political concern has been raised about fires in the Channel Tunnel and tunnels in the Alps region, high speed train crash at Eschede in Germany and a series of railway accidents in the UK, capsizing of the passenger ferries Herald of Free Enterprise and the Estonia, grounding and sinking of sea-going crude oil tankers, the Concorde crash and the mid-air collision over the border of Germany and Switzerland. In the aftermath of these events, questions have been raised about the preparedness for such disasters and capacity for emergency response, salvage and rescue. Consequently, a need for prevention, policy harmonisation and regulation at a European level has been identified. Draft Directives are prepared in the European Union to establish mandatory safety agencies and modality specific independent accident investigation agencies.

This evolution from technical-investigative and sector-specific committees into independent and interdisciplinary based diagnostic instruments for socio-technical systems yields a superior capability to enhance safety, provide a public voice advocating safety, provide transparency in the complexity of systems and contribute to a proper functioning of a civil society. The products of a fully evolved board may serve as input for risk decision making by private and public stakeholders in the management of complex systems during their design and operations. Safety boards may serve as 'problem providers' to other stakeholders in the system. Consequently, fully evolved boards may add to the learning potential of organisations. Moreover, they may serve the integration of safety in a systems safety approach at a socio-technical level.

Four safety Schools of Thought

Safety in modern transportation systems has been an issue for about 150 years. It evolved as a discipline from several different domains and disciplines and has a strong practical bias. Consequently, three 'schools of thought' have been established, which can be categorised as 'Tort Law School', 'Reliability Engineering School' and 'System Safety Engineering School' [4]. In addition a fourth school will be defined as 'System Deficiency and Change' [5].

Each of these schools represent a different pattern of thinking and can be considered as consecutive, representing the societal and scientific safety concepts of their times. They identify specific roles for accident investigation agencies.

Tort Law

The 'Tort Law School' as defined by McIntyre, has a long history and roots in the U.S. railway industry since the end of the 19th century. Out of this development, an engineering design approach emerged, focusing on certification and standardisation of technical designs and products. This development found its counterpart in 'forensic engineering', focusing on technical failure and fact-finding for the benefit of tort and litigation in liability issues concerning accident investigation, mechanical and structural failure of buildings, constructions and products [6]. The concept of failure is central to understand engineering, for engineering design has as its first and foremost objective the obviation of failure [7].

Reliability Engineering

Reliability Engineering became a new engineering school based on the problems of maintenance, repairs and field failures during the second World War. The drive to understand the likelihood of hardware malfunctions and errors, led to the adoption of Probabilistic Risk Assessment in many high-risk industries, among which the process industry and energy supply sector [4].
It was only a natural development that the focus of mechanical reliability engineering expanded to the area of the human factor, predicting human reliability. Cognitive aspects of human error, defining and operationalizing the concept of human failure, expanded from the technical aspects into organisational aspects of systems, examining the complex relation between organisational culture and safety.

Systems Engineering

The Systems Engineering school developed with the dawn of space transportation. This approach focused on accident prevention and was heavily supported by the development of safety standards, specifications and operating instructions. Several accidents in aviation underscored the need to draw a distinction between regulatory compliance for 'certification' and 'safety' when communicating risk to the public [4]. The sociologist Turner defined disaster by its social impact: a significant disruption of existing cultural beliefs and norms about hazards and their impacts. He expanded the technical systems approach into socio-technical systems. As a consequence of expanding scopes, attention should also pay attention to higher order systems levels and post-event consequences dealing with rescue, emergency and crisis management or administrative responsibilities, institutional constraints and policy decision-making and policy management issues. Demarcation lines between investigating major accidents and Parliamentary Inquiries become thin, implicitly restoring the concept of governmental blame.

<u>System deficiency and change</u>

In addition to these three 'schools of thought' a fourth school has emerged during the last decade. Based on the operational experience of Transportation Safety Boards throughout the world, a school of 'safety deficiency and system change' is developing [8]. In this school the concept of independence is crucial, separating the investigative mission and efforts from allocation of blame and vested interests of major stakeholders. This school does not longer focus on 'deviation' from a normative performance or on 'error', but refers to 'system deficiencies'. The focus is on safety critical characteristics of systems in their structure, culture, contents and context with respect to safety critical performance throughout their life cycle [9].

These characteristics can be identified and analysed, based on similarities with other systems, accident and incident data and single case studies. However, such a preventive, encompassing analysis is not always feasible in practice due to the complexity and dynamic nature of transportation systems and the lack of adequate information.

Therefore, a retrospective and independent investigation into systemic incidents, accidents and disasters is indispensable. Such independent investigations may provide a temporary transparency over the actual systems operational performance as a starting point for dealing with inherent deficiencies in such systems.

Independent investigations are considered a right of every citizen and a duty of society. They may put an end to any public concern and can help victims and their families come to terms with their suffering. In addition to learning lessons for the future, independent investigations make our actions transparent and help democracy to function properly [10].

<u>Diverging trends</u>

In retrospect, developments in the various schools of safety thinking have lead to divergence between transportation safety agencies and scientific safety thinking.

Several reasons for such a divergence can be observed:

- Divergence of expertise, experience and knowledge. Historically, accident investigation has been closely connected to technical failure of designs and objects. In their times, scientific notions of reductionism stimulated a strict distinction between research and investigation and fragmentation of scientific disciplines. Forensic engineering, by definition, restricts itself to a supportive expert role for litigation and legal court procedures [6[. The focus of safety boards followed the development of increasing operational complexity of transport systems and technological developments during design and construction, while its counterpart of governance and control developed towards liability and tort law, appointing responsibilities to operators and other stakeholders. The second and third school of thinking elaborated along these lines towards probability, reliability, prevention and societal impact of major events, shifting its focus towards quantification of risk and cost-benefit considerations, crisis and disaster, emphasising social, behavioural and managerial aspects rather than technological. At present, a need for systems integration and integral safety approaches, facilitates a shift in a reversed direction towards multi-disciplinary co-operation and co-ordination, creating the need for a fourth school of safety thinking and a reconsideration of the role of safety boards. A convergence seems immanent.

- Diversity of focus. In order to investigate complex accidents and draw lessons, safety boards have to focus their attention on the fact-finding phase of occurrences as the start of their investigation process. They have to provide a temporary transparency in complex systems, based on a single-event fact-finding missing. They are not involved in engineering design or certification processes and risk assessment decision making during design, construction or operations. They only have access to detailed knowledge and information once the ultimate test of integrated systems performance occurs during a major event. Their fact-finding strategies have a strong practical basis, in which simplified causation models and lack of structure in underlying factors rather hamper than support a realistic modelling of complex chains of events. Advanced scientific concepts of human performance, based on cognitive psychological principles, are only in their first phases of practical application by accident investigators [11], [12]. Notions of organisational failure and institutional constraints are in their early phases of development, competing each other and lack operational procedures and protocols during investigations. Moreover, analytical models for accident investigation, which are available presently, lack a systems concept, cover a specific range of problem areas or are not codified for more generic applications [13], [14].

<u>Divergence in rationalities</u>

It should be realised that actors involved in the investigations of safety boards may have fundamentally different notions of risk and may apply completely different rationalities [15].

During the conceptual design phase, projects and products are defined by a systemic rationality derived from physics, mechanics, engineering design principles and construction. This phase is linear and confined to specialists. The results of these design decisions are firstly and only exposed to an outsider view and judgement after the detailing phase during testing or operation. Risk perception of operators and users is based on a political and societal rationality. Such rationality is defined by interactions with other actors, negotiating and defining social reality in which operators have to cope with the complex and dynamic operational environment. Decisions made by commissioner and designer have led to a product which can be perceived by its physical appearances without revealing the inherent decisions of the earlier phases. Its operational performance can only be reconstructed by its physical appearance and behaviour as exposed to operators and users. The technology which is applied is therefore ‘to be discovered’ to actors during the operational phase, taking the earlier design decisions as incontestable facts. Characteristics of the design may manifest themselves during the operational phase by incidents, accidents or disaster. Transparency of safety aspects in both rationalities is a crucial issue since safety may be outbalanced and obscured by other interests of a higher order. Such interests may manifest themselves only after an independent investigation into major accidents [10].

Rationality of a designer and engineer focuses on realisation and is reasoning from goal and concept towards function and form. It follows a synthesising and decision oriented line of reasoning. Rationality of an operator and user focuses on perception and knowledge. It follows a line of reasoning from observation, perception, towards structure, function and goal. It is analytic and conclusion oriented.

To understand risks and safety issues two different lines of reasoning are available:

- an ‘inside-out’ vision of commissioners, designers, engineers and other actors which have an oversight of structure and contents of complex systems during their design, development and manufacturing. They are capable of defining complex interactions, couplings and causal relations within the system, risk management, mitigation and control included. They are less capable of dealing with the actual behaviour of the system in its dynamic social environment in terms of risk perception and risk acceptance issues.

- An ‘outside-in’ vision of operators, users, risk bearers, regulators, administrators and other stakeholders which have to cope with the system characteristics in its operational environment. They are capable of dealing with global risk notions and causal relations at an aggregated level, but lack an profound insight into the functioning of complex systems. They may concentrate on perception and acceptance rather than controlling risks.

An ‘inside-out’ vision is likely to define risk in terms of a program of requirements and standards, as a consensus document for the actual design and manufacturing. An ‘ouside-in’ vision is likely to define risk in terms of a defined reality among actors, negotiating risk as a ‘social construct’ to achieve consensus on perception and acceptance between stakeholders. If such a consensus is lacking during events with a high social impact such as disasters, a ‘battleground’ situation may occur, where actors dispute conflicting observations and perceptions.

A second diversion of rationality between accident investigation and scientific research should be taken into account as well. Investigators and researchers both apply a systematic and logic process of reasoning, but these processes have different characteristics.

- the investigative rationality has to deal with the complexity of a reality within yet unknown operating conditions, deals with non-repetitive occurrences and requires a multi-disciplinary involvement of experts. Research rationality deals with the relative simplicity of modelling reality, operates in a controlled environment, is submitted to requirements of repetitiveness, and requires in-depth involvement from one or few scientific disciplines.

- investigations have their starting point in reality, aiming at a fact-finding mission and reconstruction of a time line based sequence of events, focusing on a specific occurrence in its social environment, revealing decision making processes, actions and judgements of participants. Research has its starting point in theoretical expectations of a presumed behaviour of a phenomenon, applying formal logical methods and procedures in order to enable a generalisation of the findings under controlled conditions.

- investigations apply a toolbox of field observations, reconstruction, collection of tactical information on participants to the occurrence and may be supported by specific forensic techniques. Research applies a different type of toolbox, dealing with laboratory controlled experiments, mathematical modelling of phenomenon, controlled data sets, simulation and aims at verifying of falsifying hypotheses.

Consequently, diversity exists between a mission of investigators to establish accident scenarios and system deficiencies based on a robust fact-finding mission and event analysis, and scientists and stakeholders who are interested respectively in specific knowledge aspects, methods or actor-related and discipline-related outcomes of the investigation of the same event.

Convergence

A possible next step in the evolution of safety boards will be towards the role of public safety assessor [16]. Present safety boards already function as gatherers of information across stakeholders and actors. It is a small step into an information dissemination role as well. During the TWA 800 and Swissair 111 disasters, the NTSB and the Canadian TSB took a role of clearinghouse for informing the public and victim's relatives after the disasters. In the near future, safety boards may be seen as safety ombudsmen, the principal advocate for safety and appropriate care of accident victims [17]. They also may expand to the area of rescue and emergency issues, since modern safety boards have a mission in investigating relevant aspects before, during and after the event. TSB's may function as problem providers to other stakeholders in the system, requiring communication skills, risk assessment capabilities and safety management control options. A convergence with other system functions is emerging.

Operating in a multi-actor, multi-stakeholder and multi-rationality environment brings a necessity to reflect on notions and methodologies, which have been are applied in accident investigation. Differences exist across schools of thought, rationalities, sectors and scientific disciplines. If such differences are not recognised properly, accident investigation may take a form of crisis management rather than safety management, implicitly bringing back a notion of blame and liability.

Missions of modern safety boards: The mission of present independent safety board covers four principal objectives;

- determining preventable or mitigable causes of major accidents, disasters and catastrophes in transportation as well as other sectors, irrespective of blame and liability
- identify precursors to potential major events and systemic deficiencies
- increase safety by making acceptable and implementable recommendations
- assure public confidence in safety on a national or sectoral basis.

This mission distinguished TSB's from other investigative authorities such as in-company investigators, governmental accident investigation committees or parliamentary inquiries. The strength of a board for its mission comes from its independence, credibility and ability to address recommendations to any relevant party. Their responses to the board is not only based on a legal mandate of the board to demand timely responses to recommendations but also on the evidence that emerges from its investigations.

Primary working processes: To guarantee a successful mission, five primary working processes of boards have been identified in an international survey of best practices of multi-modal boards in the USA, Canada, Sweden and Finland and a number of single mode boards in the Netherlands.

These five processes of a safety board move the board from the decision to undertake an investigation of one or more accidents or incidents through the analysis of the events into formulations of recommendations to prevent or mitigate future accidents and finally to assessing the effects of those recommendations. Accompanying these actions are ongoing communications with the involved parties [18].

The processes can be characterised in a conceptual model as a benchmark for understanding the evolution of safety boards. The generic model identifies and links the five processes (see figure).

These five processes are:

1. an *initiation process* to decide whether to take action or not. A board obtains information about specific transportation accidents and incidents, as well as summary statistical information on transportation conditions and events and the results of research relevant to transportation safety. In the case of specific events, the board has a mechanism that helps it decide which events merit an intensive investigation.

2. A *fact-finding process* to assemble all relevant data bearing on an event and to determine findings about the main factors contributing to the event or general situation. There are three forms that the fact-finding may take: a reactive *event investigation* of an accident or incident constituting the majority of most boards efforts, a *retrospective safety study* to attempt to determine the factors associated with and preceding events or a *pro-active safety study* in which the board plans a research study that includes primary data collection of events as they occur.

3. A *safety deficiency identification process* that takes the facts at hand derived from single events or from safety studies, and determines systematic threats to transport safety. The safety deficiency identification process can use modern scientific tools such as pattern recognition, multivariate regression, functional decomposition, task analysis, dynamic systems modelling or can be based on operational experience or a combination of these two.

4. A *recommendation process* that formulates effective steps to prevent or mitigate the harms of accidents and incidents. These steps should be also economically and politically assessed in order to comply with their social acceptance and sustainable effects. The recommendation process may include considerations of how proposed actions might be implemented.

5. A *feedback process* that maintains contacts between the work of the board and the external public world. A central feature of this feedback process is a systematic monitoring of the recommendations of the board, both in terms of the actions taken in response to the recommendations and the effects of these actions on transportation safety.

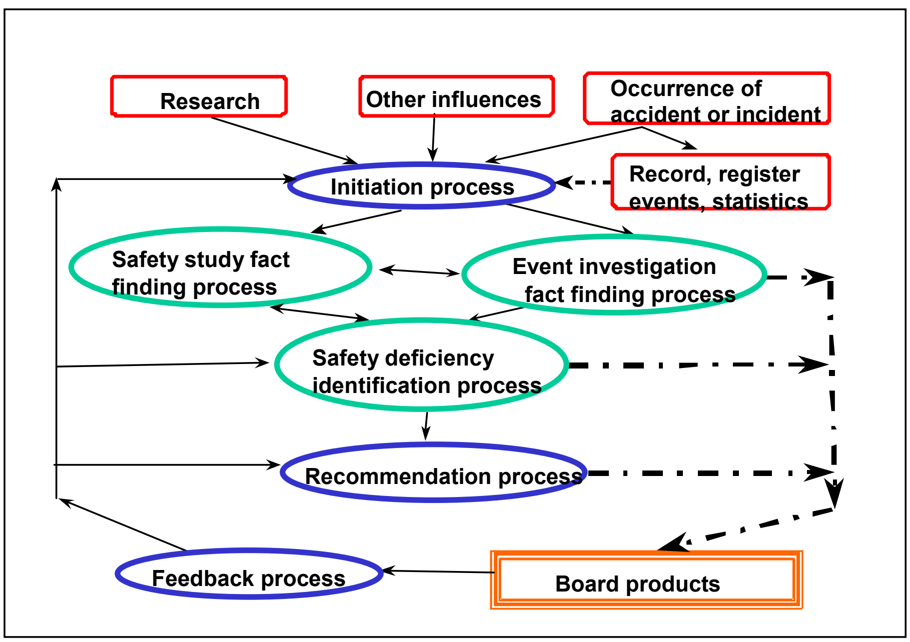

Figure - 1 Five processes define work of a board

Interfacing issues: In order to establish a working relation across investigators, researchers and stakeholders, a conceptual model of the accident investigation process has been established and the need for an investigation methodology has been recognised.

Such processes and methodologies should facilitate the required convergence between safety boards and their operating environment in view of their new missions and independent position.

A probe into the nature of the investigation process reveals several characteristics, which control the steps of the process and their interfaces:

1. the initiation process.
   This phase realises the transition *from symptom to syndrome*. In contrast with statistical and epidemiological analyses, which focus on isolated or specific contributing factors in accident causation, pattern recognition and trend analysis may reveal context specific combinations of factors that provide necessary and sufficient conditions for the causation of the event. This medical model refers to causation and context instead of correlation and may be applied to identify 'investigable' accidents by their type or classes. The transition from symptom to syndrome facilitates selectivity in the investigation process and may lead to safety studies of specific events or a single event investigation.

2. the investigation process.
   This phase defines the transition *from fact to factor*. Based on a fact-finding mission, the investigation derives a set of events in their time-dependent sequence, which together provide a satisfactory explanation of the occurrence. A wide variety of causation models and notions has been applied in practice, referring to 'underlying causes', 'contributing factors', 'primary' and 'secondary causes' etceteras. Taking into account the nature of the various schools of safety thinking, a categorisation of causality may be derived in four consecutive categories:

- deterministic causality. Related to the first school, this form of causality refers to a static relation between system characteristics. This causality has been applied in particular in engineering design, leading to design principles such as fail safe, crash worthiness, damage tolerance, containment, zoning, etc. This category relies on insights in failure modes and performance envelope parameters.

- probabilistic causality. This category has its roots in reliability engineering developments, referring to the probability of occurrences, related to RAMS principles and data analysis of past performance of similar systems. This category relies on sufficient data of similar nature, expert judgement and other sophisticated risk estimate tools.

- intentional causality. In view of the third school, a third category of causality was added to the scope of the investigation, dealing with motives for decision making. This causality distinguishes the investigation process from a judicial inquiry due to the fact that the focus in no longer on intentional and possible criminal behaviour, focusing on individual motives, means and opportunities to commit an act. However, normative notions are still frequently applied referring to human error at the operator level.

- situational causality. This category refers to the complexity and dynamic behaviour of systems under specific operational conditions, due to which accidents and incidents may occur. Unanticipated coincidences may occur due to a mismatch in synchronisation, commonly referred to as 'wrong time, wrong place' type of events.

These categories of causation however, refer to the phenomenon of 'cause' which still has an implicit normative notion of blame or liability. Consequently, it puts a 'burden of proof' on the agency that establishes the 'causes' of accidents, referring to similar mechanisms in forensic investigations and still bears similarities with judicial procedures. The concept of 'deviation' from an implicit normative standard is still present.

Therefore, to conduct independent investigations, a scientific method should replace the implicit judicial procedures and protocols. Due to the nature of the investigation process, a promising approach might be provided by a case-study methodology as defined by Yin [19]. The approach will serve as a starting point for the investigation process by fact-finding on the accident site of a single occurrence. Since such an approach will not be without theoretical framework, the data collection strategy will be provided by the systems concept, supported by forensic and analytic techniques. Theoretical assumptions are provided by a first definition of possible accident sequences, elaborated by further analysis, validation of data collection and additional scientific methods such as pattern matching, explanation building and time-line analysis. A satisfactory explanation of the occurrence should be the result, represented by one or a few accident scenarios.

3. the process of safety deficiency identification.
   This phase defines the transition *from deviation to deficiency*. In order to structure the identification of systemic deficiencies from the previous phase, systems modelling has to take place. Such a modelling should facilitate a satisfactory explanation of the overall systems safety performance and indicate where and how system characteristics have contributed to the safety deficiencies. Unfortunately, a comprehensive system modelling is not yet readily available for investigation purposes. In practice, a system modelling depends on the available models within various scientific disciplines. Theoretical models are developing, taking into account a systems level hierarchy, life cycle approaches, strategic decision making structures or engineering design processes [20], [21]. Remedies for enhancing system deficiencies are found in technological engineering design principles on a conceptual level and in specific intervention strategies, such as defence barriers, based on the model developed by Reason.

4. Drawing up recommendations.
   This phase defines the transition *from identifying explanatory variables to control variables.* Having a satisfactory insight into the origins of system deficiencies does not imply a control over their actual conduct. In any complex and dynamic system, constraints and conditions may be present, obstructing safety enhancement measures of any nature. Such variables may be of a natural origin or may be defined by institutional constraints or long term synchronisation problems across system life cycle boundaries. Technological or conceptual innovation in the systems structure, organisational culture or primary processes may be required in order to change the safety performance of the system. Historically, recommendations have primarily focused on elimination of causal factors, rather than on improving the learning potential of a system at higher organisational levels. A proper control over 'underlying factors' or 'secondary causes' should be related insights into the dynamic behaviour of the system regarding risk management strategies, regulatory and institutional levels in the system and eventually, societal values and norms.

5. Monitoring and feedback.
   This phase defines the transition *from control options to risk assessment and risk communication* in order to achieve cost-efficient and sustainable societal support for safety enhancement measures. It is debated whether or to which extend this transition is an intrinsic part of the investigation process itself in view of the required independence of the

investigations. It can be debated that an objective diagnosis of the occurrence and identification of system deficiencies does not include involvement in the actual implementation of the recommendations for systemic improvements and risk mitigation. However, the shift in focus and mission expansion indicates a trend towards further involvement of safety boards in this process. Such an involvement might require new qualifications and tools to accommodate such involvement in terms of risk assessment techniques, risk communication and expanding focus of the investigator towards all life cycle phases and operational processes of a system. Developing an investigation methodology may become necessary in the future to compensate for the accumulation of operational experience and knowledge of major players in the investigations. Changes in engineering design methodology with respect to collaborative and knowledge based engineering may put additional demands on the investigative skills.

At present the Canadian Transportation Safety Board explicitly applies the full scope of the 5 principal processes [22]. The goal of its ISIM methodology (Integrated Safety Investigation Methodology) is to strengthen the integration of the investigation, safety deficiency analysis and communication process. The methodology aims at helping investigators to identify risks in the transportation system by co-ordinating all aspects of the investigation process. The method emphasises the concept of iterative investigations, providing a way to maintain an overall understanding of an occurrence while on-going data collection, analysis, and communication are carried out. Consequently, the concept has abandoned the notion of a final report, discussing findings and recommendations in public.

Discussion and conclusions

A fundamental reason to introduce independent accident investigation was that parties involved began to realize that criminal law inquiries focus on allocating blame. To learn lessons for the future and to take steps to prevent similar accidents, it was essential to identify the causes of these accidents. Another type of investigation was thus needed. From a judicial point of view however, investigation methodology is restricted as the more useful tool for criminal intelligence analysis. It has strong ties with conventional 'forensic engineering' methodologies applied to determine liability for structural failure in engineering design. A clear distinction is made between various forms of logic reasoning, by applying either the notions of 'investigation' or 'research'. 'Research' based methodologies have been considered less useful for a fact-finding phase of investigations, since their inference do not go beyond the premises of their scientific discipline, not arriving at any new causes, conclusions or recommendations. In addition, the scope of criminal inquiries was restricted to discovering the direct cause of an accident and to identify an unacceptable deviation from a normative standard, not the underlying causes or systemic deficiencies. This was aggravated by the fact that suspects were permitted to withhold information not to incriminate themselves. Conventional accident investigation methodologies therefore, tended to focus on cause and not on prevention.

In adapting to changes in the working environment of TSB's, not only the products and methodologies of the boards are changing, their mission, role and position to other stakeholders are changing as well. TSB's might be assessed along lines of a product development cycle themselves. From a product life-cycle point of view, TSB's enter a next phase in their existence. Starting as a technical committee, focusing on causal and forensic aspects with a pre-event focus, they gained an influential and credible position within several transportation modes. In a second step, their scope expanded towards non-technical aspects and higher systems levels, such as human error, organizational failure, gaining independence from allocation of blame and governmental influence. In a third phase, external influences were incorporated in the TSB working processes such as rescue and emergency aspects, victim care and family assistance. In a next phase, TSB's might develop new mission elements, participating in a knowledge network, dealing with risk assessment approaches, communication with stakeholders and providing safety control options for stakeholders during design and operation of complex systems.

It may be concluded that independent Transport Safety Boards represent a distinct school of thought in accident investigation. Historically, they have strong relations with engineering design and identifying failure in technical systems. Transportation Safety Boards however are evolving towards a socio-technical systems approach. Several methodological issues are yet to be resolved to guarantee their independence, credibility and reputation as a qualified agency. Historically, the role of fact-finding and accident reconstruction has firmly been established in the relation to engineering design and operations in transportation. New sectors and scientific disciplines have emerged and working relations are established with other high-tech industrial sectors.

TSB's need to develop their own methodology to comply with the need to link the processes of fact-finding, establishing system deficiencies to the process of drawing up recommendations and implementing systemic changes. It may be necessary to combine these processes in an appropriate form, despite the fact that fundamental differences exist between risk notions, rationalities across actors, stakeholders, investigators and researchers and their objectives in an accident investigation process. It also clarifies the need for the Transport Safety Boards community to participate in an information infrastructure because TSB's will not be able to cover all required expertise on an in-house basis. It may be stated that in addition to a formal and functional independence, TSB's may also need to develop and maintain methodological independence.

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