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Review article
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INTEGRATED SAFETY INVESTIGATION METHODOLOGY (ISIM) – A SYSTEMATIC APPROACH TO ACCIDENT PREVENTION BY TRANSPORTATION SAFETY BOARD OF CANADA

During the past seven years (1990-1998), the Transportation Safety Board (TSB) of Canada, had investigated over 750 marine accidents and incidents (occurrences).
The analyses of these occurrences show that marine accidents, just like those in other industries, are the result of multiple causes and underlying factors. In any system operation, there is a complex interaction involving machinery, equipment, humans and the environment. Human and organizational factors are implicated in most accidents as underlying of contributing factors to the immediate causes of those accidents. In order for accident prevention strategies to be effective, an accident investigation must search beyond the immediate cause. This suggests a need for a much boarder system approach a look for contributing factors to the accident and underlying Safety Deficiencies1 (SD)[1] that pose a risk to life, property and environment. Hence, TSB developed the Integrated Safety Investigation Methodology (ISIM). The ISIM embeds the function of safety deficiency analysis into the investigation process, commencing with the assessment of the initial occurrence notification through to the effective communication of the identified risks to those who can influence the necessary change.
However, discussion in this paper is limited to the systematic evaluation of an occurrence to determine the root causes, contributing, and underlying safety deficiencies commonly found in TSB investigations.

1.TRANSPORTATION SAFETY BOARD AND ITS OBJECTIVES

A few words about the TSB; the Canadian Transportation Accident Investigation and Safety Board, commonly known as TSB, is a Canadian federal government agency mandated to improve transportation safety by:

[1] In the context of this paper, SD is defined as any inadequacy in the marine transportation system which could cause or contribute to the severity of an accident or incident

(a) conducting independent investigation, including, when necessary, public inquiries, in order to make findings as to their causes and contributing factors;
(b) identifying safety deficiencies as evidenced by transportation occurrences;
(c) making recommendations designed to eliminate or reduce any such safety deficiencies; and
(d) reporting publicly on its investigations and public inquiries and on the related findings;

TSB is independent of other government departments that regulate or operate elements of the marine, rail, commodity pipeline, and air transportation system. It is not the function of the Board to assign fault or determine civil or criminal liability, however the Board does not refrain from fully reporting on causes and contributing factors merely because fault or liability might be inferred from its findings.

The TSB's sole objective is to advance transportation safety which is predicated upon the identification of *Safety Deficiencies* and associated *risks*. As such, the investigations are carried out with the prime purpose of identifying *Safety Deficiencies* in transportation occurrences and to propose corrective safety action designed to eliminate or minimize risks associated with any such deficiencies.

2. TSB APPROACH TO ADVANCING TRANSPORTATION SAFETY

Generally, an investigation of any occurrence may have three main objectives:
(a) to find out "What happened?"
(b) to determine "Who did it?"; and
(c) to improve safety;

Traditional investigations, in the past, placed more emphasis on (a) and/or (b). Objective (a) will be met if the investigation can just determine the causes. In a traditional investigation, once the *immediate cause* of an accident is found, the process of investigation often stops without further examining the underlying factors and contributory conditions leading up to that *immediate cause*. Determination of *immediate cause* is useful in identifying who had the last opportunity to intervene and prevent the accident. However, it does little in terms of developing an understanding of the unsafe conditions which lead to the accident.

With objective (b), the investigation will be looking for who is to blame with a view to taking deterrent measures as well as establishing damage compensation and punishment (civil/criminal liability). For example, an investigation might conclude upon determining that a collision occurred because the master of the fishing vessel did not proceed at a safe speed. Possible underlying factors such as the requirement to maintain a tight sailing schedule, to take advantage of a per-trip fishing quota, or the need to work long hours resulting in fatigue due to a small complement, etc. were usually left undetermined. As such, cause determination or apportioning blame by itself would not do much to improve safety except with respect to its deterrent value.

Today, more and more investigations are conducted to learn from the accidents. As indicated above, the ultimate objective of TSB investigations is to *improve safety – transportation safety*. To that end, TSB investigations are conducted to identify inadequacies in the system which could cause or contribute to the severity of an accident or an incident.

3. WHAT IS "SAFETY" AND HOW CAN WE IMPROVE IT?

We all have our own understanding of what *Safety* is. However, for the purpose of this discussion, let us define *"safety"* one more time. The Oxford dictionary defines *"safety"* as *"freedom from danger or risks"*. Risk has two elements and is commonly defined as the product of the probability of an adverse outcome during a specific period of time and the severity of that outcome.

RISK = PROBABILITY X CONSEQUENCE

If we attach the units of measurement, the Risk equation may be written as follow:

$$\text{RISK}\left[\frac{\text{Impact}}{\text{Time}}\right] = \text{PROBABILITY}\left[\frac{\text{Event}}{\text{Time}}\right] \times \text{CONSEQUENCE}\left[\frac{\text{Impact}}{\text{Time}}\right]$$

Therefore, to improve safety means to eliminate or reduce risks. *Risk* can be treated by either reducing *probability* and/or by reducing the *consequences*. To do so, one must understand the causes and underlying factors that contribute to both elements of the RISK equation. If the focus of an investigation is only on the casual factors and on preventing "recurrence", it will limit the potential for safety improvement by not considering the second element of the risk equation - i.e. the *consequence*.

Many of us can think of an accident which had factors at play that were not causal, but that contributed to the severity of the outcome, the consequence. An obvious example would be inadequate lifesaving equipment and inadequate knowledge and training in marine emergency duties. Another could be design characteristics of a vessel that allowed a relatively minor incident to become a serious accident. Eliminating such deficiencies will do nothing to prevent a future accident, but it may significantly improve safety by reducing the severity of consequences.

4. INTEGRATED SAFETY INVESTIGATION METHODOLOGY - ISM

As a broad approach to minimizing risk in the transportation system, the TSB developed an accident investigation methodology, termed Integrated *Safety Investigation Methodology (ISIM)* which places emphasis on the identification of safety deficiencies in the system and the assessment of risks associated with such deficiencies. The ISIM process is systematically made up of several steps commencing with the assessment of the initial occurrence notification through to the effective communication of the identified risks to those who can affect the necessary change. (Figure (1)). However, for the purpose of this paper, only the following five important steps will be discussed:

1 Collection of occurrence data;
2 Analysis of occurrence events (determination of occurrence events & identification of safety deficiencies);
3 Risk Analysis,
4 Barrier (Defence) Analysis, and
5 Consideration of Risk Control option.;

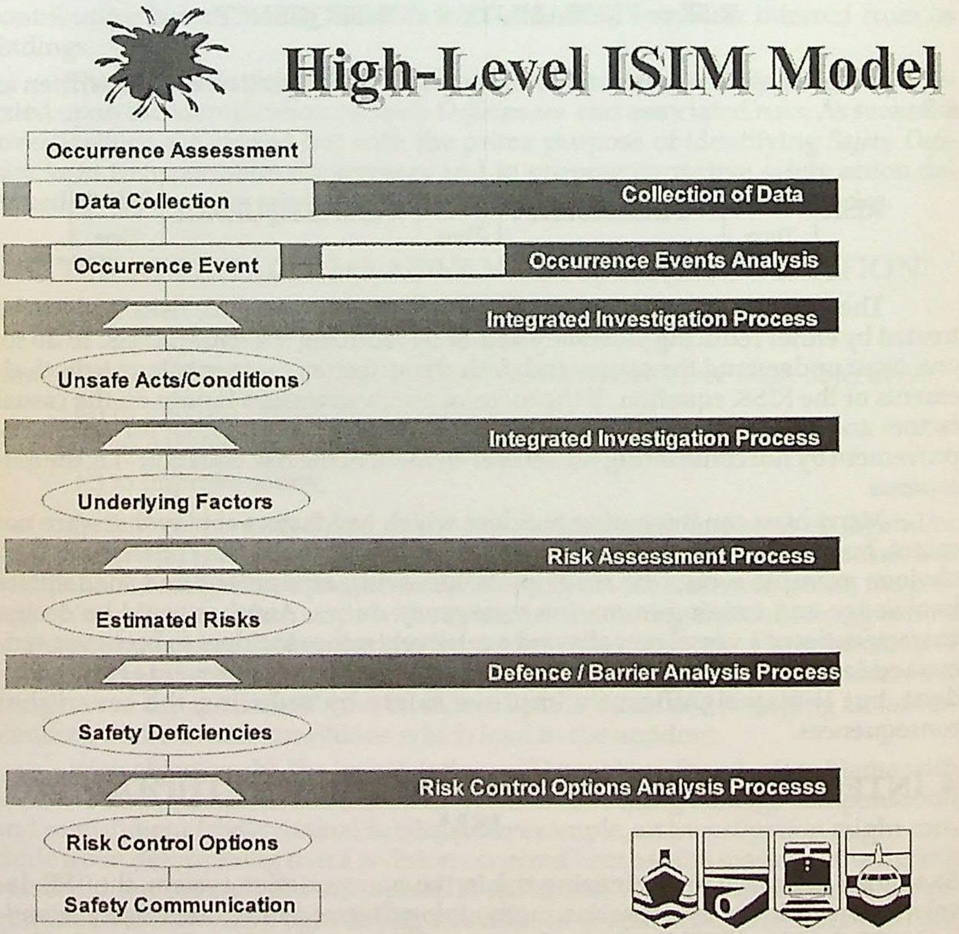

Figure (1) ISM Process Model

Collection of Occurrence Data

The first step in an investigation process is the collection of information regarding the personnel, tasks, equipment, and environmental conditions involved in the occurrence. A systematic approach to this step is crucial to ensure that a comprehensive analysis is possible to determine not only what, who and when" of the accidents but also "why and how" the accident happened.

To conduct an effective systematic data collection, the investigator must recognize from the outset than regardless of the type of accident, there are five core element that can play an interactive role in causing such accident; *Men, Machine, Medium, Mission, and Management*. Like any industrial operation, marine transportation is a complex operation system where *Men, Machine* (vessels, equipment, machinery, etc.), and *Media* (external and internal environments) interact in a confine of *Mission* (goals, needs, financial objectives, etc.) and *Management* (organization, policy, procedures, regulatory framework, fishery resource management, etc.). Often, Mission and/or Management factors influence the way Men interact with Machine in certain Media which may be unsafe. The analysis of shipping accidents over the past several years, indicate that while one or a combination of aforementioned 5 basic risk elements are generally present in all accidents, human and organizational elements play by far the biggest role in causing such accidents. Understanding the interrelationship of these elements can help the Safety Analyst in determining all the relevant causes and contributing factors of accidents. For a complex system, such as a ship, where there are numerous interactions between the component elements, there is constant danger that critical information will be overlooked or lost during an investigation.

One technique used to gain knowledge about the interrelationship of these elements in a system is a framework termed the SHELL model that was developed by Professor Edwards in 1972, and later modified by F.H. Hawkins. Although the SHELL model was intended as a tool for human factors studies, it also serves as an effective tool for data collection. The *"L"* block representing LIVEWARE, or human element, is the centrepiece of the model. The human component interacts directly with each of the other building block namely SOFTWARE *(S)*, HARDWARE *(H)*, ENVIRONMENT *(E)*, and the second component of LIVEWARE.

The LIVEWARE interacts with the HARDWARE (the machine component, which could be a vessel, an engine, or any piece of equipment).

To operate a vessel, or a machine, humans have to use SOFTWARE (written or computerised information) such as equipment manuals and instructions, standing orders, operating procedures, nautical charts, etc. The interaction between LIVEWARE and such SOFTWARE is an important factor for the safe operation of the vessel and machinery.

The third interface is that between and individual and their ENVIRONMENT; internal or external. Human performance can be impaired by factors of external environment such as climatic conditions, ship motions induced by sea states, visibility, noise, vibration, etc. Performance of ship crews can equally be affected by the internal environment such as excessive heat, noxious fumes or gaseous vapours in engine-rooms.

Finally, individuals interact with other individuals (LIVEWARE). Human interaction occurs at various levels of the operation: communications among bridge personnel, bridge-to-bridge, vessel traffic service centres, coast guard radio station, master and crews, pilot and master, ship crews and company management, etc. Problems with this interface could lead to inefficiency, misrepresentation, miscommunication or breakdowns in communication.

In marine environment, vessels and equipment should be designed, installed and maintained for the environmental conditions (wind, wave and ice) they are required to function. As such, it is useful to consider the interface between Environment and the Hardware. The model in Figure (2) depicts this Hardware – ENVIRONMENT interface.

In this SHELL model, each component has the shape of a block whose edges are not straight and possess a unique contour, suggesting that these factors may not have a perfect interface.

The use of the *SHELL* model as an organizational tool for the investigator's workplace data collections helps avoid downstream problems because:

- it takes into consideration all the important work system elements;
- it promotes the consideration of the interrelationships between the work system elements; and,
- it focuses on the factors which influence human performance by relating all peripheral elements to the central liveware element.

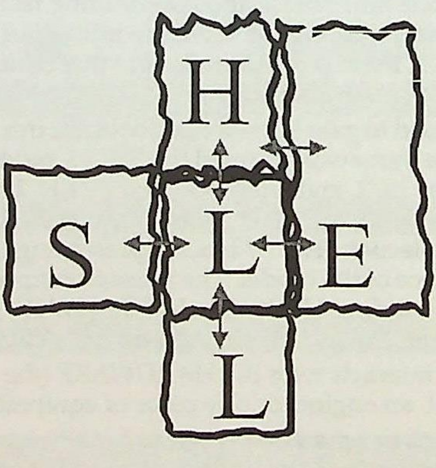

Figure (2) SHELL Model (Modified to include Hardware – Environment interface)

At this data collection stage, the investigator initially attempts to answer the more simplistic question concerning "what, who, and when" and then moves to more complicated questions of "how and why". The resulting data becomes, for the most part, a collection of events and circumstances comprised of acts and conditions. Some of these will be of interest as unsafe acts and unsafe conditions.

Analysis of occurrence events:

Having completed the task of collecting all relevant information surrounding an occurrence, the investigator must make judgements in analysing the data to arrive at meaningful and supportable conclusions. This process can be better defined in two stages as follows:

i. determination of occurrence sequence &
ii. identification of safety deficiencies

i. Determination of Occurrence Sequence
Events and Underlying Factors (E&UF) Analysis

This concept of accident investigation is not new and is based on the principle that accidents rarely result from a single cause; rather, they are generally multi-factorial and develop from defined sequences of events. The events are portrayed graphically by arranging them, chronologically left to right in rectangles, in a logical flow indicating 'what' happened. The entire sequence of events is built from the beginning of occurrence development to the actual end circumstance. (Figure (3)). Each event describes a single, discrete happening or an action step in a sequence of happenings/actions that lead to the occurrence. Each event block should contain the time and date of the event when available.

ISIM's E&UF analysis is a structured technique which forces the investigator/analyst to systematically and logically document the events in a graphical format to arrive at causal and contributory factors. The benefits of this simple technique include:

- Clarifies reasoning;
- Illustrates multiple causes;
- Provides a cause-oriented explanation (the Why?) of the accident thus helping investigators to formulate most pertinent investigative questions;
- Aids investigators in ensuring the completeness of the investigation through the identification of each event deriving logically from the one proceeding it; and
- Aids in developing all causal and contributing factors through sequence development, i.e. the basis for more in-depth analysis.

During the process, the investigation team will identify safety significant events worthy of further investigation/analysis. Safety significant event is an event which has a potential to reveal unsafe conditions and underlying factors.

ii. Identification of Safety Deficiencies
Determination of causal, contributing and underlying factors

In order to understand the "how and why" of the accident, the investigators need to identify and document not only the events themselves, but also the relevant conditions, unsafe acts, practices and underlying factors affecting each event in the accident sequence. Once the graphical representation of the sequence(s) of events is complete, the investigators will select events that have safety significance for further investigation/analysis to determine if there are other unsafe acts or unsafe conditions associated with it. The analysis of each event continues until the root causes or underlying factors to that event have been determined.

Since its inception in 1990, TSB has systematically analyzed its investigative findings to arrive not only at the proximate causes but to understand the contributory and underlying factors that caused the accidents. It has been found that the majority of marine accidents can be traced back to compounded human and organizational factors. This finding is consistent with findings from many shipping nations around the world in that human and organizational factors are recorded as causal of contributing factors in most marine accidents. According to the UK P&I Club of Insurers report on the "Analysis of Major Claims - 1992", human error was the main cause of half the cargo claims, half the pollution claims, 65% of the personal injuries, 80% of the property damage, and 90% of the collisions.

Today, several models, analytical tools, and techniques exist to assist the investigator/analysis in analyzing accident causation not only for the purpose of understanding "WHAT" happened but also "HOW and WHY" it happened, by establishing the root causes, contributing factors and or underlying safety deficiencies to the accident. A brief description of such models/technique is given below.

Reason's Model

One such model was developed by Dr. James Reason of the University of Manchester. While some analysts refer to this as the *"Swiss Cheese Model"*, it is much better known as *"Reason's Model."* (Figure (4). TSB safety analysts in all modes of transportation often use this model. The second layer represents unsafe act(s) committed by front-line operator. Fortunately, a well designed system has built-in defences (the first layer in the model), structural or otherwise, to mitigate the circumstances of such unsafe acts. But the model requires us to look beyond the immediate circumstances of the accident. It will force the user to examine all the preconditions at the time of the occurrence, including such things as fatigue, stress, operating practices, etc. The fourth layer represents the effects of line management in such areas as training, maintenance, operating procedures, etc. The fifth layer depicts the involvement of high level decision makers such as regulators, owners, the designers, manufacturers, and the unions, etc. Reason suggests that these decision makers frequently make "fallible" decisions and these latent defects stay dormant waiting for someone to commit an unsafe act and thereby triggering a potential accident scenario. If the system's defenses function as intended, a result is benign; if they do not, the result may be a tragic accident. Reducing or eliminating safety deficiencies can be represented by a reduction in the size or number of holes, and thereby reducing the probability of an accident. The Reason Model is particularly useful in illustrating the concept of multiple causality.

Integrated Process for Investigating Human Factors (Integrated Process)

TSB has developed this process that provides a step-by-step systematic approach for use in the investigation of human factors. The process is an integration and adaptation of a number of human factor frameworks - SHELL (F.H. Hawkins, 1987) and Accident Causation and generic error-modelling system (GEMS) frameworks (J. Reason 1990). The GEMS framework is used to determine the origin of a particular act or causal condition - Figure (5)). At the moment, human performance analysts at TSB use this model to identify underlying human and organizational factors by identifying error types, failure mode and behavioural antecedents. However, TSB investigators/analysts are being gradually trained to become adequately familiar with evaluating human behaviour and human performance.

For the scope of this paper, it is sufficient to recognize that to uncover the underlying causes behind the decision of an individual or group, it is important to determine if there were any factors in the work system that may have facilitated the error and the unsafe act.

Other Analytical Techniques

There are several other analytical tools that may be used to identify causal factors, contributing factors, and underlying safety deficiencies to an accident. In the nuclear industry, the MORT (Management Oversight Risk Tree) analysis technique is widely used and in considered the most comprehensive techniques. MORT analysis used a diagram which contains a comprehensive list of *system operation factors* and *management control system factors* that an ideal safety program or organization should possess. Each factor and activity under investigation is compared, element by element, with the system, facility, and activity of the MORT elements. When any MORT elements are missing, or are only partially present in an existing system or program, it is considered that deficiencies probably exist which contributed to or could contribute to accidental losses.

The principle of the Fault Tree Analysis (FTA) may also be used where appropriate. FTA is a technique, either qualitative or quantitative, by which conditions and factors that can contribute to a specified undesired event (called the top event) are deductively identified, organized in a logical manner, and represented pictorially. The faults identified in the tree can be events that are associated with component hardware failures, human errors, or any other pertinent events that lead to the undesired event. Starting with the top event, the possible causes or failure modes on the next lower functional system level are identified.

Risk analysis

Once the analysis has revealed underlying factors related to the safety significant events of the occurrence, it is important to understand the level of risk associated with that event or underlying factors. The level of risk is one of the most important criteria that an investigation team uses in setting investigative efforts and priorities.

Risk is a consideration in every decision made regardless of the role of the person making the decision. This consideration may be conscious or unconscious, formal or informal. The purpose of the Risk analysis is to estimate and evaluate risk potential associated with the identified unsafe conditions/underlying safety deficiencies. Many of the unsafe conditions, underlying factors and/or safety deficiencies identified through aforementioned processes may be neither casual nor contributory to that occurrence. Nevertheless, the potential risks these deficiencies pose on the system must be assessed and addressed in the interests of accident prevention. As discussed earlier, *risk* is the product of the probability of an adverse outcome during a specific period of time and the severity of that outcome. As such, evaluation of risks is undertaken using available data, supported by judgements on the severity of potential adverse consequences and the probability of those consequences during any defined period of time.

In evaluating the probability, the investigators will consult with various databases to determine if there is a history of similar occurrences or if it is an isolated occurrence. The investigators must also consider the extent of risk a particular system or an operation is exposed to. The answers to some of the following questions can assist investigators in assessing the probability of adverse outcome:

- Is there a history of occurrences like this or is this an isolated occurrence?
- How many similar occurrences where there under similar circumstances in the past?
- What system defenses need to fail for the adverse consequence to be realized?
- How many pieces of equipment or vessels are there that might have similar defects?
- How many operating of maintenance personnel are following or are subject to the practices or procedures in question?
- To what extent are there organizational, management, or regulatory implications which might reflect larger systematic problems?
- What percentage of the time is the suspect equipment or the questionable procedure of practice in use?

For the second element of the risk equation, the impact of the occurrence on people (individual, societal, occupational, etc.), property, environment, and often on commercial and other intangible elements must be considered, as follows:

How many persons could be affected by the risk?

- Fare-paying passengers?
- Transportation employees?
- Bystanders or general public?

Property:

- What could be the extent of further property damage?
- Direct property loss to the operator?
- Damage to adjacent infrastructure?
- Third-party collateral damage?

Environmental:

- What could be the environmental impact?
- Dangerous commodity spill?
- Physical disruption of natural habitat?

Commercial:

- What is the potential impact on carriers?
- On commercial operations?
- Corporate viability?
- Financial markets?

Others:

- What could be the public and media interpretation?
- What might be the implications:
- Internationally?
- Nationally?

Once the probability and severity of adverse consequences have been analysed, investigators can evaluate the risk. Various agencies and industries uses numerous qualitative as well as quantitative criteria against which a level of risk can be estimated. Qualitative risk analysis uses expert opinion to evaluate the probability and consequences. Qualitative method offers analysis without detailed information, but the intuitive and subjective processes may result in differences by those who use them. Quantitative analysis generally provides a more uniform understanding among different users, but requires quality data for accurate results. Qualitative analysis is considered sufficient for the purpose of TSB.

Barrier (Defence) analysis

Barrier analysis is based on the principle that the absence of adequate barriers (whether they be physical and administrative) for preventing any harmful "contact" between *hazards* and *vulnerable persons or property* is found in every accident. The purpose of the Barrier analysis is to examine the status of barriers and to identify those that are less than adequate. Defenses/barriers, in the context of this methodology, are barriers/guards that isolate and protect persons, property, and environment (targets) from hazards. Barriers may be divided into two categories:

- *Physical defenses/barriers:* (such as guards, personal protection devices, life rafts, life jackets, etc.), and
- *Administrative defenses/barriers:* (such as training, safety regulations, policies, procedures, supervision, inspection, maintenance, safe system design, system support services, operational & personal readiness, etc.)

A worksheet may be used as a job aid to identify hazards, targets (person, properties, etc.), barrier and the status of the barrier before and after the accident; (e.g. *Were barriers provided? Were they used? Did they fail or did they function as intended? Has their presence been "advertised" to system and operators?)*

In fact, some degree of barrier analysis should be done at all level of the investigation process. The information on the status of both physical and administrative barriers must be collected during the data collection phase. Analysis of the defenses will lead to a better understanding of the safety issues, unsafe conditions and underlying factors associated with an occurrence.

Consideration of Risk Control options

Risks can be minimized by a wide range of control options normally available for any risk control situation. Some control measures are more effective than the other. One of the important aspects of risk management is to ensure that the full range of possible control measures is considered and that the optimal trade-offs between measures are made.

As we all know, risk can usually be addressed in one or the combination of four ways:

- Terminate risk;
- Transfer risk;
- Treat risk;
- Tolerate risk.

It is obvious that preference should be given to developing safety measures that will completely eliminate the deficiencies to prevent similar adverse consequences in the future. Regrettably, such solution are often the most expensive and are often impossible. In such situations, some organizations may decide to tolerate certain degree of risk as a result of hazard analysis or as a result of a cost-benefit analysis. In such cases, an investigator should determine the adequacy of the rational and the extent of risk that is assumed by the organization. Risk can also be transferred to someone else, such as an insurer, for a price. But, since this is a safety conference, we are not interested in transferring the risk to someone else. In most cases, where the risk associated with potential safety deficiencies cannot be eliminated in a complex system, the risk to the system may be treated by building one or more of the following defenses/ barriers in the system[2]:

- Designing for minimum hazards;
- Installation of safety devices;
- Provision of warning devices, sign, placards, etc;
- Establishment of procedures and practices;
- Provision of training and awareness.

Some argue that the sole use of administrative interventions, such as procedures and training, may not provide an effective hazard control method in certain circumstances, especially when the level of risk is very high. Rather, the use of administrative interventions in conjunction with engineering interventions, such as designing for minimum hazards, may be more appropriate. In keeping with the "depth in defense" philosophy for complex systems, the use of multiple interventions is often desirable where multiple and diverse lines of defense are employed to mitigate risks.

In Canada as in many other countries, TSB (as the investigation agency) does not have the mandate or authority to implement specific corrective actions. Such actions are taken by the regulatory agencies, and by the industry such as manufacturers, the operating companies, etc. The TSB's role is to identify risks and potential risks associated with system deficiencies and make a convincing argument for others to take corrective actions.

5. CONCLUSION

I hope I have succeeded in explaining that in order for the accident prevention strategies to be effective, they must be based on an in-depth understanding of the safety deficiencies in the system.

It is our experience that human and organizational factors play an important role in overall system safety. Meaningful analysis of the people of the system can help us understand underlying human and organizational factors so that appropriate safety action can be taken to minimize the human contributions to risk. However, humans have more failure modes and are far less predictable than machinery or equipment. Accurately determining human reliability is extremely difficult. Yet, accident prevention is critically linked to the adequacy of the investigation of human performance issues. I am optimistic that a systematic and broad approach to minimizing risks through the use of modern investigation techniques, such as ISIM, will help us improve the safety record of the marine transportation system in and out of Canadian waters.

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[2] While there are some disagreements as to the order of effectiveness in intervention (known as "safety procedence sequence"), safety professionals are unanimous in proposing these defences/barriers.

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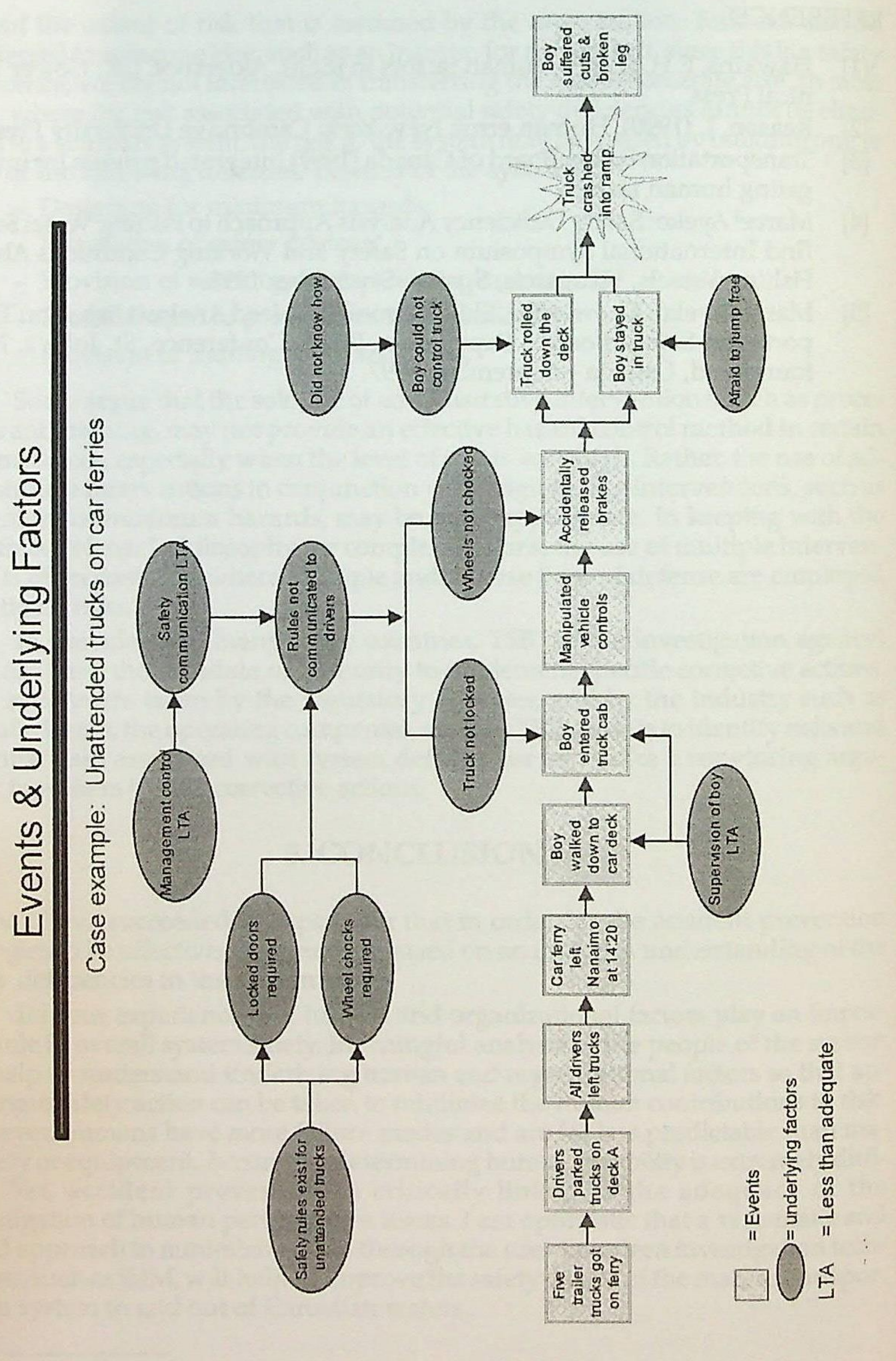

Figure (3) Events & Underlying Factors Diagram

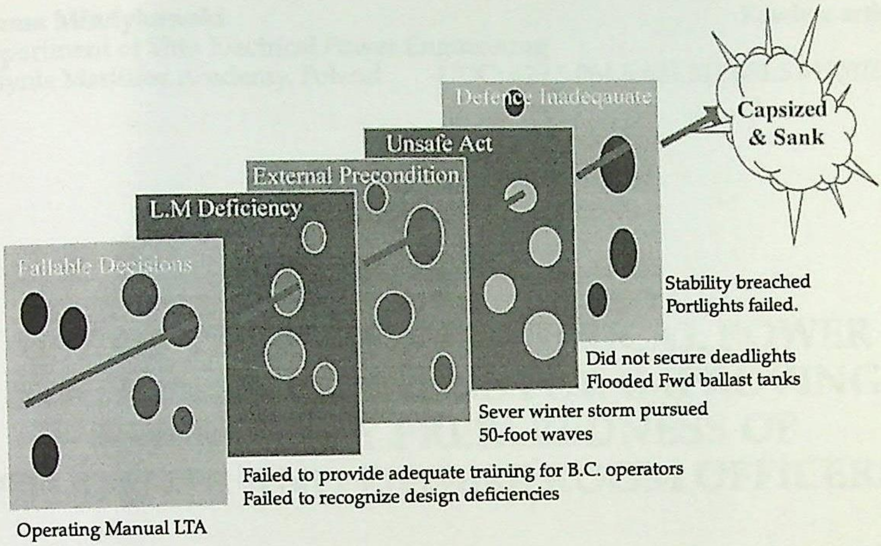

Figure (4) Reasons's Model
Case example on the sinking of the "OCEAN RANGER

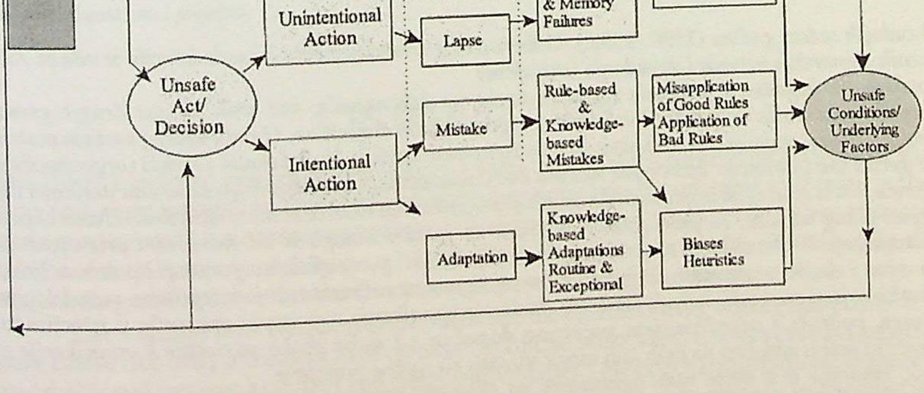

Figure (5) Generic Errors Modeling System (GEMS)

Sažetak

INTEGRIRANA METODOLOGIJA ISTRAŽIVANJA SIGURNOSTI – SUSTAVNI PRISTUP SPREČAVANJU NESREĆA ODBORA ZA SIGURNOST PROMETA KANADE

U zadnjih sedam godina (1990.-1998.), Odbora za sigurnost prometa Kanade istražio je više od 750 raznih pomorskih nesreća i događanja (slučajeva).
Analiza tih događanja pokazale su da je do pomorskih nesreća, kao onih unutar drugih grana gospodarstva, došlo zbog različitih uzroka i odgovarajućih čimbenika. U radu svakog sustava postoji kompleksna interakcija koja uključuje strojne komplekse uređaja, ljude i okoliš. Ljudski i organizacijski čimbenici implicirani su kod većine nesreća kao čimbenici koji su potpomogli stvarnim uzrocima tih nesreća. Da bi strategija izbjegavanja nesreća bila učinkovita, nesreća se mora istraživati i izvan okvira neposrednog uzroka. To pretpostavlja potrebu za jednim mnogo širim sustavnim pristupom za pronalaženje čimbenika koji su pridonijeli nesreći, ističući pomanjkanje sigurnosti što dovodi život, imovinu i okoliš u opasnost. Stoga je Odbor za sigurnost prometa razvio integriranu metodologiju istraživanja sigurnosti, koja je funkciju analize pomanjkanja sigurnosti pretvorila u istraživački proces, počevši s određivanjem početnog događanja i dalje preko postojeće komunikacije o identificiranim rizicima do onih koji mogu utjecati na nužne promjene.
Ipak, rasprava je u ovom radu ograničena na sustavno vrednovanje pojedinog slučaja, kako bi se odredilo porijeklo uzroka i time pridonijelo otkrivanju pomanjkanja sigurnosti na koje se često nailazi pri istraživanju koje provodi Odjel za sigurnost prometa.