THE INFLUENCE OF TEAM ERRORS IN MARITIME SAFETY

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SUMMARY
In error analysis or error management, the focus is usually upon individuals who have made errors. In large complex systems, however, most people work in teams or groups. Considering this working environment, insufficient emphasis has been given to “team errors”. This paper discusses the definition of human errors as team errors and these notions are also applied to events that have occurred in the shipping industry. The paper also discusses the relations between team errors and Performance Shaping Factors. As a result, the proposed definitions are found to be useful in categorizing team errors. The analysis also reveals that deficiencies in communication, resource/task management, excessive authority gradient, excessive professional courtesy will cause team errors. Handling human errors as team errors provides an opportunity to reduce human errors.

1. INTRODUCTION
It has been estimated that up to 90% of all workplace accidents have human error as a cause. Human error was a factor in almost all the highly publicized accidents in recent memory, including capsizing of the Herald of Free Enterprise. Some industries, notably health-care, experience long-term, continuous exposure to human error. The costs in terms of human life and money are high. Placing emphasis on reducing human error may help reduce these costs.

Most human work is performed by teams rather than individuals. This is particularly true complex technologies such as shipping industry. There are many advantages in teamwork, perhaps the most important is the provision of mutual aid. One member can help another when he/she is busy, or about to mishandle an operation, or when a bad decision has been, or is about to be made. Team members can divide their work among themselves to promote efficiency and economy of effort. However, while teamwork can detect and recover errors and it can also create errors.

2. HUMAN ERRORS
Most people would agree with the old adage “to err is human”. Most too would agree that human beings are frequent violators of the “rules” whatever they might be. But violations are not all that bad, through constant pushing at accepted boundaries they got us out of the caves!

As it is inevitable that errors will be made, the focus of error management is placed on reducing the chance of these errors occurring and on minimizing the impact of any errors that do occur. In large scale disaster, the oft-cited cause of “human error” is usually taken to be synonymous with “operator error” but a measure of responsibility often lies with system designers.

To find a human error is necessary to identify active and latent failure in order to understand why mishaps occur and how it might be prevented from happening again in the future.
As described by Reason, active failures are the actions or inactions of operators that are believed to cause the accident.

In contrast, latent failures are errors committed by individuals elsewhere in the supervisory chain of command that effect the tragic sequence of events characteristic of an accident.

The question for mishap investigators and analysts alike, is how to identify and mitigate these active and latent failures. One approach is the “Domino Theory”, which promoted the idea that like domino’s stacked in sequence, mishaps are the end result of a series of errors made throughout the chain of command.

1.1. VIOLATIONS AND ERRORS
Assuming that the rules, meaning safe operating procedures, are well founded, any deviation will bring the violator into an area of increased risk and danger. The violation itself may not be damaging but the act of violating takes the violator into regions in which subsequent errors are much likely to have bad outcomes.

The resultant situation can sometimes be made much worse because persistent rule violators often assume, somewhat misguided, that nobody else will violate the rules, at least not at the same time! Violating safe working procedures is not just a question of recklessness or carelessness by those at the sharp end.

Factors leading to deliberate non-compliance extend well beyond the psychology of the individual in direct contact with working hazards and include such organizational issues as:
- the nature of the workplace
- the quality of tools and equipment
- whether or not supervisors or managers turn a “blind eye” in order to get the job done
- the quality of the rules, regulations and procedures
- the organization’s overall safety culture, or indeed its absence.
1.2. UNSAFE ACTS AND PRECONDITIONS

A brief description of the major components and causal categories follows beginning with the level “nearest” the accident – unsafe acts. The unsafe acts committed by operators generally take on two forms, errors and violations. The unsafe acts operators commit can be classified among three basic errors types and two forms of violations. The basic error forms are:

- Decision Errors – this is one of the more common error forms, represent the actions or in-actions of individuals whose heart is in the right place, but they either did not have the appropriate knowledge available or just simply chose poorly.
- Skill-based Errors – is best described as those basic operating skills that occur with little or so significant conscious thought, are particularly vulnerable to failures of attention and/or memory.
- Perceptual Errors – when your perception of the world is different then reality, errors can, and often do, occur, like visual illusions or spatial disorientation.

Violations in general are defined as the willful departure from authority and are two distinct types of violations, as:

- Routine/Infractions – tend to be routine/habitual by nature constituting a part of the individual’s behavioural repertoire and can be further broken down in: routine violations, optimizing violations and situational violations.
- Exceptional – appear as isolated departures from authority, not necessarily indicative of an individual’s typical behavior pattern, nor is it condoned by management.

Preconditions for unsafe acts are described by two major subdivisions: substandard conditions of operators and substandard practices of operators.

The substandard conditions of operators are categorized as:

- Adverse Mental States – those mental conditions that affect performance;
- Adverse Physiological States – those medical or physiological conditions that preclude safe operations;
- Physical/Mental Limitations – those instances when the task requirements exceed the capabilities of the individual at the controls.

The substandard practices of operators are categorized as:

- Crew Resource Mismanagement – often the substandard practices of the team will lead to the conditions and unsafe acts;
- Personal Readiness.

Till now we presented the errors as individual error. But, in most cases the work is done in a team organization that means many persons.

Below we’ll try to present the errors made as “team errors”

2. TEAM ERRORS

Team error is one form of human error. The difference is that team error considers how a group of people made human errors when they work in a team or a group. Then we can define team error as human error made in group processes. Reason categorized human errors into three types: mistakes, lapses and slips. Mistakes and lapses arise in the planning and thinking process, whereas action slips emerge primarily out of these execution processes. Mistakes and lapses are more likely to be associated with group processes. Slips are errors in the action process of a single individual and are likely to be divorced from the activities of the team as whole.

2.1. THE ERROR MAKING PROCESS

**Individual errors** – are errors which are made by individuals. That is, an individual alone makes an error without the participation of any other team member. Individual errors may be further sub-divided into independent errors and dependent errors. Independent errors occur when all information available to the perpetrator is essentially correct. In dependent errors, however, some part of this information is inappropriate, absent or incorrect so that the person makes an error unsuitable for a certain situation.

**Shared errors** - are errors which are shared by some or all of the team members, regardless of whether or not they were in direct communication. Like individual errors, shared errors may also be sub-divided into two categories: independent and dependent.

2.2. THE ERROR RECOVERY PROCESS

The error recovery process may fall into any one of three stages: detection, indication and correction.

1. Failure to detect – the first step in recovering errors is to detect their occurrence. If the remainders of the team do not notice errors, they will have no chance to correct them. Actions based on those errors will be executed.
2. Failure to indicate – once detected, the recovery of an error will depend upon whether team members bring it to the attention of the remainder. This is the second barrier to team error making. An error that is detected but not indicated will not necessarily be recovered and the actions based on those errors are likely to be executed.

3. Failure to correct – the last barrier is the actual correction of errors. Even if the remainder of the team notices and indicates the errors, the people who made the errors may not change their minds. If they do not correct the errors, the actions based on those errors will go unchecked.

3. TEAM ERRORS AND PERFORMANCE SHAPING FACTORS (PSFs)

3.1. PERFORMANCE SHAPING FACTORS AND THEIR ESTIMATION
The next question is why team errors are made. An error is usually the result of some influencing factors which are called Performance Shaping Factors. Generally, there are two kinds of Performance Shaping Factors: External Performance Shaping Factors and Internal Performance Shaping Factors. These two kinds are probably enough to discuss why individuals made human errors. However, as described before, most human work is performed by teams rather than individuals. Especially when the remainder of a team failed to indicate or correct individual or shared errors in spite of their notices, there must have been influences of human relations between them. For that, has identified three classes of Performance Shaping Factors: external, internal and team performance shaping factors.

External Performance Shaping Factors are, for example, darkness, high temperature, excessive humidity, high work requirement. These factors are shared by people working within the same working environment.

Internal Performance Shaping Factors include high stress, excessive fatigue, deficiencies in knowledge, skills and experience. There are ideas that the internal PSFs are results of external PSFs. Although internal PSFs are not necessarily independent of external PSFs, the adverse impact of an external PSFs depends, in part, upon the individual.

Team Performance Shaping Factors are defined as factors arising from a group of people working together on a common project or task. They include lack of communication, inappropriate task allocation, excessive authority gradient, over-trusting and others. It could be argued that team PSFs is a subset of internal PSFs. However, it is believed that the purposes of this study are better served by treating them as separate categories.

3.2. RELATIONS BETWEEN PERFORMANCE SHAPING FACTORS AND TEAM ERRORS
In order to identify why teams make team errors, it is probably best to see the relation to the categories defined earlier. As described above, the data have biases so that some categories are largely unrepresented. Accordingly, we will focus upon the relations between Performance Shaping Factors and individual errors, shared errors, failures to detect or failure to indicate and correct combined.

3.3. SHARED ERRORS AND PERFORMANCE SHAPING FACTORS

1. Shared errors and external PSFs

<table>
<thead>
<tr>
<th>External PSFs</th>
<th>Shared errors</th>
<th>Individual errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seriousness</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Deficiency in human machine interface</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>High workload</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Deficiency in procedures</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Deficiency in training</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>High level activity</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Routine task</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Regulation</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Time pressure</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Insufficient visibility</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>100(%)</td>
<td>100(%)</td>
</tr>
</tbody>
</table>

Table 1. External PSFs observed in the shared and individual errors

Table 1 shows the external PSFs associated with shared errors and individual errors. Major differences were not found between the external PSFs provoking the shared and the individual errors. This table suggests that deficiencies in the human machine interface exert a larger influence upon shared errors.

2. Shared errors and internal PSFs

<table>
<thead>
<tr>
<th>Internal PSFs</th>
<th>Shared errors</th>
<th>Individual errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficiency in knowledge/experience</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>High arousal</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>Low situational awareness</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>Low task awareness</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Excessive adherence/over-reliance</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Inadequate attitude</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Low confidence</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Others</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>100(%)</td>
<td>100(%)</td>
</tr>
</tbody>
</table>

Table 2. Internal PSFs observed in the shared and individual errors

Table 2 shows the internal PSFs associated with shared errors and individual errors. Low situational awareness, low task awareness and excessive adherence (on their
own ideas, opinion, decisions, actions)/over-reliance (on indicators, warnings) are observed more frequently in the shared errors than in the individual errors.

3. Shared errors and team PSFs

<table>
<thead>
<tr>
<th>Team PSFs</th>
<th>%</th>
<th>External PSFs</th>
<th>%</th>
<th>Internal PSFs</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficiency in communication</td>
<td>7</td>
<td>Seriousness</td>
<td>9</td>
<td>High arousal</td>
<td>9</td>
</tr>
<tr>
<td>Excessive belief</td>
<td>6</td>
<td>Deficiency in human machine interface</td>
<td>7</td>
<td>Deficiency in knowledge/experience</td>
<td>9</td>
</tr>
<tr>
<td>Excessive professional courtesy</td>
<td>4</td>
<td>High workload</td>
<td>6</td>
<td>Low situation awareness</td>
<td>7</td>
</tr>
<tr>
<td>Excessive authority gradient</td>
<td>2</td>
<td>Deficiency in procedures</td>
<td>4</td>
<td>Low task awareness</td>
<td>6</td>
</tr>
<tr>
<td>Friendship</td>
<td>2</td>
<td>Deficiency in training</td>
<td>4</td>
<td>Excessive adherence/over-reliance</td>
<td>4</td>
</tr>
<tr>
<td>Deficiency in resource/task management</td>
<td>1</td>
<td>High level activity</td>
<td>2</td>
<td>Inadequate attitude</td>
<td>1</td>
</tr>
<tr>
<td>Organizational factors</td>
<td>1</td>
<td>Routine task</td>
<td>2</td>
<td>Low confidence</td>
<td>1</td>
</tr>
</tbody>
</table>

Subtotal: 24

Table 3. Team PSFs in the shared errors

Table 3. shows PSFs observed in the shared errors. Earlier, we argued that shared errors are defined as errors shared by some or all members, regardless of whether or not they were in direct communication. Therefore, we expected that the influences of team PSFs observed in the shared errors are very small. Deficiencies in communication and excessive belief have the equivalent percentages to some external and internal PSFs.

3.4. FAILURES TO DETECT AND PERFORMANCE SHAPING FACTORS

<table>
<thead>
<tr>
<th>External PSFs</th>
<th>%</th>
<th>Internal PSFs</th>
<th>%</th>
<th>Team PSFs</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seriousness</td>
<td>8</td>
<td>High arousal</td>
<td>11</td>
<td>Deficiency in communication</td>
<td>14</td>
</tr>
<tr>
<td>High workload</td>
<td>5</td>
<td>Low task awareness</td>
<td>8</td>
<td>Excessive belief</td>
<td>9</td>
</tr>
<tr>
<td>Distance</td>
<td>4</td>
<td>Deficiency in training</td>
<td>4</td>
<td>Deficiency in resource/task management</td>
<td>9</td>
</tr>
<tr>
<td>Time pressure</td>
<td>2</td>
<td>High workload</td>
<td>34</td>
<td>Extraordinary</td>
<td>2</td>
</tr>
<tr>
<td>Deficiency in procedures</td>
<td>11</td>
<td>Subtotal</td>
<td>11</td>
<td>Deficiency in resource/task management</td>
<td>55</td>
</tr>
</tbody>
</table>

Subtotal: 22

TOTAL: 100%

Table 4. External, Internal and Team PSFs observed in team errors with failure to detect

Table 5 lists observed PSFs surrounding the remainder of teams who failed to detect errors. In most cases, the remainder of a team were in the common situation where the people made errors. The analysis found some external and internal PSFs which were found in shared and individual errors as well. The most common team PSF is deficiency in communication.

3.5. FAILURES TO INDICATE/CORRECT AND PERFORMANCE SHAPING FACTORS

<table>
<thead>
<tr>
<th>External PSFs</th>
<th>%</th>
<th>Internal PSFs</th>
<th>%</th>
<th>Team PSFs</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seriousness</td>
<td>15</td>
<td>High arousal</td>
<td>2</td>
<td>Excessive belief</td>
<td>9</td>
</tr>
<tr>
<td>Distance</td>
<td>5</td>
<td>Low situation awareness</td>
<td>2</td>
<td>Excessive professional courtesy</td>
<td>7</td>
</tr>
<tr>
<td>Deficiency in training</td>
<td>5</td>
<td>High level activity</td>
<td>2</td>
<td>Deficiency in communication</td>
<td>2</td>
</tr>
<tr>
<td>Time pressure</td>
<td>2</td>
<td>Inadequate attitude</td>
<td>1</td>
<td>Deficiency in resource/task management</td>
<td>5</td>
</tr>
<tr>
<td>High workload</td>
<td>34</td>
<td>Subtotal</td>
<td>23</td>
<td>Extraordinary</td>
<td>2</td>
</tr>
<tr>
<td>Deficiency in procedures</td>
<td>11</td>
<td></td>
<td></td>
<td>Air of confidence</td>
<td>4</td>
</tr>
</tbody>
</table>

Subtotal: 22

TOTAL: 100%

Table 5. External, Internal and Team PSFs observed in team errors with failures to indicate/correct

Table 5 lists the observed PSFs surrounding the remainder of teams who failed to detect errors. In most cases, the remainder of a team were in the common situation where the people made errors. The analysis found some external and internal PSFs which were found in shared and individual errors as well. The most common team PSF is deficiency in communication.

Session D
3.6. SUMMARY ON TEAM ERRORS AND PERFORMANCE SHAPING FACTORS

Figure 2. Team Errors and Performance Shaping Factors

Figure 2 summarizes the relations between team errors and Performance Shaping Factors. Shared errors are influenced by deficiencies in the human-machine interface, low task awareness, low situational awareness and excessive adherence or over-reliance. Failures to detect are influenced by deficiencies in communication, resource/task management, excessive authority gradient and excessive belief. Failure to indicate/correct are influenced by excessive authority gradient, excessive professional courtesy and deficiency in resource/task management.

Given the incomplete nature of the source material, it was not always possible to identify all relevant factors. This analysis has revealed some interesting patterns, both with regard to the nature of the errors that occur in teams and their recovery. It has established some relationships between error types and performance shaping factors. Working together creates many problems such as deficiencies in communication, resource/task management, excessive authority gradient and excessive belief. Many of these problems have their origins in deficiencies of responsibility. Understanding what is one’s own responsibility and what needs to be done may overcome other obstacles such as excessive authority gradient, excessive professional courtesy and the like.

4. HUMAN ERRORS AND TEAM ERRORS CASE STUDY – “HERALD OF FREE ENTERPRISE” DISASTER

“The Herald of Free Enterprise capsized on the 6th March 1987, killing 200 people. It sank because its inner and outer bow doors had been left open on sailing, as a result of a combination of factors and decisions. The subsequent investigation found that all of these could have been avoided or ameliorated. Management failures set up a culture which compromised safety and allowed individual human errors to occur. Disaster could have been avoided if management had addressed safety in a more informed and committed way. Management put pressure on crews to sail early by sending memos to staff demanding that ships leave 15 minutes early. To speed up sailing times, the chief officer, who was responsible for ensuring the bow doors were closed, was required to be on the bridge before sailing, rather than on the car loading deck. He was thus on the bridge before the cars had finished being loaded. It was the management’s responsibility to ensure that a safe procedure was in place to prevent this type of omission. Another failure included orders that only ‘negative reporting’ should be employed; officers on board the ship were to assume that all was well unless they heard otherwise.

The assistant boson, whose job it was to actually close the doors was asleep in his cabin after a maintenance and cleaning shift. If more attention had been paid to rostering and monitoring staff, this would not have occurred. The boson left the deck without checking either that his assistant was on duty, or that the doors had been closed.

Ship masters had repeatedly requested that bow door warning indicators be installed on the bridge, but management did not act on these requests. For an estimated £400, the equipment could have been installed and the ship’s master would have known about the state of the doors before he left port. Other design failures included the top-heavy design of the ferry and inadequate equipment to remove water from the flooded deck.”


5. CONCLUSIONS

Improving personal skills is important for error prevention. Human error is inevitable. Reducing accidents and minimizing the consequences of accidents that do occur is best achieved by learning from errors, rather than by attributing blame. Feeding information from accidents, errors and near misses can drastically reduce the chances of future accidents. Studying human errors and their evolution in a team, generating team errors can be a very powerful tool for preventing disasters.

6. BIBLIOGRAPHY

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