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P&I Loss Prevention Bulletin

The Japan Ship Owners' Mutual Protection & Indemnity Association Loss Prevention and Ship Inspection Department

4M4(5)E Analysis

Analysis of Accident Cases

Contents

Attachments

Please use the following attachments and blank form of the 4M4(5)E Analysis List using the QR code below or by downloading them from the follow URL:

https://piclub.box.com/s/qkc4c4w88m9izvmkegymyunpe7m93yd6

Please note that the attached documents and data are provided by an external service and that publication may be suspended without prior notice.

Examples

Vessel A and Vessel B: Collision accident off the port of Kobe

Vessel E: Collision Accident with Bridge

§1 Introduction:
Safety and Casualty Mechanism & Maritime Accident Prevention

In our previous Loss Prevention seminars and Loss Prevention Bulletins, we introduced the definition of "safety", mechanisms behind maritime accidents, how to prevent maritime accidents and so on. (Please see our Loss Prevention Guides "Thinking Safety (Vol.35)" published in 2015 and "A Psychological Approach to Safety Behaviour" (Vols. 46 and 47) published in 2020.

1—1 What Is Safety?

In the world, absolute safety does not exist, and we are always exposed to all hazards. According to the International Basic Safety Standards 1st Edition (ISO/IEC GUIDE 51: 1990) published in 1990, safety is defined as:

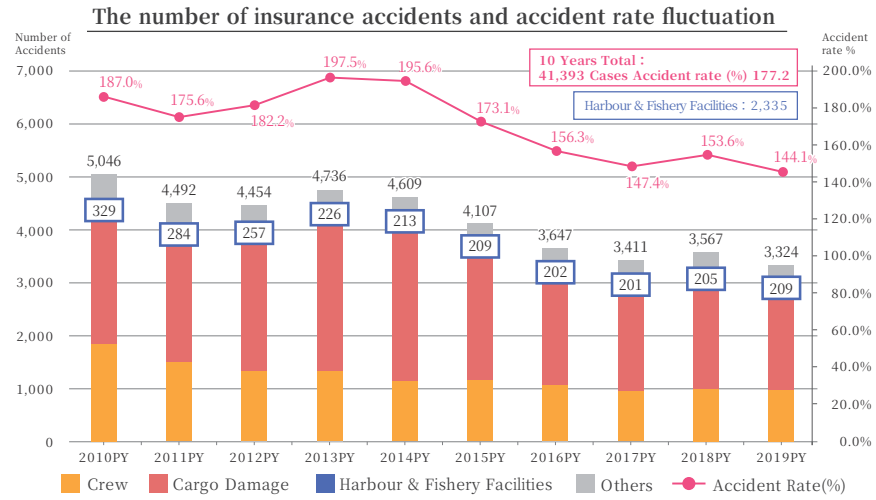
> **" Quality is not a synonym for safety and consequently the respective roles of quality and safety should not be confused. "" There can be no absolute safety. "and" There is no freedom from unacceptable risk. "**

Also, thinking of "Safety" has been discussed in various different fields, but, in summing them up, "Safety can be defined as the result or evaluation of all danger being avoided."

Although each related person, not only those on the vessel but those also working in the offices on land, is always in pursuit of safe operation, unfortunately, "zero marine accidents" have not been achieved yet. Looking at the statistics of P&I accidents reported to us, the accident rate which was calculated by dividing the total number of accidents that occurred over the last 10 years by the number of entered ship

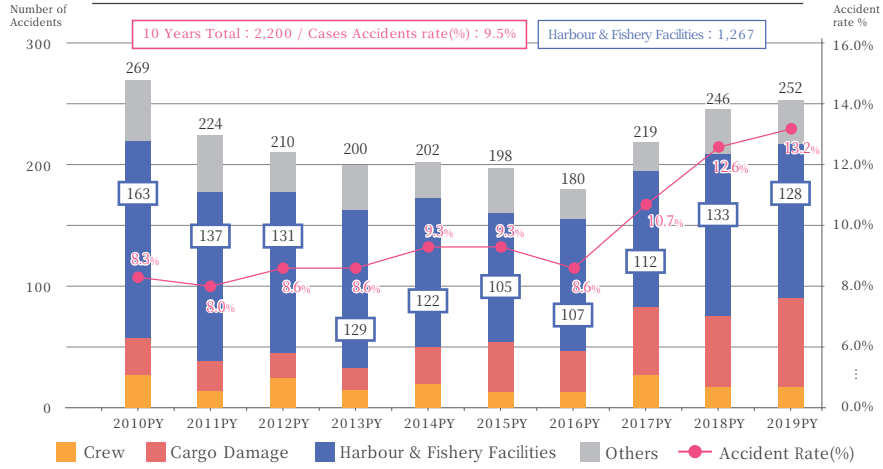
underwriting at the beginning of the term was 171.7% for oceangoing vessels and 9.5% for coaster vessels. This means that, with regards to some P&I accidents, oceangoing vessels caused 1.8 accidents per vessel per year, while this amounted to less than one in ten coaster vessels per year.（See Graphs 1 and 2）

Ocean going vessels



Graph 1

Domestic vessels



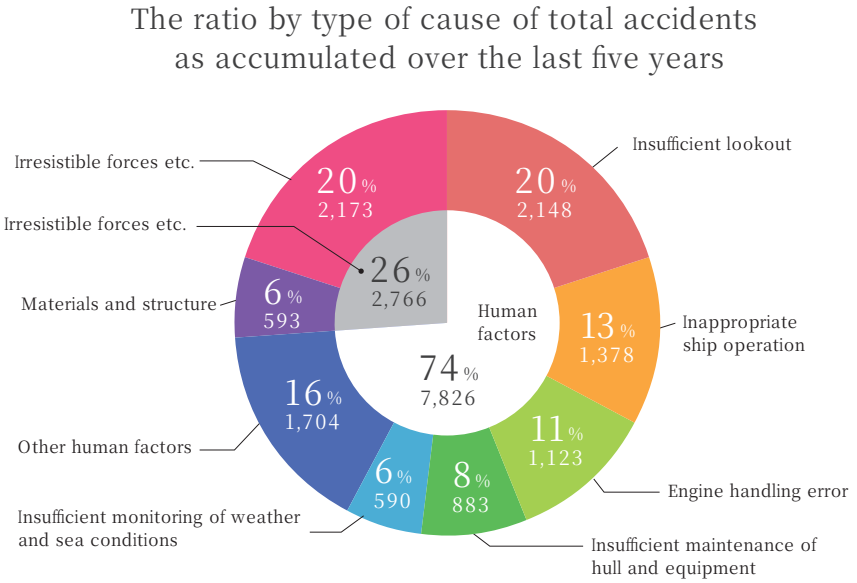
Graph 2

It is concerning that the number of accidents have been increasing since 2017/18 Policy Year for oceangoing vessels and 2016/17 Policy Year for for coaster vessels.

1−2 As a Mechanism behind Maritime Accidents Caused by Human Error

Why then do marine accidents still occur, even though we are aiming to eradicate them every day by taking all possible safety measures? It is necessary to consider the mechanisms that trigger marine accidents.

According to a guidebook called “Facts and countermeasure against maritime accidents in 2017 (provisional translation)” issued by the Japan Coast Guard, the ratio by types of causes as accumulated over the last five years of total maritime accidents reported to the Japan Coast Guard shows that approximately 74% of the causes were those of Human factors. (See Graph 3)



Graph 3

In addition, those which are caused by Force Majeure (unforeseeable circumstances) are also almost all related to human errors. Then, it may be presumed that 94% of all maritime accidents are caused by human factors.

Therefore, it follows that if there were no human errors, most maritime accidents should not occur. However, unfortunately, it is not possible to realize zero human errors, as the following four aspects are behind the main root cause.

Causes behind Human Error

1 Common characteristics among the people who have acquired advanced skills such as Master, Navigation Officer, aeroplane pilot, medical doctor and so on.

(80th Cultural lecture held by the Japan Captains' Association: Ensuring safety in a proud profession - Why BRM is paramount - from a person with a proud profession (provisional translation.)

These common characteristics of technicians, which are shown in Figure 4, sometimes cause human error.

1. Pride and confidence in one's work and skills.
2. When hearing of an accident, they have a strong sense of conviction that they would never cause such an accident.
3. Behind this there is the assumption that safety comes naturally if one has a high level of skill.
4. Feel offended by imposition of Safety Management Regulations and SMS manuals etc. from the management division.
5. Cover-up: Protect each other, particularly in the case of an accident.
6. Mistakes are matters of acute embarrassment, and are concealed.

Fig. 4

2 Human characteristics (Nihon VM (Visual Motivation) Centre Co., Ltd from Anzen-no-komado 18 (Safty Loopholes) dated 30 June, 2002 (Provisional translation)

Figure. 5 shows the “human characteristics that everyone has” which are likely to cause human error.

Twelve human characteristics

1. Human beings sometimes make mistakes
2. Human beings are sometimes careless
3. Human beings sometimes forget
4. Human beings sometimes do not notice
5. Human beings have moments of inattention
6. Human beings sometimes are able to see or think about only one thing at a time
7. Human beings are sometimes in a hurry
8. Human beings sometimes become emotional
9. Human beings sometimes make assumptions
10. Human beings are sometimes lazy
11. Human beings sometimes panic
12. Human beings sometimes transgress when no one is looking

Fig. 5

3 Psychological Factors

The following psychological factors mainly induce human error.

① **Psychological reactance**（**self-efficacy**）

This is when people do not wish to do something that is not of their own volition. They may be inclined to say, “I won’t do what you tell me.”

② **Entrainment, Peer Pressure and Normalcy Bias (justification and cognitive dissonance**）

Anyone else would do the same and the psychology of, “What will the neighbours think?” and “I’m special, nothing can hurt me!”

③ **Confirmation bias**

People are unconsciously prone to believe only “what they want to believe” and “information that supports what they believe” rather than purposefully seeking information to the contrary. They may say something like, “Stop exaggerating!”

④ **Social loafing**

This is when someone does not choose to take the initiative. They may say, “Someone will do it for me.”

4 Human Brain Capacity

The reason why we can say that the human brain is a very inefficient organ is because it occupies only 2% body weight, yet consumes 20% of all the energy. Our brains are programmed to save as much energy as possible, while aiming to achieve maximum energy efficiency. The following are examples of its energy-saving mode, and it is these that are responsible for optical illusions and perceptual errors.

Since Neoanthropic man (Cro-Magnon man) was born 70,000 years ago, human beings have been making a living from hunting, pasturage and farming. In 1769, which is just 250 years ago, a Scottish mathematician and engineer, James Watt invented the steam engine, which was epoch making for humanity. In other words, problems in the era of farming and pasturage were mainly only floods, fires, and natural disasters, but now, new disasters can be added to this. It is said that human beings inhabited the earth approximately 40,000 years ago. If this were compressed into 1 year, and human beings started to inhabit the earth from 00:00 on January 1, the industrial revolution would have begun at 17:15 on December 29. Meaning that only 2 days and 6 hours and 45 minutes have passed since human beings came into contact with machines. It is true that technological advances in machinery and equipment are becoming more upgradable and complex, however, we should still think of our DNA and brain capacity as “first-generation processes that cannot keep up with these changes”.

- **Avoids thinking deeply (it gets tired)**
- **Is not good at thinking logically**
- **Forgets and does not remember easily**
- **Not able to reject our assumptions**
- **Tends to believe that our choice is correct**
- **Tends to make choice based on first impression etc.**

Fig. 6

Optical illusions

Human beings sometimes make assumptions

Fig. 7

When looking at the illusion in Figure. 7, we recognize that there are two different women: one is a young lady who is facing away from us, and the other a profile of an elderly lady. If you can only see a young lady, try focussing on her ear to then see an eye, and her chin to then notice a nose, and then her necklace to see a mouth. On the other hand, if you can only see an elderly lady, try focussing her eye and you will notice an ear, her nose to reveal a chin and her mouth to reveal her necklace. Now it is possible to recognize both ladies, but isn't it hard to switch to seeing the other lady, once your mind is set on either of them at one time?

Interestingly, there is a strong tendency that someone of a younger generation will recognize the young lady at first and that someone of a senior generation will rather recognize the older woman first.

It is an old painting from the 19th century, and as of 2016, it is the oldest confirmed drawing on a German postcard from 1888. The author is unknown, but what is known is that this postcard's illustration was used for a US automobile manufacturer advertisement for the Anchor Buggy Company at around that time in 1890.

Source from Wikipedia: Trompe l'oeil (deceive the eye)" My Wife and My Mother-in-Law "

Optical illusions

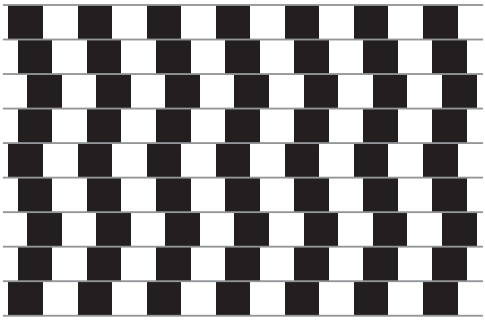


Fig. 8: Café Wall illusion

Observe the black and white tiles that are separated by grey lines. The grey lines appear as though they are crooked. This is an optical illusion. Really, each of these grey lines are in fact straight and not crooked. This is one example of a geometric illusion. The straight lines between the rows of alternating black and white "bricks" appear to be tilting, when they are in fact parallel.

This illusion was first described under the name of Kindergarten illusion in 1898, and was re-discovered in 1973 by Richard Gregory. According to Gregory, this effect was observed by Steve Simpson, a member of his laboratory, on the wall tiles of a cafe at the foot of St. Michael's Hill in Bristol. This is a variant of the "shifted-chessboard illusion" originated by Hugo Münsterberg.

Source from Wikipedia: Cafe wall illusion

As a Mechanism behind Maritime Accidents

Unlike traffic accidents that may be caused by a single driver, casualties at sea are seldom caused by one single human error. In most cases, there is a chain of human errors that leads to an accident, and unless the error chain is broken, as a result, an accident is likely to occur.

An example of a collision accident is shown in Figure 9. It is understood that an accident occurs when several errors overlap.

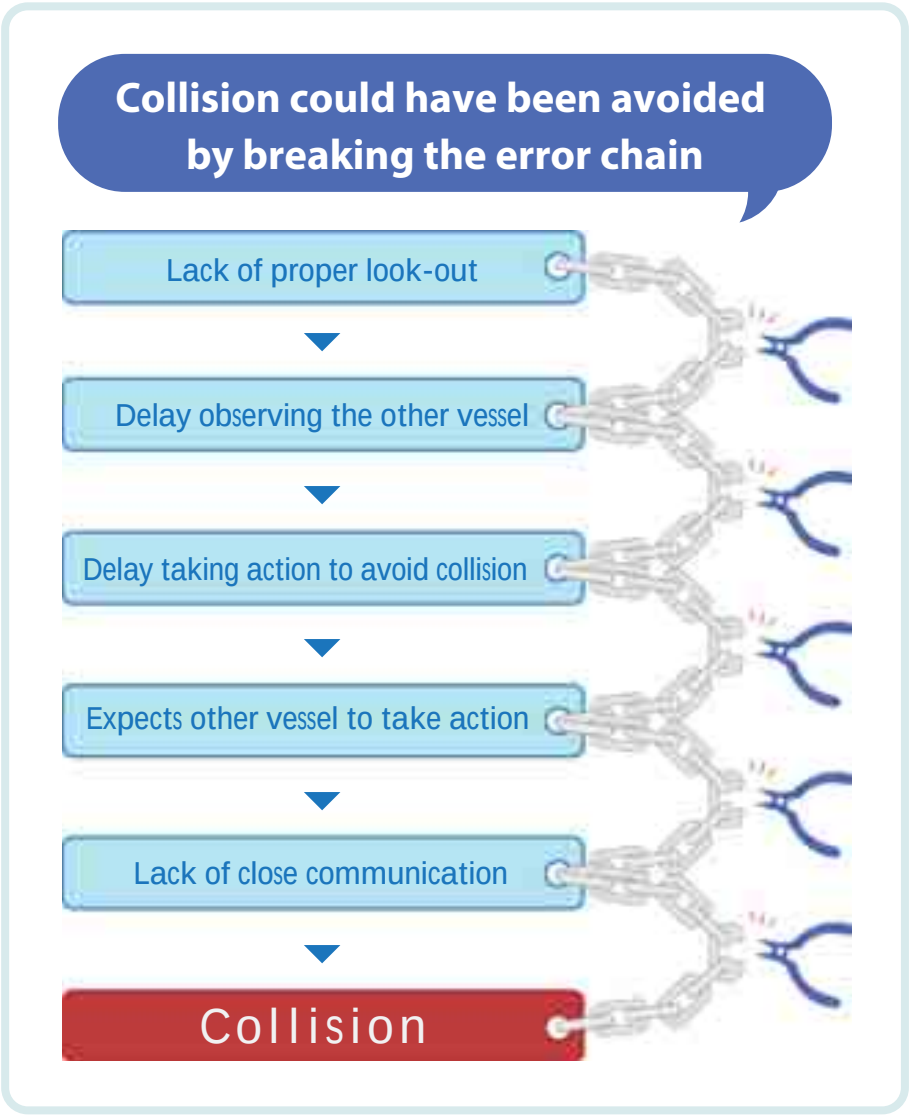

Collision could have been avoided by breaking the error chain
Lack of proper look-out
Delay observing the other vessel
Delay taking action to avoid collision
Expects other vessel to take action
Lack of close communication
Collision

Fig. 9

1－3　Prevention of Maritime Accidents

Basic approach

Herbert William Heinrich (1886-1692). When working as an assistant superintendent of the engineering and inspection division of a non-life insurance company in America, his law Heinrich's Law was derived from his thesis which was published on 19 November, 1929.(Heinrich's Law: Figure 10)

Behind every serious accident or disaster, it is said that there are 29 minor ones and that there are 300 near misses that fortunately do not lead to any accidents. Hazardous "unsafe acts" referred to as "unsafe situations" number in their thousands, meaning that even more dangers lurk in the background.

Thus, if we are able to decrease the several thousands of unsafe conditions and 300 near misses, maritime accidents either minor or major, could definitely be reduced.

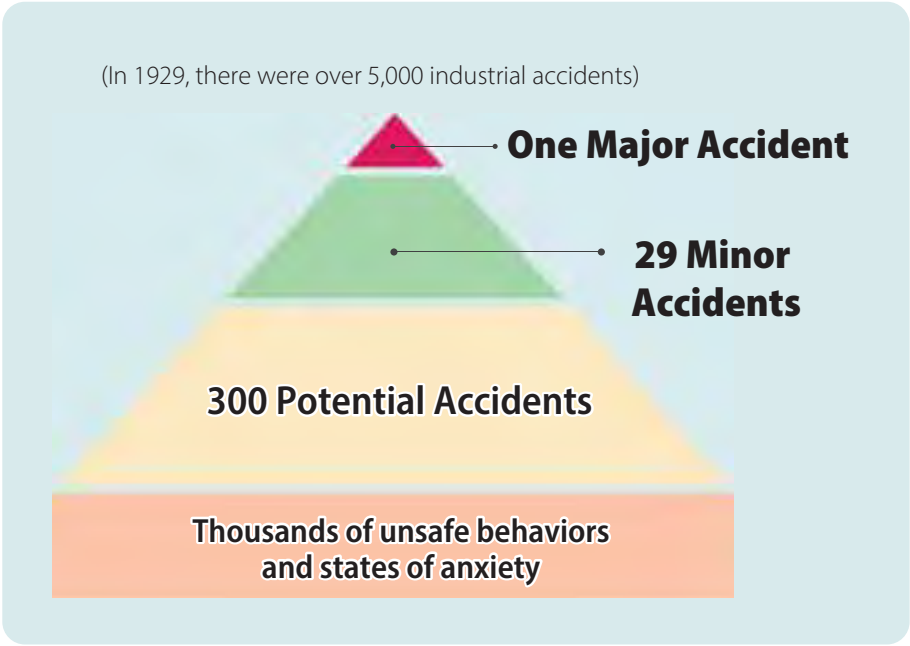


Fig. 10

There can be no “absolute safety” and “Safety can be defined as the result or evaluation of all danger being avoided”, as explained above in 1-1. Then, how can we achieve the safe operation of vessels which are always exposed to a variety of dangers? By understanding the Johari Window (see Figure 11) in the field of psychology, we can see that it is possible to “heighten the level of safety”.

Considering the scope of activities in vessel operation, there are many dangers lurking in the Johari Window. This consists of four window-panes: ① Known to self (Open area), ② Not known to self (Blind spot), ③ Known to others (Hidden area) and ④ Not known to others (Unknown area). The most dangerous area is the “Unknown area”. Namely, the unknown area is an area that no one knows about (or a danger that no one notices) where safety measures are yet to be taken.

A requirement that would heighten the level of safety would be to enlarge the Open area. In other words, the Open area specifies that all members within the range of activity, including the vessel and its land management department, are equally aware of the danger, thus proactive measures can be taken.

The “Blind spot” can be narrowed by learning from each other’s knowledge and experience, thus expanding the “Open area” of the team. Also, by opening our Hidden areas (what we know that others don’t) and by being aware of others’ blind spots, the Open area will be expanded, which will in turn bring about improved safety, eventually. If we remain unaware of the “Unknown” area and its inherent dangers, this will render us defenceless.

However, if we enlarge the Open area, the Unknown area will reduce. At the same time, the Blind spot and Hidden area will also reduce. This means that the level of safety will improve.

Johari Window

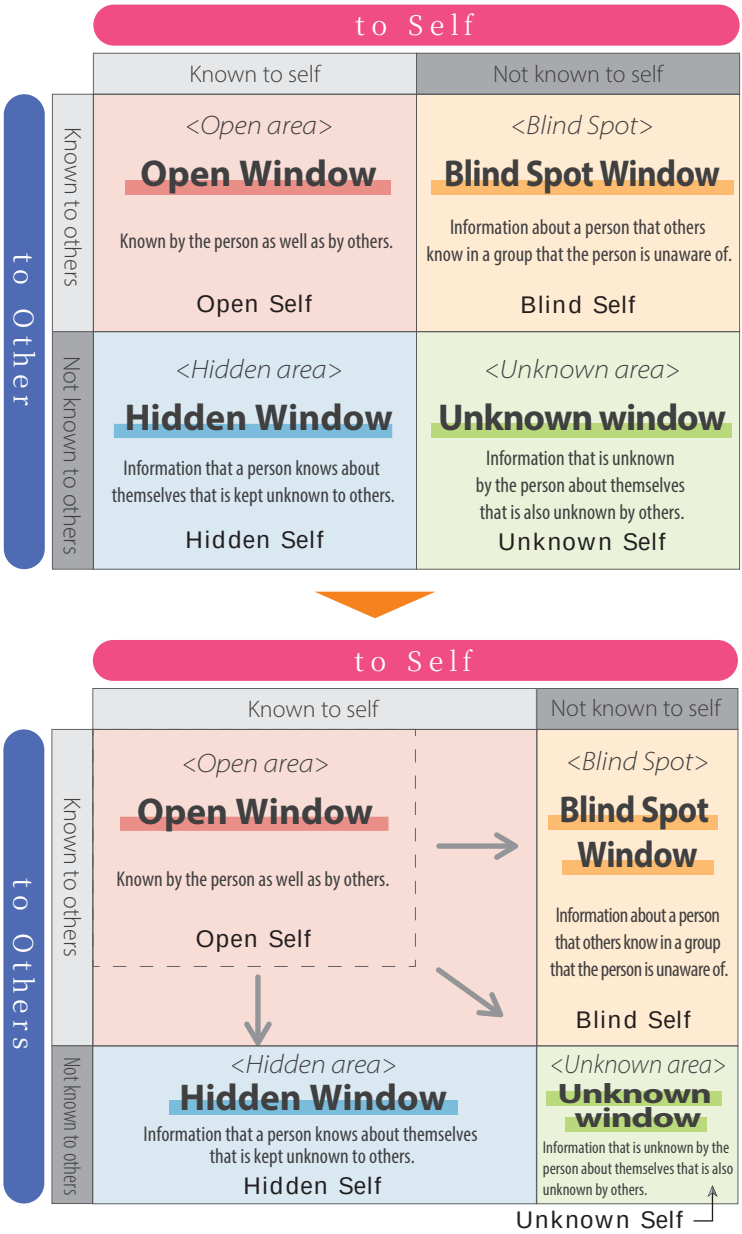


Fig. 11

BTM and ETM

Bridge/Engine Room Team Management

BTM and ETM have been introduced as methods to prevent maritime accidents from occurring by breaking the chain of human errors (error chain). This method seeks to acknowledge that it is a) impossible not to generate human error, b) that the team unite and work together so that one person's mistake does not create a dangerous situation, c) that mistakes be noticed and corrected in a timely manner, and d) that everyone find a way to support each other and break the error chain.

The concept of BTM and ETM is based on communication with the resources surrounding the subject.（See Figure 12）

Fig. 12

The person at the centre（L：Person responsible for the accident）is surrounded by those resources such as:（H：Hardware）,（S：Software）,（E：Environment）, and（L：Persons other than the person responsible for the accident）. Each resource is always in a state of change. This situation can be shown in terms of quivering rectangles.