2009 CHINA-JAPAN
Symposium on Safety Management Theory and Practice

Progress in Safety Management Research and Practice

安全管理研究与实践新进展

主编 田水承 施桂荣 李红霞 井上枝一郎

Chief Editors Tian Shuicheng Shi Guirong Li Hongxia Shiichiro Inoue

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2009中日安全管理
理论与实践学术研讨会
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主编　田水承　施桂荣　李红霞　井上枝一郎
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Brief Introduction

This monograph *Progress in Safety Management Research and Practice* is the Proceedings of the 2009 China-Japan Symposium on Safety Management Theory and Practice (2009CJSSM). Selected in this volume are 68 papers from 140 authors of more than 40 enterprises in China and Japan, in which 28 papers are in English and 40 are in Chinese. These papers involve aspects on safety management theory and technology, safety education, human error and unsafe behavior, safety psychological test and measurement, identification of hazards and risk management, safety emergency management and technology of computer application, safety economic theory and analysis, mine ventilation and safety management, etc.. The proceedings discuss that development of safety management is confronted with challenges and opportunities by the idea of Safety Development. It basically reflects the recent new situation, new problems, new theories, new methods and new thinking in safety management research and practice.

The proceedings will be a useful reference for those engaged in safety management, safety education, human error and unsafe behavior, mining engineering, emergency management and relative engineers in work and research as well as the college students and teachers.

This symposium on safety management theory and practice was organized by Xi'an University of Science and Technology (China), Kanto Gakuin University and Institute for Science of Labour (Japan), with great support from China Association for Science and Technology, China Occupational Safety and Health Association, Ningxia Administration of Coal Mine Safety, Shaanxi Administration of Coal Mine Safety.

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序

安全是人类最重要和最基本的需求，是人们生命与健康的基本保障。一切生活、生产活动都源于生命的存在。全世界平均每天发生约68.5万起事故，造成约2 200人死亡。这让我们深深感到，安全就是生命。随着经济、社会的发展，人们对安全的需求和呼声越来越高，对安全管理知识的需求也更加迫切，而当前安全管理科学的发展显然不能完全满足人们的现实需求。

自“安全科学技术”成为国家标准中的一级学科至今已有16年之久，“安全管理工程”作为其二级学科为安全科学技术学科建设注入了新鲜的血液，推动了安全科学理论与实践的发展和创新。1992～2010年间，全国安全工程专业教育高等院校由50余所发展为110余所，从事安全管理理论和实践研究的学者、企事业单位安全管理人员等也逐步形成了一支庞大的队伍。作为研究安全管理活动规律的科学，安全管理学是一门学科渗透性、综合性很强的新兴交叉科学，它运用现代管理科学的理论、原理和方法，探讨、揭示安全管理活动的规律。安全管理就是通过合理、有效地配置社会、人、机系统中的人、物、环境、信息、时间等要素，以达到系统中安全状况的持续实现，保证人类社会活动中的安全生存、安全生活、安全生产的目的。

由于社会的进步和科技的发展，生产系统、工艺及环境日益复杂，人们周围的能量越来越呈现集中化、密集化，人的行为的复杂性、难控性以及各种社会环境因素等的综合作用，给安全管理带来了前所未有的挑战。如何在充满挑战、日益精密且复杂的生产环境下确保人员、生产安全，如何使人们在工作中得到更充分的劳动保障、身心健康保证等，这些都是安全管理研究与实践工作者需要面对的问题。

事故案例和科学研究表明：加强科学的安全管理，强化安全管理（综合）部门的功能对改善安全水平具有重要作用。安全管理研究与实践意义重大，没有科学的管理，就难以实现持久的安全。安全管理对预防、控制事故及促进经济发展具有不可替代的巨大作用，同时安全管理也是一门发展中的新兴学科，需要我们不断地认识、继承、总结并发展安全管理的理论和方法。安全管理研究与实践工作者任重而道远。

为了深入广泛地研讨和交流安全管理方面的研究成果和实践经验，在中国职业安全健康协会等单位的大力支持下，2009年12月3～5日，西安科技大学联合日本关东学院大学、日本财团法人劳动科学研究所，在西安共同举办了“2009中日安全管理理论与实践学术研

讨会”，并在会议交流的基础上编辑形成了会议论文集《安全管理研究与实践新进展》。这次研讨会与出版的论文集，对社会转型期和事故易发期安全管理研究与实践面对的新情况、新问题做了深入探讨与分析，重点交流了安全管理的新理论、新方法、新思路等最新安全管理方面的学术成果，探讨了“安全发展”理念下安全管理发展面临的挑战和机遇，反映了安全管理研究与实践的最新成果，是一本颇具参考价值的文集。

“2009 中日安全管理理论与实践学术研讨会”的成功举办，对努力营造综合性交叉学科的学术氛围，交流最新安全管理方面的学术成果，促进安全管理研究与实践的创新，加强安全与管理学科之间的融会与交流都将发挥积极的作用。希望这次会议秉承“安全发展”的理念，以中日安全管理界学术、经验交流为契机，把握目前安全管理存在的新问题、新形势、新要求，深刻认识安全管理发展面临的挑战和机遇，综合研究、应用安全学科、管理学科等的成果和方法，推进我国安全管理水平的稳步提升。希望安全管理学术研讨会持续、列届办下去，逐步打造成具有国际影响的学术交流平台，为安全生产、社会进步发挥更多、更重要的作用。

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冯长根

2010 年 4 月 21 日

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Education of Human Error Protection and Organizational Culture*

Shiichiro Inoue
(Kanto Gakuin University, Institute of Science for Labor, Japan)

Abstract: For the prevention of accidents by human errors, it is of utmost importance to accurately understand the details of human errors. The point is whether a person concerned consciously acknowledges that there is an error. It determines measures to be taken. The next issue is safety education, and it becomes essential that those who provide relevant education surely understand what to teach. To be more specific, it is a difference between training and education. Lastly, by giving analysis of specific cases, the importance of organizational culture that exists behind the above-mentioned two points is described.

Key words: Human error; Organizational culture; Safety education; Case study

1 Principle of error prevention and its application

To date, various measures to prevent human errors have been proposed and implemented. However, there are not enough pages to consider each measure in this article. Therefore, the basic understanding(or principle of human errors) that seems important in both identifying causes and planning countermeasures is examined

In order to deepen an understanding of this principle, it is first need to understand the classification of human errors. Please see Fig-1. This is a classification list made by J. Reason(1990). There are two prominent types of errors: the upper part is errors caused without intention, while the lower part is errors caused with some intention.

The upper part is a group of errors caused by "unintended" acts, while the lower part is a group of errors caused within "the range where one can contemplate". It is important to distinguish these two groups. (Extract from James. Reason, "Human Error", 1990)

As is obvious from Fig. 1, there is a significant difference between these two groups. When the people of the business community talk with it, always that's meanings has an impression that they consider human errors as a single concept in most cases and rack their brains over causal analysis and measure planning. However, it is quite important to recognize the differences between these two groups(acts without or with intention) clearly in examining causes as well as considering measures.

It is widely thought that, in general, human errors are caused by individual's fault including implication of one's responsibility(all errors are acts with intention). Surely, some human errors caused by intentional acts are more applicable to this kind of thought such as specific violations noted in this table. Therefore, as mentioned below, countermeasures to deal with this type of human errors such as reprimand and reeducation are considered effective and therefore implemented(violators often express remorse). For violations, effectiveness of such measures cannot be denied completely. However, the trou-

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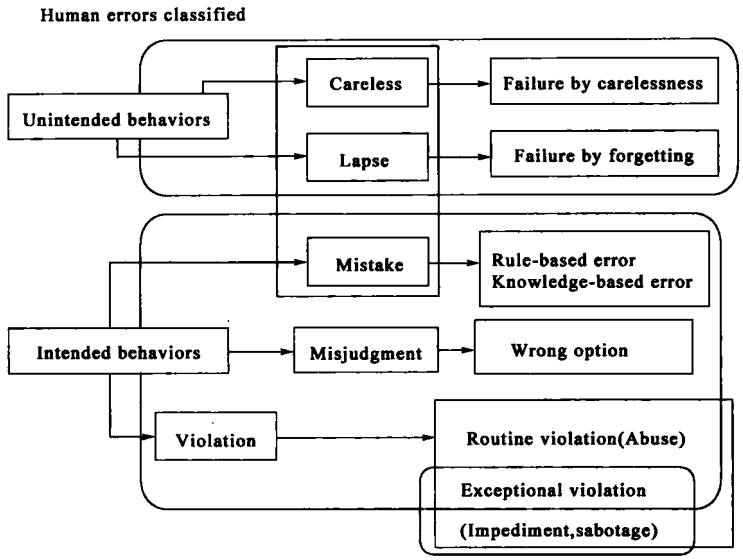

Fig. 1 Classification list of human errors

ble is that once such measures are considered to be effective, measures to cope with human errors tend to focus on letting each person change one's behavior as well as intention. This eventually leads to establishment of a simple idea that measures to deal with human errors are reeducation of individuals. What concerns us most is to expand these measures to human errors caused by unintended acts. What we need to think about is whether it is truly reasonable and effective to use reeducation as a preventive measure for absent-mindedness(failure due to lack of attention) and lapse of memory(failure due to lack of memory). It is a common knowledge of human science that humans always have a swing in behaviors(both physiologically and psychologically) as a fate of living substance. Is it really possible to control(to control a behavioral swing to keep it steady) such physiological phenomenon by means of education? The answer is no. It is seemingly possible to adopt education as measures on a superficial level(in many cases, people are deceived by this format and tend to rely on education), but the content of such education is just an explanation of causes that leans on afterthought. Thus, this kind of measures is misguided as preventive measures in a real sense. For reconfirmation, let us think from the point of view of a person who makes an error. If such person is told that s/he was "careless" in the educational process as afterthoughts including relative facts, s/he may feel that "that may be the case". However, as soon as this person returns to work, s/he promptly realizes that it is an unreasonable demand to "focus on one's work and continue to pay attention to others". It is impossible to act one's primary duty, if one tries to comply with such demand. Human errors caused by unintended acts are named so because they occur in the world where one cannot contemplate, and it is impossible to bring these errors into the world of intentions. Reflecting on this fact, in the existing education, we cannot help feeling that those who provide education as well as those who receive education are caught up in the visible things and have pursued impossible challenges as rightful things. What we want to confirm is the fact that humans' intended acts and unintended acts are two different things in the sphere of behaviors. It is a grave mistake to apply education to errors caused by unintended acts only because this method turns out to be effective for errors caused by intended acts due to its easiness of specifying causes or its visibility.

Then, that what kind of perspective is required in understanding measures to cope with human errors must be considered. First, it is necessary to analyze case examples of human errors scientifically and make a sharp distinction between errors caused by intended acts and other type of errors. Based on that, for errors that are identified as those caused by unintended acts, it is necessary to review in detail physi-

cal environment condition, work control condition, organizational structure condition and human resource condition that were required for such identification and examine which condition induced a swing in human behaviors. That is, it is important not to confine human errors to the stage of causes but to clarify conditions that induce human errors. In other words, identification of causes and measures for errors caused by unintended acts should not focus on humans but on wider environment conditions of their surroundings. If this fact is fully understood, a path to countermeasures as an application of the principle will manifest itself. Surely, engineering systems have been adopted that "work safely even when humans make errors" such as fail-safe and foolproof systems based on the similar perspective. However, we need to further promote this policy and proceed to the stage where we identify potential causes that may induce human errors and remove them from the perspective of prevention, not as after-the-fact measures such as the abovementioned engineering systems. In this aspect, issues we need to consider exist in the problem of man-machine interface on the hardware side and the search for organizational factors such as a concept of safety culture on the software side. In addition, for solution of these issues, it is important to accumulate the results of the abovementioned reviews/examinations, promote cross-industrial disclosure of data and share the knowledge as the common asset of the business community.

2 For smooth implementation of education/training for error prevention

That there is a certain limitation, depending on its targets, on the idea to utilize education for measures to prevent human errors is already stated. That is, education is not a suitable measure to prevent errors caused by unintended acts by humans. On the other hand, as is obvious from Fig-1, behaviors that are called human errors surely include those that belong to the range where a person concerned can contemplate. However, to avoid any misunderstanding, It must emphasize that "the range where a person concerned can contemplate" does not instantly mean it is such person's error. Except for errors from violations, it is rather rare that a person concerned is making an error intentionally. In many cases, an act with a good intention turns out to be an error. Therefore, "the range where a person concerned can contemplate" asks us in what direction this "good intention" has been promoted in an organization and in what way this "good intention" has been brought into "the range where a person concerned can contemplate". This is in answers to these questions where the importance of existence of education can be acknowledged as measures to prevent human errors.

Then, a concrete method and its detail are examined. Again, there are two matters that need a sharp distinction. That is a difference between training and education. The purpose of training is to acquire skills required to perform one's duty. Therefore, during the process of acquiring skills, there is no room for preference. From the perspective of safety, it is a process to feel and realize solutions for issues without which one may get injured or die(for example, falling and electrification). That is why even Spartan training is often accepted as a barrier that needs to be overcome. As an aside, experienced workers often lament the fact that nowadays many young workers drop out at this stage.

Now, what education used as measures to prevent human errors is all about. It is probably to build up details of the abovementioned "good intention". In the initial stage, it is a fundamental understanding of knowledge and rules required to perform one's duty(which eventually leads to compliance) and expansion/development of knowledge database(how many choices one can think of when pressed for a decision). Subsequently, in the next stage, "good intention" means self-control where one stops performing one's duty to closely examine the results of one's act, values to prioritize safety when there is a conflict between productivity and safety(e. g. whether to stop the production line), tolerance to resist pressures from within and without the organization with respect to one's decision, organizational culture that does not press individuals to respond to such tough challenges and motivation to aggressively participate in

fostering of safety culture. By adding this analysis, it turns out that education of human error prevention is nothing more or less than cultivation of skills as a human being, just like other type of education. This can never be achieved by description of simple books.

Now we change our point of view and look at who should provide such education. Currently, in many cases, experienced staffs are in charge of education in the daily activities provide education of human error prevention. Of course, it is not deny the fact that there are excellent staffs are equipped with the abovementioned skills as a human being among them. However, it is extremely rare and difficult to generalize because we have never heard that such education has been provided systematically in an organization(in many cases, it was left to individuals). Therefore, there is no evidence to prove that such experienced staffs are appropriate as those who provide education of human error prevention. The purpose of distinguishing training and education indeed lies here. The fact is that education of human error prevention is provided in the same manner and idea(in education, spiritualism is widespread) as training in most cases. Some companies have fancy education centers, but instructors are often senior staffs or intellectuals who do not know the actual work. And what they talk about remains a matter of training or good lecture. That may be enough for training centers but not for education centers.

After we completed analysis of relevant issues, an issue with regard to how to carry forward education for human error prevention still remains. We should think that there are no ready-made materials and instructors for such education. Education for human error prevention can be achieved only after an occasion for education is provided and through interactive communications between appropriate instructors and students using past case examples as teaching materials. We will further consider this point in the next section.

As the last point in this section, that what education aims for in the area of human error prevention is "education of wisdom" in a word would be proposed. Please see Fig. 2 for a conceptual diagram of components that consist of this "education of wisdom".

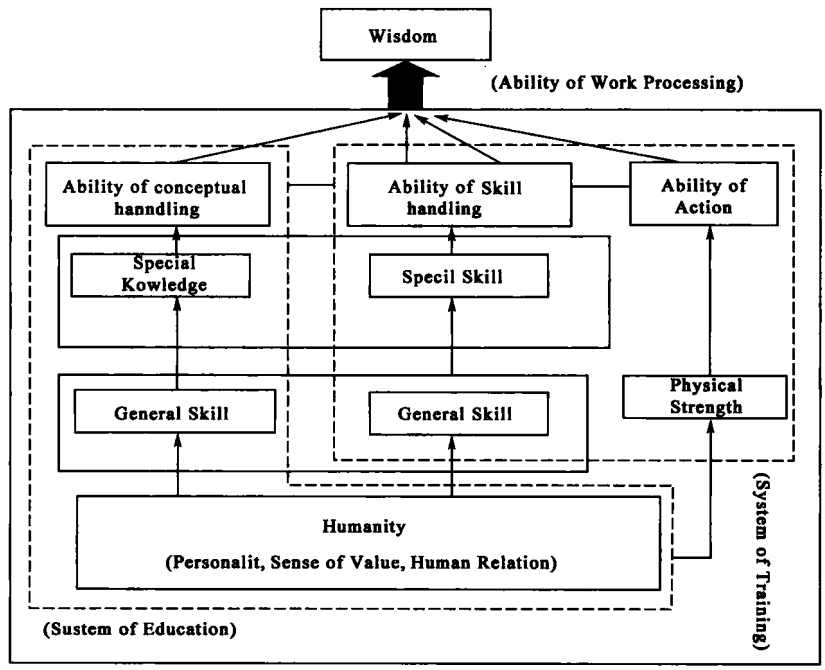

Fig. 2 Education of wisdom

When implementing measures to prevent human errors, it is necessary to make a sharp distinction between training and education. Training is relatively easy, while education is a serious issue that is

close to the theme of cultivation of skills as a human being. Skill development that integrates both training and education is "education of wisdom" in a word.

3 Evaluation method of working process by collecting cases of failure

It is a royal road for measures to cope with human errors to collect case examples, learn lessons from them and reflect them in preventive measures. In the current society, management systems that focus on format are popular such as safety and health management system and risk assessment system. However, I think there is no other education for human error prevention as efficient as horizontal expansion of lessons learned based on scientific analysis. This is because there are various factors involved no matter how small an error may be, and it is the best preventive measure to analyze these factors and utilize them to prevent human errors compared to any safety management system.

Now let us examine one example. This case is about a human error(stipulated so by the management) occurred in the production line of a certain organization.

① Summary of case examples

Please see Fig. 3. In this case, two materials(special sheet material and powder) are combined on a conveyor-belt, and all the necessary processes are carried out until end products on the assembly line. Of course, human intervention in this work process is not necessary(in principle at lease), and workers are placed for process monitoring. At first, a worker found that powder material was attached to the belt guide(If this attached power is left as it is, it eventually solidifies and leads to meandering of the belt). The worker tried to remove the powder by using the attached auxiliary tool. When he was removing the powder near the driving unit of the belt, his hand and the tool got caught in a gap between the safety cover of the driving unit and the belt. The worker got injured.

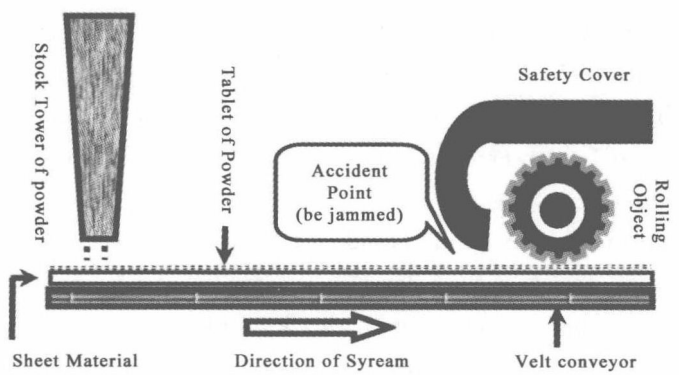

Fig. 3 Illustration of Accident conditions

This is an outline of the case example. Management of a gap between the safety cover and the belt was a problem. In addition, the fact that a removal of powder material treated as an ancillary work such as "cleaning" by the management led to oversight of the potential risk.

② Cause and measures

According to the findings, the first problem was a defect on the hardware side that the belt meandered unless attached power material was removed every 30 minutes(led to a halt of the production line). The management did not realize the this point because they thought a use of the attached auxiliary tool was for cleaning, not for maintaining the normal operation of the line. On the other hand, the reason workers did not report the actual situation to the management was that the management did not hear workers' opinions in general, and therefore workers thought it was no use. Next, the management believed there was hardly a potential risk involved in this process of one's hand being caught because the

safety cover was already placed on the driving unit, and no trouble had been reported for a long time. Thus, the fact that the routine risk assessment and measures to be taken were already implemented, and no trouble had been reported for a long time was used as a rationale. Therefore, a human error that the worker moved the auxiliary tool too close to the safety cover emerges as a potential cause. However, site observation shows that a removal of attached power material by the auxiliary tool is not just ancillary work such as cleaning but plays an important role in maintaining the smooth operation of the belt. As a swing in behaviors was mentioned above, when a human being is forced to implement this type of work about 20 times a day, s/he may conduct an act unintentionally(swing in behaviors) even when s/he moves too close to the belt(partly due to lowered risk prediction as a result of habituation).

③ Lessons to be utilized for process evaluation

a. Was a gap between the safety cover of the driving unit and the belt set up appropriately?

Perhaps when the cover was installed, the width of a gap was determined by operating the belt. However, we must say that the validation was insufficient because in reality, attached powder must be removed every 30 minutes. The primary cause must be that safety management was completed too soon without observing the actual work process. In many risk assessment activities We have observed now and then, assessment is conducted in a static state(sometimes work process is stopped). Work on the filed is alive, and long-term observation in a more dynamic state(in a regular work condition) is required.

b. Human error as a cause of the accident.

Under the conditions in this case example, who can declare that "I will not make one single error in 100 trials" Despite this, the idea that the accident was caused by a human error(carelessness of the worker) emerges based on the rational that "nothing had happened before". We can observe this in many cases, and it is due to the three major human error causal consequences, "cause that is easily understandable for anyone", "cause that leads to early resumption of production" and "cause that does not hold the management responsible". There is always a factor behind any trouble. It is that the management determines caused by a human error and it is that a human error is just an act induced by this factor. Therefore The word, "A human error is a result, not a cause" must be assisted for the management into the work process evaluation.

c. Why did the management fail to understand the actual situation?

Abovementioned, the validation of the safety cover installment was insufficient. However, it is understandable that they cannot spend much time on this kind of validation. Then, what is the next-best solution? What concerns us here is a statement of the workers that "the management may not hear us if we tell them about the actual situation". If the management cannot grasp every single detail of the work site, opinions of workers of each work site should be the most reliable information. Then, it should be the best measure for finding any potential risk to keep a channel of communication with workers open and hear what they say regardless of its validity. This is a first step to foster safety culture that attracts a lot of attention these days and a circuitous but very effective measure for human error prevention.

Lastly, we must refer to the remaining issue. That is "what is the effective education as measures to prevent human errors?" As already mentioned, one idea is to have discussions repeatedly between instructors and students based on case examples(examples of one's own organization are most effective) without setting any taboo. In fact, I have tried various human error education based on requests from many companies, and what I have achieved so far is the abovementioned conclusion. However, some students who received education and returned to work complain actual implementation of what they learned is extremely difficult due to organizational impediments in various ways. Fortunately, however, it is becoming a mainstream to analyze the entire organization and evaluate it on the level of safety cul-

ture. What is required of us now is to take advantage of this opportunity and include organizational factors into fundamental measures to prevent human errors.

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