

Accident Science: An Exploration as A New Discipline Through the Lens of Safety Methodology

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Abstract

In order to establish a new discipline specializing in accident science from the perspective of safety science. Under the guidance of the current research theories and methods of safety science, combined with the research paradigm of humanities and social medicine, this paper puts forward new viewpoints, new theories and new models about accident research. First of all, through literature puts forward eight kinds of attribute relations of the accident, and makes clear the characteristics and connotation of the accident. At the same time, according to the thought of science of science, this paper puts forward a new definition of safety under the thinking of accident science and other basic concepts related to safety science, and explains the connotation. In addition, it creates and constructs the basic concept of accident science, establishes the conceptual model of accident science, and points out the "3-4-5" model of accident science research and its connotation. Finally, the research contents of three main aspects of accident science are summarized. The results show that the research results in this paper not only play a fundamental role in the basic construction of accident science, but also further enrich and perfect the discipline system of safety science, which has a certain theoretical significance.

Keywords

Accident science; New definition of safety; Basic conceptual model; Discipline basic construction.

1. INTRODUCTION

Today, the world is in the wave of great development, adjustment and change of industry and production. In various fields of the world, human beings are faced with the risks and challenges brought by changes all the time, in which all kinds of accidents and disasters emerge one after another. Aside from the death brought by war, perhaps the casualties have always accompanied the human beings and never left. The casualties in times of war were heavy, and the injuries in times of peace were also shocking. Since ancient times, human beings have begun to fight against accidents, for which hundreds of millions of people around the world have given their lives. Accidents are like the sword of Damocles hanging over their heads, which will lead to death without warning. The history of human society is accompanied by accidents, so for thousands of years, especially since modern times, with the advent of three revolutions, accidents seem to occur frequently people's lives, especially several major accidents that shocked the world so that people feel afraid when talk about them [1,2]. Accidents can cause as much pain as diseases, which makes people attempt to avoid it.

Thus, simulation reference for accident prevention and consequence emergency was provided. Karen Landay et al. [3] investigated the relationship between the personality characteristics of professional truck drivers and the accident according to the company's accident records over the years. Analysis showed that people who were more understanding

were less likely to have an accident, while people who were more anxious, more guilty, more expressive, and more adventurous were more likely to have an accident. Bernard Youkhana et al. [4] analyzed the technical and clinical data of patients with facial injuries caused by car accidents, and investigated factors such as sitting posture, sex, age, accident time, use of seat belts, deployment of front airbags, direction of impact, collision speed at that time, occurrence and location of facial injuries, and so on. It was concluded that the primary factor causing injury in a collision accident is the high speed at the time of collision. And car safety measures reduced injury to people in the event of an accident. Ludwig Benner Jr. [5] studied the basic issues such as the definition of accident and investigation, the purpose of accident investigation, and the cause of the accident, which showed the diversity of thinking in this kind of accident investigation, and explained the reasons for the existence of so many methods of investigation and analysis. These studies guided people how to use accident data for analysis and investigation. Marislei N. and Fabiana F.R. [6] researched the accident consequences of tailing dam failing and pointed out that the accident losses included: deaths and injuries, economic losses, environmental pollution and health problems associated to heavy metals in the water. This study found evidence that the dam accidents had a positive and statistically significant impact on dengue indicators. Nadia K.N. [7] believed that improvements in vehicle and road design, medical technology and care, and driver education and training have decreased the incidence of traffic accidents and several evidences showed that fuel price changes also had a major impact on road traffic accidents through other mediating factors. For example, less car travel and more fuel-efficient driving like speed reduction on high-speed roads could reduce driver exposure. Furtherly, it was proved that the high fuel price increased road traffic accidents. Ryan W.A. et al. [8] provided a methodology and costing structure that facilitates the calculation of true construction accidents costs, used an incidence-based-post 'approach to promote the internalization of true accident costs and positively proposed the improvement of safety programs.

Compared with the research on accident-related technology and engineering strategy abroad, domestic scholars also have a lot of research on accident basic theory, and there is a "two-wheel drive" trend of accident engineering and accident basic research in our country. Luo Tongyuan and Wu Chao [9] proposed an accident cause theory based on the cognitive model of safety information, which studied the role of safety information in the occurrence of accidents from information dissemination and cognitive processes. Huang Lang et al. constructed the conceptual model of accident chain evolution based on material flow, energy flow and information flow and summarized the strategy framework of accident prevention and control [10]. Fu Gui et al. [11] clarified the development history of accident causation models over the past 100 years, and believed that 'Organizational factors' would be replaced by more modern 'safety management systems' and people would pay more attention to the role of 'safety culture' in accident prevention. Li Xiangxin discussed mechanism of the multi-hazard coupling effect based on analyzing multi-hazard coupling types. Hazard area model of accumulation and amplification effect was determined through the disaster initial risky index as well as the risk composite index of harm extent for the multi-disaster coupling accidents[12]. Zhang Jianshe et al. ZHANG analyzed the effect pathways of safety accidents on each dimension as well as an empirical test by using structural equation model [13].

To sum up, at present, the scientists have carried out relevant research on accidents from the two dimensions of accident engineering application and accident basic theory. Although they have obtained certain theory and application value, these two research paths limit the development of upstream basic theory of accident science. it is also not conducive to promoting the development of safety science as a whole. Accident researchers often focus on their departments or industries and take specific accidents as the starting point to put forward new methods or solve new problems combined with accident analysis technology. There are several

types of tendency characteristics: ①the construction of accident cause model, ②the new application of old accident model, ③the transfer and application of other scientific theory, ④the industry practice of self-scientific method. The above researches have not stripped the core essence of accident science, and have not formed the theoretical accumulation of accident itself. Accident science as a new cross-discipline, its discipline system remains to be improved, and its theoretical basis is still very weak. At present, the research on accidents, especially the exploration of mechanisms and laws, is more towards the perspective of risk, emergency and safety. A series of self-theories related to accidents, such as what is an accident, what is the nature of an accident, what is the characteristics, connotation and mechanism of an accident, and so on, are not unified and have a high degree of understanding. Studying accidents is a necessary topic for safety workers, and how to prevent or reduce accidents is also very important. Scholars who study accidents pay more attention to specific problems, rather than learning, do not pay attention to the promotion of accidents into a discipline. This is the malpractice of emphasizing transformation rather than research and application of theory at present.

The comprehensive and intersecting characteristics of safety science determine that it must be integrated with other disciplines in order to develop in the long term. The new accident theory should consider not only the achievements of management, sociology and political science, but also the theories of epistemology and philosophy to realize the security of different views of knowledge. In the context of the current complex social and technological systems and activities, it is no longer allowed to exist simple and linear security theories, methods and models to solve increasingly complex security problems. Modern social and technological systems are open "system of system", and their complexity and coupling are increasing day by day. For the security design and operation of the system, it has become an urgent scientific problem to study how to improve the security resilience of the system itself. It is difficult for traditional safety engineering methods to keep up with the development of new technologies and new technologies. These methods are based on a certain degree of predictability and decomposable assumptions. This is the disadvantage of the traditional method collectively known as "safety I". In view of the continued international attention to resilience engineering, finding a new breakthrough for safety science issues has also become a matter of urgency, resulting in a methodology called "safety II" that controls adaptation to unexpected situations. It is necessary to transfer the research of safety accidents from the surface research that promotes the analysis and prevention of system accidents to a deeper model and a more abstract dimension. The period of risk activity before the accident of the system is also the embodiment of the value of resilience.

At present, accidents are still deeply rooted in the hearts of the people all over the world. Accident researches are easier to be recognized by the society than the current safety-related disciplines. Thinking from the perspective of discipline construction, it is still possible to give new content to accident research. There are tens of thousands of domestic and foreign accident-related documents, which have long been in the shackles of the involuntary effect. So far, there has been a lack of improving accident research to the height of discipline construction. Accelerating the establishment of accident science has become an urgent requirement to build a basic theoretical system of safety science. This paper tries to discuss the basic problems of the establishment of accident science in order to lay a foundation for the development of the branch of safety science.

2. RELATED CONCEPTS OF ACCIDENT SCIENCE

2.1. New Definition of Safety

Safety means no accident, but no accident does not mean safety. Accidents are the origin of safety research, and safety is an abstraction based on accidents. In order to study the problem of accidents, we must first clarify the basic concepts of the relevant disciplines, and in the category of safety science, it is urgent to analyze the new definition of accident science based on the thinking paradigm of accident. According to this thinking, some new vocabulary understandings of new disciplines are established, and the concept of subject in the field of safety science can be restated with accident thinking according to the science guidance. Referring to the literature at home and abroad, we can see that the concept of safety discipline is not unified so far, and scholars understand the concept of safety from different angles. Basic concepts guide the establishment of basic theories. At the discipline level, the primary task is to clarify the basic concepts, and the expression of the main safety concepts and connotation interpretation are shown in the followings.

Liu Qian, one of the predecessors in the safety field in China, put forward a scientific definition of safety. "Safety is the existing state (or health status) in which people's body and mind are protected from external factors and its guarantee conditions" [14]. The definition strictly summarizes the nature and characteristics of safety. Based on this, a new definition of safety is proposed. Safety is an activity carried out in order to enable rational people to achieve a certain intention within a certain scope of time and space, and through the adoption of management and technical means, it achieve the comprehensive state and guarantee conditions of rational people's physical and mental well-being, stability of system elements, control of organizational functions, prevention and resolution of risks. The basic connotation of the new definition is as follows.

(1) The new definition is a logical refinement under the discipline theory of accident science, reflecting the characteristics of accidents. The foregoing shows that the accident has the characteristics of system process and occasional loss, and taking accident science as a starting point to explain that the basic definition of safety reflects more emphasis on the core of safety research, highlighting that the fundamental problem of safety research should be accident. It is an attempt to refine the safety problem in conjunction with accident science, which can make a further discussion on the accident-related theory. From the new definition of safety, it can be seen that safety is still a comprehensive state and a set of conditions to guarantee this state, which is not a simple application but is clearer and more specific than the traditional definition. Showing the state problem is not only about the physical and mental harm of human beings, but also extends to the areas of factor stability, organizational control, risk mitigation and so on. The reason for expanding the scope of the new concept is to take into account the systematic process and prevention complexity of the accident.

(2) Define the conceptual subject category and clarify the research boundary. The rational person mentioned in the definition is different from the irrational person, and the general accidents are often caused by the behavior of the rational person. The rational person mentioned here is a person whose cognition, experience, perception, consciousness, attitude, emotion and personality characteristics under normal state meet the statistical state of most people. Such as mental abnormality, chaotic thinking, visual and auditory hallucinations, passionate crimes and minors without civil capacity can be categorized as irrational people. Rational people are very important in social life, especially for ensuring system safety. The definition of safety defines the subject nature of human beings, which also shows that security research must be considered within a certain range of elements. Otherwise, the lack of a clear boundary will easily lead to chaotic scientific definitions.

(3) Determine a certain category of time and space to provide assumptions for the content of safety research. Ontologically speaking, if there is no limitation of time, space and nature, accidents exist objectively and disappear without human will. So far, human understanding of safety science is still very limited, and human beings have not fully grasped the changing laws and various emergence results of accidents. According to the epistemological and ontological viewpoints and the theory of complex systems science, accidents actually occur in the form of emergence, if a certain field of time and space is not defined, that is, the scope of discussion is not defined, then safety problems will always arise, which is an inevitable objective law. Safety has explicit value only in a certain field of time and space, and the problems of accident science can also be recognized and understood.

(4) Human activity is one of the basic connotation of safety, and there is no accident without activities to achieve a certain purpose. No matter what kind of system it is, as long as people participate, some activities will take place, and the elements of the system are always dominated by certain activities. In a broad sense, human activities are a series of activities of different scales and types in order to survive and improve living standards, including agriculture, forestry, fishing, animal husbandry, mining, industry, commerce, transportation, tourism and various engineering construction. Human is a constituent element of the system. In recent hundreds of years, the irrational overspeed development of human society has made human activities become the dominant negative factor affecting the security of various systems in the society. Such as accidents in high-risk industries, accidents in social life, damage to system and failure of personal safety protection, all of these have sounded the alarm for human safety. Therefore, some human activities must be taken as the prerequisite when studying the safety core of accident science.

(5) Management and technology are the core of safety methodology. From a broad perspective, all accident prevention methods are nothing more than engineering and management. The safety problem is a comprehensive system problem involving many aspects in the whole field, and comprehensive measures must be taken to solve the safety problem. Accidents are caused by complex factors or chain reactions. therefore, comprehensive and systematic measures must be taken for accident prevention. Only by adopting a two-pronged approach to cure both the symptoms and the root causes can we achieve immediate results. Accidents will inevitably involve human participation, and the study of human beings is inseparable from the means of management. the theories of sociology, management, politics, psychology and behavior play a core role in individual control. The operation of the material (device) in the system is inseparable from the blessing of the existing technical means, in which electronic and electrical technology, computer technology, mechanical material technology and "four new" play a fundamental role in control of material. Therefore, the study of accident science and the definition of new safety from the most important human and material factors in the system requires a dual approach of management and technology.

(6) The core content of the new safety includes four aspects: physical and mental well-being, stability of system elements, control of organizational functions and prevention and resolution of risks. The safety of human body and mind is the basic pursuit of safety. The traditional definition of safety is to take the body and mind as the research object, which involves the body, that is, the physical body is healthy and the external psychological is noninvasive. Physical health means that the body is not subject to sudden injuries (occupational injuries and life accidents) from outside, and chronic occupational diseases are also included. Psychological non-invasive refers to the long-term and intractable secondary cognitive impairment caused by internal accidents (such as psychological shadow, nightmares, false hallucinations). The new safety definition refers to this part of the research as transforming accident people. The stability of system elements refers to the stability mechanism and method against accidents from the point of view of system resilience. The content includes four aspects: system structure stability,

system function stability, system risk stability and system element stability. One of the connotations of new security is to take system engineering as the paradigm to promote the maintenance of system stability. The control of organizational function means that the basic functions of social organizations are controlled to a certain extent in the process of realization to prevent functional disorders and morphological spillover. Preventing risks is one of the new missions of new safety, and defusing risks is also the content of safety research. New technologies and management measures are introduced in the study of how to determine risk factors, risk classification and risk control.

2.2. Basic Concepts

According to the new safety definition and its connotation, a series of basic definitions of safety science can be concluded. Table 1 shows the new definition and connotation of important basic terms in the field of safety science, from which we can see that a series of concepts based on accident thinking are necessary and valuable for the construction of basic accident science. Only after clarifying the concept can we provide ideas for the basic research of accident discipline and avoid impracticality.

Table 1. Basic concepts of Accident Science & Expressions based on new safety definition

concept	definition	connotation
Safety	Safety is the comprehensive state and guarantee conditions for rational people to adopt management and technical means in the process of realizing a certain intention in a certain time and space to achieve the physical and mental well-being of rational people, the stability of system elements, the control of organizational functions and the prevention and resolution of risks.	The new safety definition has eight important connotations. See above.
Risk	Risk is the possibility and severity of harm to rational people in the system in a certain time and space.	The possibility and severity of damage to the elements in the system not only determines its state, but also reflects the security state of the system. It can be described qualitatively and quantitatively.
Accident	Accident refers to the harmful results that lead to the physical and mental damage, the destruction of system elements and the failure of organizational function of rational people in a certain time and space.	Accident can be understood as a state or event, which generally produces undesired consequences and has a systematic destructive effect. The accident will inevitably lead to certain negative consequences.
Danger	Danger is the state in which the system may be endangered in a certain time and space and the lack of safeguard conditions or a measure that may lead to negative consequences.	Danger can be quantitatively described by the degree of danger. Danger can be regarded as the actual premise of risk. In the system, the danger may be caused by the unsafe behavior or unsafe state of the system elements.
Hidden Danger	The hidden danger is the unsafe behavior of all people who may cause danger in a certain time and space, the unsafe state of things, or the defect of management.	Including hidden dangers of the system, hidden dangers of the system elements and external hazards, unsafe behaviors of people, unsafe states of things, bad environment and management defects all belong to hidden dangers of the system elements.
Source of Danger	The hazard source is the sum of the internal and external factors that can form the systematic risk hazard in a certain time and space.	The actual source of danger may exist, but it does not necessarily bring danger, or even an accident. Hidden danger must be a source of danger, and the source of danger is not necessarily a hidden danger.

Accident science covers a wide range of areas, and the breadth and depth involved are extremely profound. The contents of accident science are the fundamental elements to promote

the development of safety science at all levels of upstream, middle and downstream. Based on the analysis of accident science, there are five levels of logical associations: accident systematic system, accident person subsystem, accident material subsystem, accident environment subsystem and accident management subsystem. And accident science has three levels of realistic relevance: prevention in advance, handling during the event and recovery after the event.

3. BASIC PROBLEMS OF ACCIDENT SCIENCE

3.1. The Definition

Safety is an ancient topic, but accident science is emerging as one of the safety disciplines. In the national standards for discipline classification, many safety disciplines are in urgent need of improvement and development. Accident science is a virgin land for basic research. The purpose of the establishment of accident science is mainly to clarify the confusion of the basic theory of accidents and form a consensus on accidents. This paper discusses the subject boundary and research category of accidents and establishes the conceptual model of safety accident science from multiple perspectives. According to the aforementioned accident concept and the purpose of accident science, and based on the interpretation of several concepts in safety science, the definition of accident science can be summarized. Under a certain category of time and space, accident science is a comprehensive cross-discipline, which taking safety as the purpose and the accident as the research object studies the mechanism and law of accident cause, evolution, disaster or disappearance, accident prediction, prevention optimal control methods engineering measures in the management and technical means of emergency, exploration, identification, treatment and reference of accidents. It is simply understood that accident science is a safety scientific theory that studies the law, management and technology of accidents in the system. The conceptual model of accident science is shown in figure 1. Through the construction of the conceptual model, the research purpose, research object, research content, theoretical basis and discipline objectives of accident science can be clearly defined, which lays a foundation for exploring the development of accident science.

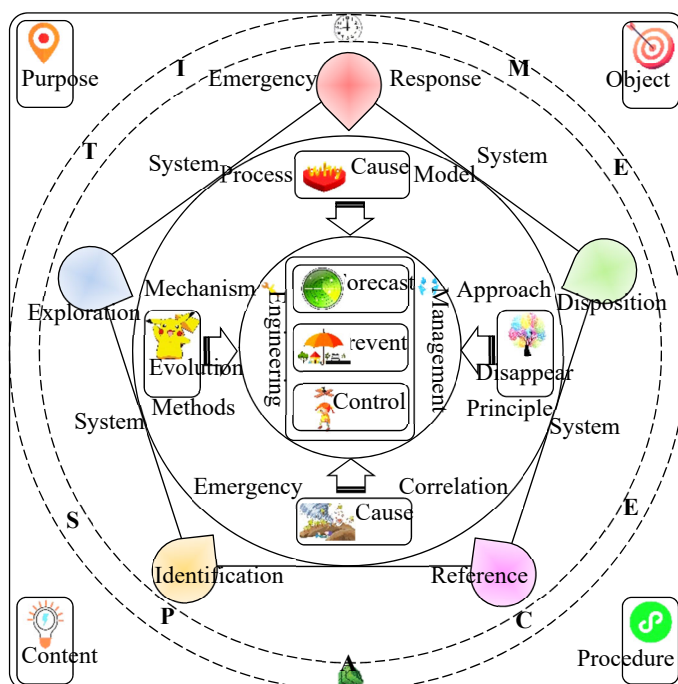


Figure 1. Definition model of accident science

3.2. Connotative Explanation

Accident science is a comprehensive and interdisciplinary subject. Solving subject problems requires the support of multidisciplinary theory and the comprehensive application of scientific principles to guide the establishment of accident theory [15]. According to the accident definition model above, it can be seen that the concept of accident has important connotation and denotation. The concepts and subject connotations involved in accident science are explained as follows.

(1) The definition of accident discipline describes the basic framework of accident science. From the conceptual model above, we can see the purpose, object, content, procedure, method, theory and disciplinary framework of accident research. In the concept, a certain scope of time and space is defined for the study of accident science, which provides the basic conditions for the subject construction to limit the assumption and materialize the research object. System as one of the objects of study reflects that accident science exists in order to solve system problems, which is the mission entrusted by history. After the long-term development of accident theory, it has gradually formed a scientific hypothesis in line with human scientific cognition and reality. The trend of systematic research also promotes the transformation and upgrading of safety science. The research purpose of accident science is to achieve system safety, and this purpose is also the endogenous driving force for the construction of new disciplines. It is important to understand that the purpose and object of research is the philosophical scientific problem that must be solved in the establishment of accident science.

(2) What is the “3-4-5” model of research content? It can be seen from the model diagram that the research content of accident science is very complex and in-depth, and the structural research content can be roughly divided into three layers. That is, the outer layer includes emergency, exploration, identification, treatment, reference and other programs and technical means. The middle layer includes engineering or management measures for the cause, evolution, disaster or disappearance of system accidents. The inner layer includes the prediction, prevention and control methods of an accident. The research content of accident science is the core of the concept of accident science, which supports the development and improvement of accident theory. The following points are the specific explanation of the research content.

(3) The “3” of accident science refers to the prediction, prevention and control methods of accidents of the inner layer, which is one of the core contents of accident research. Accident prediction is a comprehensive measure that uses prediction methods to analyze the risk and risk degree of accidents, then to provide managers with accident risk, accident severity assessment and early warning of accident consequences. Accident prevention is an accident management method based on prediction. Combined with the results of prediction, a series of engineering and management programs are put forward to prevent the occurrence and development of accidents. Accident control is to learn from the management control theory to strengthen the control of various elements in the accident management system, in order to achieve the purpose of accident prevention, emergency and safety. The important part of accident research is prevention in advance, emergency in the event and prediction after the event. Generally speaking, it is the theory of control methods for accidents.

(4) The “4” model of the research content is the engineering or management analysis of the cause, evolution, disaster or disappearance of accidents in the system. Through the cause analysis, the cause, rheology, derivation and coupling relationship of the accident are obtained. Accident evolution has also been a research hotspot in recent years in accident studies, because the more complex the system is, the easier it is to produce the evolution and change of accident. This evolutionary process is an important cause of derivative accidents and chain accidents. The cause analysis of disaster is caused by the disaster effect after the accident. The small accident

evolves into a big accident, and the big accident evolves into a disaster. Both natural disasters and man-made disasters can be caused by the disaster-causing effect of complex accidents. Accidents also have the stage of disappearance, no matter which link of the life chain of disasters and accidents can take measures to cut off the development of accidents, and finally make the accidents disappear. These are the specific description of the "4" model of accident studies in the middle layer, which is also a bridge connecting the outer layer and the inner layer.

(5) Specifically, the "5" of the content model is five aspects of emergency, investigation, identification, treatment and reference. Among them, emergency is the process of rescue and treatment after the accident, which is not only the product of traditional post-event management thinking, but also a common practical method of accident management. Investigation is a specific preliminary work carried out after the accident, which provides a preliminary reference for search and rescue at the scene of the accident. Identification is the basic process of analyzing the cause of the accident by using the materials such as personal evidence and material evidence at the scene of the accident. Treatment is to put forward technical and management measures for the parties and matters of the accident according to the analysis of the nature and cause of the accident. Reference draws lessons from the knowledge and experience of similar accidents in accident analysis and prevention, and provide cases for the specific disposal of accidents. The outer layer model of accident science is the focus of modern safety science research. With the development of history to modern society, accident research is moving towards the direction of law and mechanism, and future accidents are bound to develop towards the core of prediction, prevention and control. The above three points are based on the accident science research content of the "3-4-5" model, which aims to promote the further and scientific development of accident science research.

(6) A comprehensive cross-discipline based on engineering measures and management measures. Accident science is the underlying basic research field of safety science, which is guided by the methods and principles of safety science under the framework of safety science. Safety science is a large cross and comprehensive science, and the content involved is very complex. It roughly includes the theoretical support of more than ten basic disciplines, such as science, engineering, management, law, liberal arts, medicine and so on. The attribute of cross-discipline determines that the study of accident science must find a new way in accordance with the law of accident science on the basis of reference and integration. The basic theory of accident science is not a self-system with its own profound scientific accumulation, but another system that needs integration and innovation. The methods, principles, procedures and systems of accident science research are constantly absorbed and innovated in the development of the discipline. The study of accident science is inseparable from human beings, who are not only the parties to the accident but also the decision-makers of the accident. The research involving people is not a simple problem in the field of technical engineering, but a comprehensive complex body that must carry out psychological, physiological, behavioral and cognitive research. such research requires the multi-disciplinary intervention of engineering measures and management measures.

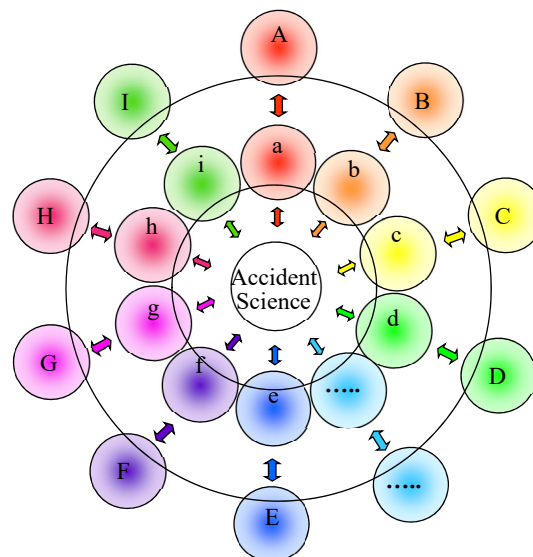
(7) Generally speaking, the concept of accident science is a preliminary exploration, which is of fundamental significance for follow-up in-depth research. There is almost no special precedent for systematic research on accident science at home and abroad. after thinking deeply about the current development situation and future trend of safety science, the author decided to conduct a systematic study of accident science. Truth is always developing, and there is no absolute exhaustion of truth. The basic concept of accident science is also inadequate or even wrong, which needs to be constantly improved and condensed thinking. The development of safety science is a spiral process in China, and countless scholars should be admired for their corresponding contributions from their respective fields. The author hopes that the conceptual

model of accident science established above can also be regarded as a small innovation of safety science and provide a new method for follow-up research.

4. THEORETICAL BASIS AND DISCIPLINE CLASSIFICATION

4.1. The Theoretical Basis of Accident Science

As one of the basic disciplines of safety science, accident science also has the basic attributes of safety science, and accident science also has the characteristics of comprehensive and interdisciplinary science. Throughout the development of other disciplines, we can see that many classical basic disciplines (majors) are produced through a certain form of synthesis on the basis of intersection. The interdisciplinary intersection of accident science is a comprehensive intersection involving multi-level relations, including the basic interdisciplinary of the outer layer and the related disciplines of safety science in the middle. Accident science is mainly related to safety behavior, safety evaluation, safety psychology, safety management, safety ergonomics, safety law, safety systems, safety pedagogy, safety monitoring and monitoring, safety planning, emergency management engineering and industry safety engineering. Through the intersection of the above disciplines, accident science has a theoretical basis based on cross-disciplines, and forms its own theoretical system under the theoretical basis of other disciplines. The main theoretical basis of accident science is law, psychology, pedagogy, behavioral science, management, economics, systems, mathematics, physics, chemistry, biology, logic, investigation, technology, engineering and so on. These basic theoretical disciplines are combined with safety to form a safety-based discipline, and then become the basis of accident science.



Note:

A: behavioral science; B: management; C: ergonomics; D: law; E: system science; F: economics; G: pedagogy; H: psychology; I: technology,
 a: safety behavior; b: safety management; c: safety ergonomics; d: safety law; e: safety systematics; f: safety economics; g: safety pedagogy; h: safety psychology; i: safety assessment

Figure 2. The theoretical basis of accident science

The theoretical basis of accident science is complex and diverse. Based on different research perspectives, targeted basic theories can be obtained, which are combined with different dimensions of accident research to form a model under the background of accident discipline.

For example, the cheese model in management has become one of the accident cause theories when it is transferred to accident research. Monte Carlo simulation algorithm in system science can be used to calculate the occurrence probability and accident risk of system links. The application of behavioral cognitive theory in accident research is the cognitive processing process of safety information, and the resulting information distortion leads to the model of accident. The psychological effect of psychology on the decision-making mechanism of people's unsafe behavior in accidents is also the key content of accident science research. Evaluation methods in technical science are widely used for risk assessment and hazard grade determination, and so on. Therefore, accident science needs the theory of various disciplines as a support. In fact, the establishment of the discipline of accident science is the innovative exploration of the discipline. Specifically, the interdisciplinary relationship of accident science is shown in figure 2.

4.2. Discipline Classification

At present, there are few disciplines related to special accidents in the Classification and code of disciplines, and there are many blank disciplines in safety science that need to be supplemented and improved. Accident science as a new discipline still lacks the necessary theoretical system, so its research content is comprehensive and complex. First of all, the establishment of the discipline system needs to be guided by the foundational disciplines, to study the further classification and refinement of the discipline branches, and to learn from the natural science system to complete the enrichment and perfection of the discipline branches of accident science. According to the research field and definition of accident science, it can be seen that it has an independent discipline system. Accident science is formed by the cross integration of safety science system, natural science system and management science system, and subordinates to the foundation of safety science. The discipline of safety science has a wide range of research fields and branches, and the accident science as a branch discipline of safety science have a rich discipline system. On the basis of learning from the attributes, levels and research objects of different disciplines of safety science (WU, 2007), this paper attempts to enumerate the discipline branches of accident science combined with the research objects of accident science. The branches should at least include: accident psychology, accident cause theory, accident evolution law, accident prediction and prevention methods, accident emergency management, accident investigation methods and techniques, accident simulation and reproduction technology, accident identification technology and norms, accident control engineering, typical accident cases, accidents in a certain industry, et al.

5. RESEARCH CONTENT OF ACCIDENT SCIENCE

From the definition of accident science, it can be concluded that the research content of accident science is the "3-4-5" model, which is divided into the aspects of accident prediction, prevention, control, engineering or management analysis of accident cause, evolution, disaster or disappearance, emergency response, exploration, identification, treatment and reference. To sum up, the research contents of accident science are mainly classified into the following three aspects.

(1) Research on accident theory

In the study of accident science, the most basic and important task is to analyze the cause of the accident and the mechanism behind the accident. The accident is the result of the comprehensive influences of many system factors. With the increasing complexity of the social and production system, the variability and complexity of hidden dangers are also increasing. The control and management methods of sources of danger also urge managers to think about how to achieve safety management, on the basis of which a new understanding of accidents is formed. The cause model has existed for a long time, but the accident theory which accords with

the characteristics of the period is seldom. One of the research contents of accident science is to excavate the accident cause theory and accident mechanism.

(2) Research on accident application management

As an unexpected result, accidents rarely involve the technical knowledge of accidents, but as a discipline, a theoretical system and methodology in line with the applied technology of accidents should be established. The ultimate goal is to use the accident principle and model to explain the process of the accident and to use the accident analysis method to study the law of accident development. In the aspect of analogue simulation, further research is also needed to provide scientific guidance for emergency rescue and prevention. The prevention organization strategy before the accident, the emergency management method in the accident and the improvement and promotion plan after the accident are all the practice of accident application management.

(3) Basic researches on the discipline of accident science

The basic contents of accident science, research framework, research objectives, accident science principles, accident science methodology, accident science procedures, accident strategy analysis etc. are involved. The study of the discipline is more from the perspective of scientific thinking to use a systematic method to construct the disciplinary basis of accident science. Based on principles, methodology, conceptual framework and practical methods, the theoretical research of accident science draws lessons from the framework and construction models of other safety science disciplines, then innovates the framework system of accident science, and finally realizes the independent discipline system of accident science.

6. CONCLUSIONS

(1) Accident science can be regarded as a comprehensive science under the intersection of multi-disciplines, and accident science needs the cross-integration of sociology, management, engineering and other disciplines. Various management models can provide theoretical reference and guidance for accident cause models, and sociological methods provide a supporting basis for accident prevention. People are always at the core of social accidents. Realizing the function of the system and ensuring the safety of the system are decisions that people participate in. In accidents, people's cognition and behavior will affect the development and trend of accidents, and the spread and coupling of accidents in the system will also be affected by people. The accident itself has certain system characteristics. An accident is a state in which the various elements of injury are coordinated under a certain morphological structure. The accident is the inevitable result of the increase of system entropy. Entropy is the inherent attribute that leads to the destruction of system balance, and the increase of entropy means that the safety state of the system is challenged.

(2) Under a certain category of time and space, accident science is a comprehensive cross-discipline, which taking safety as the purpose and the accident as the research object studies the mechanism and law of accident cause, evolution, disaster or disappearance, accident prediction, prevention optimal control methods engineering measures in the management and technical means of emergency, exploration, identification, treatment and reference of accidents. It is simply understood that accident science is a safety scientific theory that studies the law, management and technology of accidents in the system. The concept of accident science can be summarized as "3-4-5" model. That is, the outer layer includes emergency, exploration, identification, treatment, reference and other programs and technical means. The middle layer includes engineering or management measures for the cause, evolution, disaster or disappearance of system accidents. The inner layer includes the prediction, prevention and control methods of an accident.

(3) Accident science is formed by the cross-integration of safety science system, natural science system and management system, which is subordinate to the foundation of safety science. The discipline of safety science has a wide range of research fields and branches, and the accident science as a branch of safety science has a rich discipline system. The main theoretical foundations of accident science are law, psychology, education, behavioral science, management, economics, systems, mathematics, physics, chemistry, biology, logic, investigation, technology and engineering, etc. The main branches of accident science should at least include accident psychology, accident cause theory, accident evolution law, accident prediction and prevention methods, accident emergency management, accident investigation methods and techniques, accident simulation and reproduction technology, accident identification technology and specification, accident control engineering, typical accident cases, accidents in a certain industry, and so on.

(4) The basic theory of accident science is not a self-system with its own profound scientific accumulation, but another system that needs integration and innovation, and constantly absorbs and innovates the methods, principles, procedures and systems of accident science research in the development of the discipline. The research content is the "3-4-5" model, which is divided into the aspects of accident prediction, prevention and control, engineering or management analysis of accident cause, evolution, disaster or disappearance, emergency response, exploration, identification, treatment and reference. To sum up, the main content of accident science research is divided into three parts: accident cause, accident application management and basic research of accident science discipline.

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