Significant Features of Innovating Signal Control and Transport Management Systems

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In the context of the integration of the EU, against the backdrop of building a trans-European railway network and of establishing safety management for that network, signal control and transport management systems are gaining further importance.

The decision-making apparatus of the EU is deeply involved in European railway network and safety management. Specifically, the European Commission proposes directives which member nations are obliged to conform to in their different national rules and regulations, and the European Parliament and the Council of the European Union coordinate and adopt those directives. The EU enacted the Railway Interoperability Directive on the European network in 1996 and 2001 (integrating and amending those two directives in 2008) and the Railway Safety Directive on safety management in 2004.

Interoperability aims at ensuring smooth train operation over borders by harmonizing different national train control systems. The Railway Interoperability Directive specifies essential requirements to achieve that aim. The European Rail Traffic Management System/European Train Control System (ERTMS/ETCS) has been developed to achieve interoperability, and its detailed component subsystems are specified in Technical Specifications for Interoperability (TSIs) which explicate the essential requirements. Safety conditions for system development and production under ERTMS/ETCS also refer to EN standards for reliability, availability, maintenability and safety (RAMS), for electronic systems for safety-related signaling, and for software. They also specify authentication of conformity to those standards, including cross-acceptance. The recent remarkable proliferation of IEC standards on railway signaling reflects these European circumstances.

In order to facilitate step-by-step introduction, ERTMS/ETCS has two application levels: Level 1 to achieve ATP functions, and Level 2 to achieve radio-based cab signaling with track circuits. By the end of 2008, use of Level 2 system had started on sections of approx. 2,000 km total track length in Switzerland, Italy, Spain, the Netherlands and Germany. Meanwhile, Level 1 systems have been put in use in Austria, Hungary and other countries.

At the same time, the entirety of safety management for railways in the EU, from the concept to measures to achieve that, is conducted based on the articles of the Railway Safety Directive. Among those, Safety Management Systems (SMSs) of individual railway operators and infrastructure managers are systems for the national safety authorities that control those parties, and they mainly provide processes and procedures under the European system of infrastructure and operation separation. Implementation of SMSs from 2012 is obligatory, but SMSs do not specify details; thus, they do not impose heavy burdens on railway operators and infrastructure administrators.

Common Safety Methods (CSMs) are risk assessment methods for railway transport and facilities that cover more technical topics on operation and facilities. Quantitative Common Safety Targets (CSTs) have been determined at values achievable for all member nations as a common framework building process for safety management. Actual values are based on past accident data such as

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the number of fatalities per train or kilometer. Furthermore, risk assessment is required in cases such as facilities renewal and new system development. As an impact assessment method for the safety of railway system change, CSMs require application of one or more of the following three risk acceptance principles: (1) risk assessment by applying codes of practice, (2) risk assessment by comparison with similar systems, or (3) risk assessment by explicit risk estimation. In April of 2009, the European Commission enacted a regulation that obliges conformance to CSMs within the area of the EU from 2012 (partly from 2010).

What is the situation then with general industries other than railways in Europe? In order to create a single market for the EU, the Council of the European Union promulgated the so-called "New Approach" and "Global Approach" in the period from 1985 till 1993. Those cited different national safety and quality standards as barriers to free movement of products in creating the EU's single market, and they gradually established EU directives that specify the essential requirements by product and sector. Member nations must harmonize national laws in accordance with those directives. Essential requirements are the minimum requirements to protect public interests. European standardization organizations define technical specifications that fulfill essential requirements as harmonized standards. Manufacturers must undergo conformity assessment and attach CE conformity marking on their conforming products. Whether conformity assessment should be done by the manufacturer or by a Notified Body is determined by the formalized "Module" methods. Today, there are approx. 25 EU directives such as the Machinery Directive applicable to industrial machines and the Electromagnetic Compatibility (EMC) Directive.

What is important is that harmonized standards require implementation of risk assessment before the distributions of products to the market and that strict safety management based on the risk through the full life cycle, including countermeasures against misuse, is required. The US Department of Defense standard (MIL-STD-882), started in the 1960's, and diversified methods to ensure safety established in other different application fields can now be regarded as having converged with methods based on risk control.

Such measures are for the creation of a single market in the EU area, but now we can understand that the above-mentioned framework to build a trans-European railway network and establish safety management methods is in line with those measures. Then, in the light of the situation of general industries, how should signal control and transport management systems be?

In Japan, many accidents with elevators, amusement attractions and other products have made headlines. It can be pointed out that the cause of those accidents is the lack of a perspective of safety management throughout the life cycle including advance risk assessment and maintenance. That demonstrates to us the importance of the advance implementation of countermeasures using harmonized standards. In the railway sector also, the importance of risk-based safety management will continue to grow, even though the situation is somewhat different from that of other industries. In particular, the EU's CSMs for railway safety management set down the need for focusing on traditional safety principles and technologies and studying those even using them in combination when quantitative evaluation in explicit risk assessment is applied. This view can be shared and it is possible to learn from those methods.

At the same time, the active attitude of European nations in technology development for signal control and transport management systems can hardly be perceived. That could be because they are too busy in implementation of Level 2 ERTMS/ETCS for achieving the interoperability in the EU area to develop other systems such as Level 3 systems without track circuits. As many European railways still use existing train control systems, they cannot immediately introduce new ERTMS/ETCS to replace existing systems. A long-term migration plan to new systems is thus necessary. Furthermore, individual optimal solutions for railway operators or infrastructure managers are not always appropriate to the railway as a whole.

Signal control and transport management systems should ideally be the systems to achieve the visions of railway management. As Japan implements regional separation instead of infrastructure operation separation, system technology development based on the visions of railway management is more possible. Optimal solutions can be sought to achieve advanced functions and their optimal allocation to wayside facilities and on-board devices from a comprehensive perspective. Even total system development including stations is possible. Regardless, it is also true that EU's efforts in railway networks and safety management give useful suggestions for the railway safety management in Japan and for global technology development.

Today, technology development is underway in Japan for signal control and transport management systems such as network signal control systems, the Advanced Train Administration and Communications System (ATACS) and the next-generation greater Tokyo area railway system. While it is important to understand Europe's efforts, which are underway from a different perspective, there remains our responsibility as opinion leaders in the sector to put out information globally, on advanced signal control and transport management systems based on railway management vision, and to propose international standards.