AUTOMATIC SUPERVISION SURVEY FOR SPICA-RAIL PROGRAM

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Abstract

Also considered as not safety critical, modern railway traffic control system remains the ultimate solution to solve potentially dangerous scenarios (Belmonte 2006). Also, study the impact of Automatic Train Supervision (ATS) systems on railway safety is mandatory. The way of simulations analysis was chosen to perform necessary human operator's behaviours evaluation. Real ATS system is installed in our research centre. Before starting evaluation, a state of the art of industrial supervision, including the widest panel of activities was performed. This work, including traffic control supervision survey, show relevant information on modern aspect of supervision.

Keywords: Supervision, Traffic Control, Railway control centre, safety.

1 Introduction

Train Control Centres have evolved over time to include many other functions than the initial ones of tactical and strategic control over the traffic network. In keeping with technological developments, customer requirements on Train Control Centres have become ever more sophisticated, requiring increasing numbers of functions in order to extract the best from their existing assets.

This paper first presents a state of the art of modern industrial supervision systems, including the widest possible panel of activities (urban and intercity railway, civil and military nuclear applications, chemistry, air traffic...).

The paper will then present experimental platform integrating a modern railway supervision system similar to a real one (ALSTOM Transport's supervision product: ICONIS™), installed in Compiègne research centre. Using this platform, it is possible to re-create in laboratory real accidental scenarios, and to be able to confront human operators with these situations, in order to analyze the impact of supervision on railway safety by studies of the human machine system through user's centred point of view.

2 Industrial survey

2.1 Companies visited

A general survey on automatic supervision was performed from March 2005 to January 2006 (see Table 1).

The supervision systems visited are divided in three categories: (1) supervision of industrial process; (2) supervision of "launching system" and (3) supervision of traffic control.
Supervision of industrial process includes the supervisory control of a plant (manufacturer, chemical, energy production, etc.). The "launching system" class represents all system that performs one shot production with sequential preparation actions. An example of typical launching system to supervise is the spatial rocket launching sequence before launch. Finally traffic control supervision consists of guiding mobiles in one, two or three dimensions.

Company	Places visited	Domain	What to supervise
CEA	LIL (Laser line integration)	High technology, defence and prototype experiment	"Launching system"
	LMJ (Laser Mega Joules)	High technology, defence and experiment	"Launching system"
CFF	Computer-controlled all-relay interlocking Lausanne's station	Mainline railway transport	Traffic Control
	Regional operation process	Mainline railway transport	Traffic Control
CRNA-Nord	North French air traffic control	Aerial transport	Traffic Control
EDF (CIPN)	Nuclear power plant engineering	Energy production	Energy production process control
RATP	Centralized Traffic Control CTC (Bourdon)	Metro transport	Traffic Control
	CTC RER A	Urban railway transport	Traffic Control
	CTC 14th line (METEOR)	Automatic metro transport	Traffic Control
	CTC 4th line	Metro transport	Traffic Control
SANOFI-AVENTIS	Vitry (94) production unit	Pharmaceutical, chemical industry	Discrete or continuous chemical processes
SNCF	Computer-controlled all-relay interlocking Paris Montparnasse station	Mainline railway transport	Traffic Control
	Centralised traffic control of French's South-West high-speed line	High-speed railway transport	Traffic Control
Transpole	CTC Lille	Automatic metro transport	Traffic Control

Table 1: Panel of industrial surveyed

2.2 Supervision of industrial process

The visit of the engineering centre of nuclear production has revealed that everything is controlled from a single control room. In this room, the operators vary the electrical power emitted according to the consumers needs and the reactor behaviour is managed regardless the operating mode. The computerized supervision is a specific post of this room. It is not related to the reactor behaviour. Although non critical for safety, this system is very appreciated by the operators because it provides information allowing the checking of the analysis carried out starting from the conventional instruments without the data processing assistance. Being unable to prove the reliability of the information provided by the computer based supervision, the use of this one in a situation of preservation of nuclear safety or safety of the auxiliary systems and people is formally

prohibited. The continuous formation of the operators and the regular carrying out of crisis simulations on simulator is very significant in order to guarantee the training and the effectiveness of the operator facing a real degraded situation where the assistance systems are no more used.
Within the framework of the medicine (drugs) production, the SANOFI-AVENTIS company implements supervision activities of its workshops of production or of management of general flows (water-nitrogen-oxygen). The manufacturing unit is made up of heterogeneous workshops. The monitoring and the control of a workshop are integrated in the same system. This system is always centralized in a supervision room but can be locally redundant for a particular tool. The workshops are reconfigurable and thus the supervision systems too. The safety requirements evolve according to the products to manufacture. A safety constraint can be transformed to an operation rule according to the preparation in progress. The reconfiguration campaigns are long and heavy tasks to validate. All the wiring of the relay cards guarantee safety and the alarms treatment is completely redone.

2.3 Supervision of "launching system"

The Laser Mega Joules (French Atomic Energy Commission, LMJ is still in construction) will be a single shot system that permits to reproduce the physical context of a thermonuclear reaction in a little sphere. As a rocket launching, a programmed shot is sequenced with a countdown. Time is the major constraint of the experiment, time scale of process is close to nanosecond. The need of supervision comes from the high technology used in the process. No operator could manipulate components without computer helps because of requiring unbelievable precision. Moreover the large power delivered by LASER imposes distant command control supervision for safety reasons.
Each operator of the supervision shall have a specific profession and supervision screens specific to their professions. They all have an emergency stopping device making it possible to cancel the sequence of the shooting.

2.4 Supervision of traffic control

The management of the air and railway traffic control is based on the following two concepts: (1) the circulation control that manages the conflicts and redirects the trains and the planes; and (2) the regulation of traffic flow which control late, advance and flow traffic management.

2.4.1 Air traffic control

The Northern CRNA in Athis-Mons controls the air navigation of the northern area of France. The air-traffic controllers handle only circulation control operations and a little bit of regulation. Whole regulation is done at higher level of control in the regulation centre of Brussels. An evolution of the supervision application is in the process of integration. The new system is called ERATO (Leroux 1991). The studies for a new computerized system offering the possibility to increase the capacity of the air navigation while respecting the safety levels have started in the mid eighties. The solution suggested in ERATO was to decrease the quantity of information to be evaluated by the controllers. For example, some filters have offered the possibility to automate certain tasks such as the detection of some conflicts. The detection is implemented by procedures stemming from different used logics (fuzzy, defects …).

Moreover, when a controller needs to focus his attention on a precise point, although the system offers filters, ERATO authorizes the access to all the data by clicking on icons to visualize all the necessary information. These studies gather large panel of specialist from psychologist to engineer, the challenge was to obtain full performance collaboration between these different sciences.
Also well studies in aerial activities (Leroux 1991) the railway supervision must be clarified.

2.4.2 Railway control centre

As mentioned above supervision of traffic control includes 2 concepts: Circulation and regulation control. In railway specific supervision system, this model could be specialised by 3 hierarchical levels: (1) The first level achieves the circulation control including field control and commands as route setting, train control and protection functions. (2) The second level realise regulation of traffic flow. It insures conflict solving, and time graph monitoring functions. Finally (3) the highest level performs management, coordination of lower levels and planning tasks. There is further implementation of the three levels. One could separate each level in three control room, this is particularly the case of large railway networks with lot of inter connexions, these kinds of networks are segmented in switching zone where signal boxes achieve circulation control level. Generally, centralized traffic control (CTC) centre gathers further switching zones, CTC achieves regulation of traffic flow level. Finally, coordination control centre manages the entire network, it could be international, national or regional organised. Other implementation centralise the three level of supervision in a unique centralised room called operation control centre (OCC). This is typically the case of metro and urban railway network. Indeed, such networks are characterized by their unique line and their rare connections with other network, which simplify coordination tasks.
These kinds of implementations could be explained by the technology used until today that not permitted to integrate very large network control in a single room. With the emergence of high intensive computerized systems in railway supervision, operational company, whichever their characteristic, use more and more integrated control centre (ICC). ICC could gather operation and control or the three levels of supervision of railway network. ICC is the generalisation of urban application OCC of all types of railway supervision.

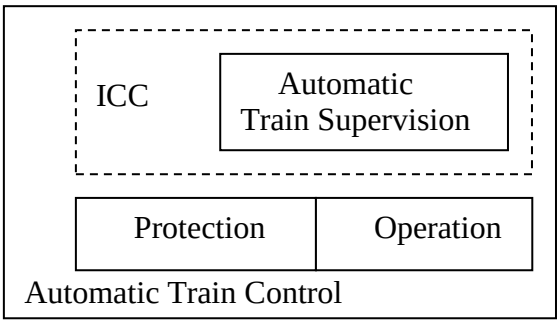

Figure 1 : Automatic Train Control

At the same time, Automatic Train Control system (ATC) performs three underlying functions in railway application, protection, driving assistance (operation) and

supervision (see Figure 1). In this system supervision function is performed at the ICC and the train driver's tasks could be simplified considerably and safety stems from protection.

3 SPICA-Rail project

Studies on human operator behaviours experiments will be performed at the University of Technology of Compiègne (UTC) using a supervision platform "SPICA-Rail" based on Alstom's product (see Figure 2): ICONIS™. This product is a generic one of railway supervision based on Supervisory Control and Data Acquisition (SCADA) (Boyer 2004). This equipment will of course include an "environment simulator" making it possible to do "as if" the experimental platform would be really connected to a railway network.

The network simulated is divided into six control sections. The platform could supervise the entire line or each part of the network independently. These last functionalities used in real situation for degraded circumstance permit to create real multi-agent system experiments. The ATS system installed in UTC includes three levels of control on traffic: manual automated and optimized. SPICA-Rail could simulate the control and the supervision of an entire network by integrating traffic control functions as signalling supervision, route setting, train tracking, train describer and timetable management.

The main interest will be the possibility to re-create in laboratory real accidental scenarios, and to be able to confront human operators with these situations, in order to analyze their comportment and their decisions.

Figure 2: SPICA-Rail

As showed in (Vicente 99) human operator excels to react in case of unexpected situations. The increase automation in railway supervision's tasks (Belmonte 06) implies more and more risks because the operator is taken away from process control (Bainbridge 83, Amalberti 92).

In order to preserve human performance facing unexpected situation (anticipation, expectancies), automation must not prevent operator from doing necessary adaptation. SPICA-Rail experiments will evaluate this degree of adaptation through cognitive work analysis.
Result of experiment will be integrated in a global safety analysis of the human machine system including machine safety analysis techniques coupled to specific human centred safety analysis techniques (Villemeur 88, Kolski 98, Vanderhaegen 99).

4 Conclusion

New generation of supervision systems in industry can achieve operations from display process variables to all automated control where human is just monitoring automaton. In railway specific industry, supervision is organised in switching zones and aims to be centralised in an Integrated Control Centre. Such centres implement integrated and computer based systems that perform train protection, train operation and supervision. Thus railway dispatchers using supervision have their tasks considerably simplified.
This work continues its progression with the preparation and configuration of SPICA-Rail platform in order to achieve the more realistic simulation. Future tasks depend on this work presented here, it determines actual context of automatic supervision.

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