PRESENTATION OF A RANGE OF DRIVING DESKS FOR LOCOMOTIVES

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Summary

In the light of ever increasing popularity of international transport, rolling stock is very often used beyond the borders of its own network. So, there is very often a problem of the suitability of rolling stock to the regulation of other networks.

ALSTOM Transport has been dealing with this problem for a long time now. The High speed train PBKA is an example of the complexity because it is able to operate on four networks. In order to propose the best solutions for Man Machine Interface (driving desks), ALSTOM Transport is working on the uniformity of its rolling stock by replacing the juxtaposition of driving equipment specific to each railway by the use of reconfigurable displays.

This process converges with the work done for the integration of safety equipment by ERTMS or the development of a new radio by EIRENE project. Thus, the driving desk structure is constructed in a way that allows all the following types of driving positions. The aim of this article is to explain the measures taken by ALSTOM Transport Belfort to meet the aims of this project in the field of locomotives. These decisions have been made following advice justified by ergonomists and drivers.

Interviewing drivers accustomed driving several types of locomotives, enables us to create an optimised MMI and meet the needs of drivers and operators. The aim of these discussions was also to discover the actual needs of drivers so as to avoid the continuation of driving methods stemming from technological solutions of the past.

The first applications of these studies are already under way and can be viewed and tested on the prototype of the new range of electric locomotives PRIMA developed by ALSTOM Transport with the first industrial application for SNCF.

Keywords
Man machine interface, driving cab, locomotives, interoperability

1. INTRODUCTION

On the market of locomotives or high speed trains, just like the gauge or catenary voltage, the driving cab is one of the specific characteristics of each individual customer. This remark holds both world-wide, but even more so in Europe, where the density of the different constraints is probably the greatest in the world. The fact is that the construction requirements of our equipment come in addition to very sophisticated and dedicated safety equipment dedicated to a range of speed.

In order to increase railway exchanges in Europe, ALSTOM Transport has launched a major project for rationalising its locomotive product in order to provide its customers with equipment adapted to their needs at the lowest possible cost.

In order to analyse the needs of the market at the threshold of the 21st century, we have carried out field enquiries to stock of the future needs of our customers.

More particularly, action has been taken on the driving cab, since it is here that the fundamental changes will take place in the coming years. We have chosen to develop this position in several stages, which we propose to describe later.

- Definition context
- Design of the ALSTOM locomotive driving desk range
- Man-machine interface execution methodology
- Results of enquiries with the customers
- Future developments

2. DEFINITION CONTEXT

What is at stake in this project is the very development of international transport in Europe. Today, it is handicapped at two levels:

- Technical
- Railway culture

Technically, requirements of the different networks (even when restricted to two or three) renders our equipment more complex.
In addition, in the face of a very highly aged European fleet of locomotives, the operators accustomed to technologies that are today obsolete. The railway culture, highly attached to its safety and reliability, imposes very exhaustive validation of any new subassembly before integrating it into a new locomotive. This is why products develop so slowly. One must await very often construction of new rolling stock to see a small proportion of the equipment evolve.

In order to increase the international transport in Europe, the optimization of the traffic is a basic necessity. So, the same locomotive must be maintained throughout the trip (no load loss). Only the drivers may have to be changed at frontiers. Once this is done, the second step is to develop a common driving culture in Europe.

For instance, development of railway exchanges in Europe, entails harmonisation of the driving equipment. It is why ALSTOM Transport, working in partnership with the Technological University of Belfort Montbéliard and the SNCF has been active since the 1990s in developing very progressively the transformation of the driving desk.

A number of examples of such developments are indicated below (Table 1):

Step	Former solution	Future solution or solution already applied by ALSTOM Transport
A	Information indicated on the desk in the language of the Country	Development of standard pictograms
B	Right/left driving, depending on network	Central driving position proposed
C	Driving with conventional displays (lamps, switches, pressure gauges…)	Use of reconfigurable screens
D	Driving with conventional safety equipment	Integration of ERTMS (see original table)

Table 1 : Steps of developments

Some of these stages have already been built and set up on the most recent machines. For example, the PBKA (Paris – Brussels – Cologne – Amsterdam) High Speed Train (TGV) built in 1994 (to be validated) was afforded special work to enable this high speed train to be driven both by French, German, Belgian and Dutch train drivers.
In particular, a compromise was reached to install the driving equipment, since the driving desk is situated on the centreline of the locomotive ensuring visibility of all signals (on the right and on the left).
Stage C is at present integrated into our new markets and in particular the FRET locomotive for the SNCF.
Stage D will be implemented in the medium term on the locomotives.

On completion of all these stages, the Man Machine Interface will have been changed completely.

3. DESIGN OF THE ALSTOM LOCOMOTIVE RANGE OF DRIVING DESKS

In the present transitional phase, ALSTOM Transport has chosen to construct a range of modular driving desks to embrace the needs of the different operators who have integrated these modifications to varying degrees. For instance, the specification of the range of products desired was to be capable of integrating all the possible demands of our customers and in particular those indicated on Figure 1.

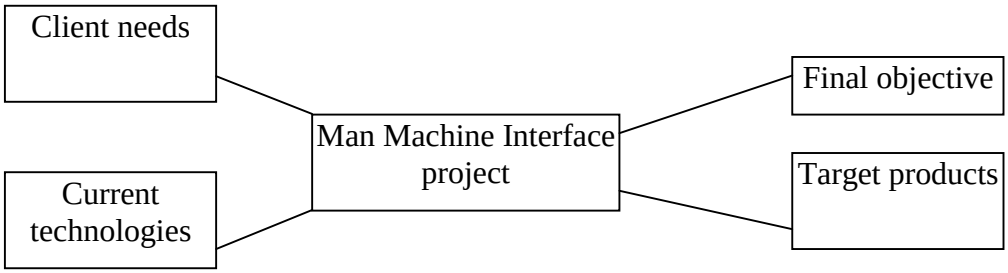

Figure 1 : Synoptic of the project

This study had led us to build a standard driving desk with five facets ensuring maximum flexibility. For example, except for the zone for safety equipment, no zone is exclusively dedicated. Our experience has nonetheless provided us with a number of standard schemes of organisation of the information and controls.

The reference product, variable to form sub-products is shown in figure 1.

Figure 2 Standard driving desk

The controls are grouped together by function and facility of access to them is provided in the light of their frequency of use or high level of safety. For instance, we have given priority to service and operation.

In order also to limit the quantity of information displayed continuously on the desk, we have used screens equipped with function keys providing fast and ready access to the different levels of information.

This will be detailed in next chapter.

Consequently, one should note on the image shown in figure 2 the possibility of installing equipment for a locomotive running on classical networks in France, Germany, Italy, Switzerland, Belgium and the Netherlands.

4. MAN-MACHINE INTERFACE IMPLEMENTATION METHODOLOGY

The innovative aspect of this new range of driving desks is its systematic integration of driving screens with a view to improving the way the information are carried on the desk. This integration corresponds to evolution C of our project.

There is a major drawback to use conventional equipment: all the information that may be useful at a given time when driving is displayed permanently in the permanent visual space of the driver.
In addition, the repeated accumulation of a wide variety of equipment in the end handicaps the total availability of the desk (for example: blown bulbs,…).
Accordingly, using screens fulfils a twofold function (in this situation, two screens used in redondancy, fulfil reliability of displaying the information) :

- to show useful information,
- to improve the availability.

4.1. Show useful information

Our project, which was conducted in close collaboration with the SNCF, therefore aimed at:

- classifying the information in order of importance,
- separating the driving information from the maintenance information,
- defining the necessary and sufficient useful information for each driving phase.

Several essential phases in the driving activity were brought to light by this study (figure 3) :

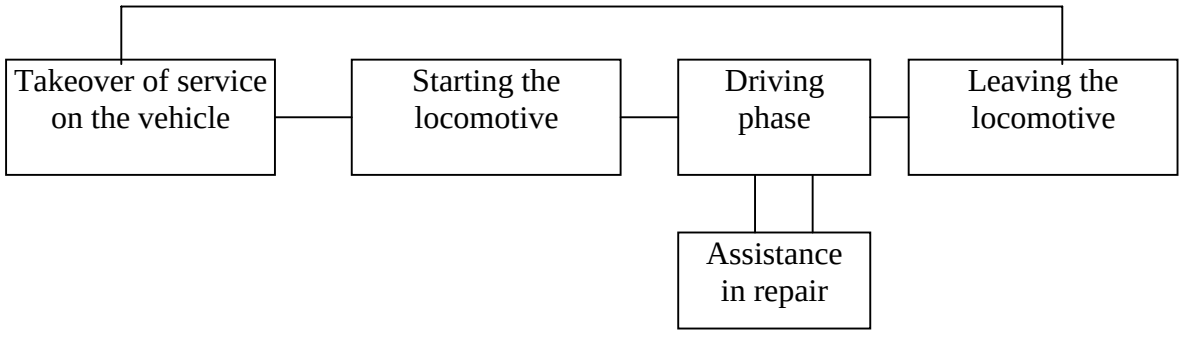

Figure 3 : Driving phases

For each of these stages, only the strictly necessary information is displayed. In this way, by analysing the driving needs, one can rationalise the quantity of information brought to the attention of the personnel.

For example, for a diesel locomotive, data concerning level (water, fuel, lube oil …) are necessary only during the phase of taking over the locomotive. This information is clearly indicated at this exact time. They are no longer displayed after.
If an abnormal level appears, a fault message is announced to the driver. He can then consult his repair manual to take the necessary decisions to continue the operation.

4.2. Optimization of the availability of information

Several aspects have been settled at one on the same time by using screens:

- the information is displayed legibly (compliance with railway standards such as those of the UIC or the constructor where there were gaps in the railway standards),
- restriction of the flow of information,
- favour the accessibility of the secondary level information
- minimize the number of spaces where information is displayed

To counter problems of language, as far as possible, we have used pictograms, whilst limiting their number to avoid regenerating an entirely new language “per se”.

It appears that this new method of display exceeds known standards used hitherto (such as standard UIC651 or UIC640). Thinking on this matter may in a medium term help to facilitate future standardisation.

5. VALIDATION CONDUCTED BY OPERATORS

From the standpoint of installation of the equipment on the driving desk and validation of the ergonomics, validation operations were performed on the prototype. Thanks to the modular nature of our design, the necessary adjustments were made very quickly. A period of only a few weeks can now be compared to several months, as was the case in the past.

With regard to the man-machine interface, much more thorough evaluation was needed in view of the deep going changes to driving habits. The train drivers dedicated to different types of machine (electric locomotives, diesel locomotives, high speed trains) and service (FREIGHT, passengers) underwent tests facing an Man Machine Interface prototype.

The following is the methodology used:

- Apprenticeship in driving through the screen
- Simulation of a real-life situation
- Verbalizations adjustment of the interface

This iterative process transpired to be extremely limited inasmuch as the preliminary analysis phase was conducted in detail. The inquiry made among the drivers has allowed us to take into account most of the real service operations and we have simplified as much as possible the accessibility to information. The driving screens must represent

assistance in driving and not the result of learned driving algorithms reproducing pre-defined situations.

The overall conclusion that emerged for us following this interface evaluation stage is that drivers are all ready to accept presentation of information on a screen in accordance with a simple structure. User-friendliness, the intuitive nature of the search for information make it possible to arrive at very short learning times compared to the density of information presented.

Use of a screen and computer does not appear to set any problems to drivers, whereas one might have apprehended a certain degree of resistance to change, a lack of confidence in the system, …

In addition, whilst the visual presentation of the information appears to be well accepted and the man-machine interface well perceived in the majority, the installation of the controls on the console remains an additional stage yet to be completed.

6. COMING DEVELOPMENTS

The developments achieved within the framework of this project are already integrated into our equipment. Furthermore, we propose to activate the following phase concerning efficient integration of the safety equipment, under the ERTMS project.

Nonetheless, at this stage, a number of lines of validation must be achieved at European level and more generally international level. Use of equipment such as screens is not characterised by exact standards. On the contrary, some of them would even require a certain degree of updating.
Acceptance by the maximum number of networks and validation with train drivers of new rules would bring about considerable concrete improvement to the flexibility of rail transport. Accordingly, working parties should be formed on the subject.

7. CONCLUSION

The progress brought by new technologies is about to revolutionise the profession of driving locomotives. All conventional driving equipment is in the throes of complete change:

- radio,
- safety equipment,
- screens,
- control systems

For these changes to be accepted and beneficial to the best possible degree, they must be brought about gradually according to customer requirements. Some of these stages concerning rationalisation of driving activity have been performed jointly and in partnership by the SNCF, UTBM and ALSTOM Transport S.A.

According to the conclusions of this work, we are highly optimistic as to setting them up operationally in the fleet of new locomotives.

This work opens up many paths for harmonisation between networks. This work entails simplification and rationalisation of the information displayed, which is what has already been done in France.
Validation by train drivers of several networks working under different regulations then becomes necessary and this point will be developed in the near future. In our opinion, this is one of the ways to facilitate dismantling of technical barriers limiting international transport.

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