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## Fleet migration towards ETCS – challenge and experience gathered

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### Abstract

Alstom Transport is in the process of retrofitting the entire Danish rolling stocks fleet with the European Train Control System (ETCS) system. This paper describes how Human factors have been integrated in the design process of the final solution in order to provide a smooth transition to the European Rail Traffic Management System (ERTMS) technology. The scope of the Human factors activities taken into account are the design of the solution, the validation with drivers and Union, the training and the maintenance activities. We have developed a new methodology to address the fleet heterogeneity and the large number of rolling stocks to retrofit, the diversity of the Operators (historical public, and privates) and the diversity of the driver's needs (passenger, freight, and maintenance rolling stocks). We have adapted up-to date technology (3D printing, measurement tools) to implement rapid prototyping at the early stage of the design. We present the various meetings (information collection, brainstorming, discussion and solution definition) that lead to define the acceptable solutions. The different principles used to provide requirements to the mechanical designers are described. They deal with location of equipment and the way to minimize the number of components to be moved. We present how the cabs have been measured to get the required information in order to check the visibility according to international standard, to assess the room available to integrate the ETCS system, to check the reachability of controls and to check the risk of glare. We show the different sounds level measured and the criteria to ensure the right audibility threshold. The paper also discusses the way to manage the different proposals from the different actors (drivers, crew and maintenance people, mechanical designer, trainer, and installation people) of the project and the steps to reach a workable solution. This methodology leads to a better efficiency by achieving compromise with the different stakeholders.

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## 1. Introduction

Alstom Transport was awarded a contract by Banedanmark (a state-owned enterprise that operates under the auspices of the Danish Ministry of Transport and Building) to retrofit 789 trains with the ETCS system. The content of this paper describes how Human factors have been integrated in the design process of the solution in order to provide a smooth transition to the ERTMS technology.

The diversity of the Denmark fleet is a major issue to be addressed not only from the hardware point of view but also from the diversity of staff in charge of driving or maintaining the trains and the locomotives. Rolling Stocks were classified into two categories: the white fleet (for passengers and freight transportation) or the yellow fleet (for track maintenance). Considering it was a very critical issue, Banedanmark decided to invest a lot in the Human Factors engineering for the design of the solution, the validation with drivers and Union, the training and the maintenance activities.

This paper will discuss the way a compromise has been found between driver's requests, design feasibility and efficiency of the integration of the equipment in the train.

## 2. Challenges

A great challenge was to deal with the number of trains. The complexity of the project is due to heterogeneity of trains operating in Denmark, diversity of Operators (incumbent, and privates), variety of the driving requirements. A first inventory revealed at least 35 trains types and a deeper analysis established 48 types (for the passenger fleet) and more than 32 yellow fleet trains. On the Alstom side, several teams were interacting with stakeholders (e.g. customers, driver's representatives, ...) as shown in Fig. 1:

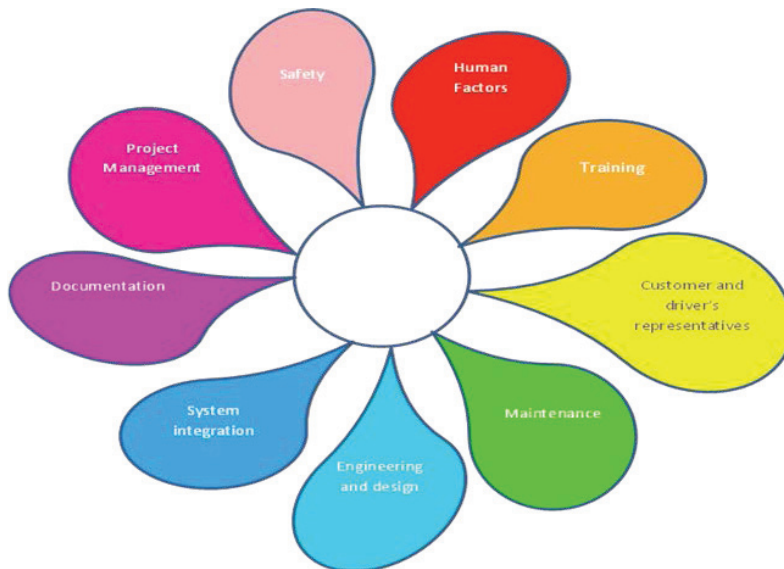


Fig. 1.

As several countries were represented in the project, a inter-cultural training has been organized to optimize the work done.

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