GE TRANSPORTATION: ADVANCES IN LOCOMOTIVES FOR TIER 4

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ABSTRACT
GE Transportation (GET) is a business within the GE conglomerate which manufactures locomotives, Off Highway Vehicles, mining equipment, stationary power units and marine. Using an international scholarship in the summer of 2012 the author participated in the GET internships in Erie Pennsylvania. The work carried out was in the Electric Drive Packaging Division and was towards the next generation of locomotives from GE that would comply with the new Tier 4 standards. The project work carried out by the author will be reviewed here and lessons learned from the experience will be highlighted, in particular: the adoption of Lean and the company culture.

1 INTRODUCTION

GE Transportation is a world leader in locomotive construction and technology. The core technology for the company is their diesel engine which they have continuously improved since their first iteration over 80 years ago. In order to improve the efficiency of the engine they have adopted a diesel-electric system and reduced the number of cylinders whilst maintaining a high output power. Recently they have announced plans for a diesel-electric hybrid system to further improve fuel efficiency and environmental impact.

In tandem with the advancements GE makes the US government also sets legislation for non-road diesel engines, these requirements take the form of Tiers, the newest is Tier 4. The standard lays out the constraints on the exhaust composition for each engine based on the output power. Tier 4 is being phased in for all new engines constructed in the US and all must comply by 2015.

2 PROJECTS CARRIED OUT

The work carried out by the Electric Drive Packaging Division was to reduce the weight of the cabling, packaging and the costs of manufacturing these aspects of the design. As part of this the author worked on: cable routing from the IGBTs to the busbar, the fixtures for securing cables and cost analysis of rheostat resistors.

2.1 CABLE ROUTING

This project was to reduce the mass of the current cable routing in order to reduce manufacture time and weight. Ribbon cables were chosen to reduce mass and to avoid the large bend radii associated with a cable bundle. This allowed for a 180^0 turn without incurring a large cost in space. In order to assist in the routing a small budget was provided which was used to build a full scale mock-up of the assembly. This provided the opportunity to test different cable configurations for interference. The project was considered a success as it concluded with a cable routing which avoided mechanical interference and conformed to the requirements of assembly.

2.2 CABLE HOLDINGS

A large cost to the assembly was incurred, both in weight and time, from the implementation of U bars for holding cables within the auxiliary cab. As part of the continuous improvement of the packaging division it was necessary to investigate any possibility to reduce this waste in material and money. The increase in time and cost was due to the two welding points of the bar and the labour time to assemble.

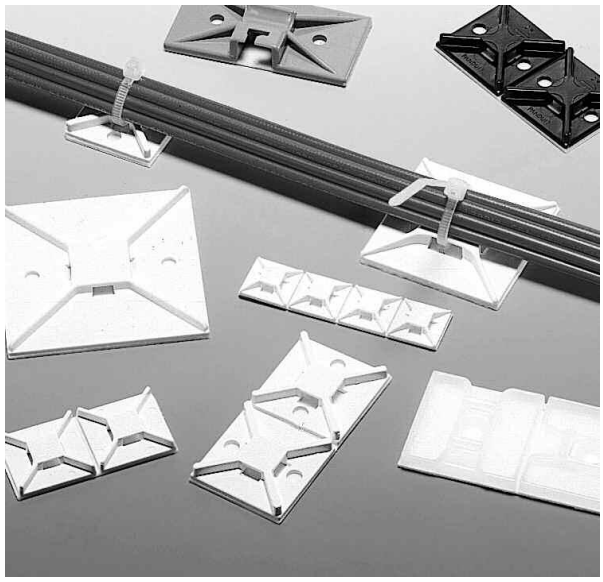

Figure 1IS-Rayfast wall mount unit

Commercially available solutions were first looked at for suitability, an example of this is shown in figure 1. These solutions were deemed unsuitable as they would not have withstood the load conditions or the vibration profile that the cables within the aux cab can be exposed

to. The next solution was to shift the issue back to the manufacture of the panel as this would result in a zero cost improvement by removing the assembly. The change would be to etch grooves with clip holes in them and this would be reflected in the drawings for the panelling so the panels would be machined with provision for the insets. The assembly time would then only be required to group the cables once routed and then fix down to the groove using a plastic cover/lid, an example of the lid is shown in figure 2.

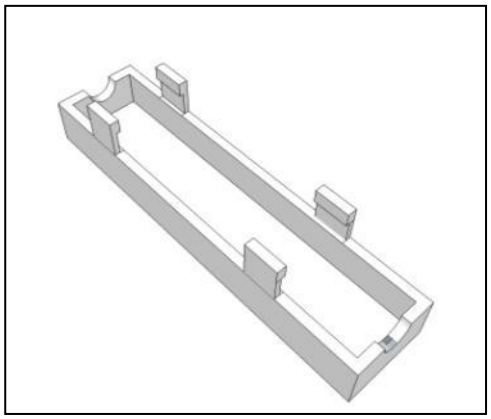

Figure 2 Underside of lid

This design is appropriate as it fulfils the original requirements to bundle cables whilst reducing the time and cost to do so.

2.3 COST ANALYSIS

In order to reduce the consumption of brake pads the new series of locomotives make use of dynamic braking. This method uses the control electronics to switch the electric machine from motoring to generator and so act as a retarding force on the motion of the locomotive. However, as the loco derives its power from diesel there is no way to store the recovered energy as current battery technology and capacitors are not capable of storing the energy. Due to this the energy must be dumped onto large resistor banks in order to burn off the power, these are known as rheostat resistors. Figure 3 shows a resistor bank from IRE - Industria Resistenze Elettriche.

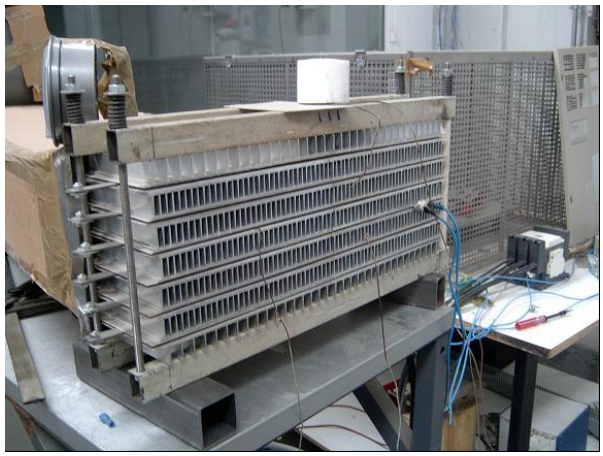

Figure 3 Testing of Rheostat Resistor from IRE

This assembly was new to the design and was externally sourced. To ensure the cost was kept to a minimum a "should cost" exercise was carried out on the rheostat resistor.

Element	Length (")	Breadth (")	Depth/thickness (")
Steel resistor	18.8	4.75	0.188
Mica	18	4.75	0.188
Heat sink	18	4.75	1.25
Outer casing	23.2	29.3	5.75
Outer casing beam (length)	23.2	7.15	0.25
Outer casing beam (breadth)	29.3	7.15	0.25

Table 1Dimensions of Rheostat Resistor

Table 1 provides the dimensions and components for a single rheostat resistor. This was used along with a list of suppliers and labour cost to estimate the price of construction for the resistor. Using this provides the designer with a cost estimate and more information on what is reasonable for the manufacturer to charge for the sourced assembly, in the sourcing office this information can be crucial in assuring the company is not over charged.

3 CONCLUSION

The purpose of the scholarship was to expose Scottish students to large scale international businesses and to bring the practices that bring them success back to the UK. One of these methods was Lean, this is a method of improving processes that aims to reduce waste and so increase the value added by the process on the end product. GE has widely adopted this principle and makes use of it to maintain a competitive manufacturing edge in a market that must compete with rival companies that could manufacture at lower cost through cheaper labour. All managers are trained to utilise Lean

in all aspects of design and in management of resources, this wholesale adoption has resulted in GE maintaining its position as a leading producer of locomotives and other heavy machinery. Each project carried out here was informed by this methodology and by designing the new Tier 4 locos in this way GE is able to increase performance whilst reducing cost.

4 ACKNOWLEDGMENTS

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