

Wabtec: Freight Segment



Statement of Work

Regional Locomotive Product Family

EDSGN 100: Intro. to Engineering Design

Spring 2019 Client-Driven Design Project



**ENGINEERING DESIGN, TECHNOLOGY,
AND PROFESSIONAL PROGRAMS**

Regional Locomotive Product Family

Project Objective

Design a regional lightweight locomotive system that can be sold across multiple regions, countries, and customers.

Project Background

The world is a big place and the global rail industry is far from standardized. Infrastructure capabilities, government regulations, operations, environmental conditions, etc. all play critical roles in shaping the requirements for locomotives and the subsequent design configurations that can be utilized. As you can imagine, this presents a very challenging scenario for a locomotive producer as the size of individual markets does not always justify the costs required to offer customized solutions to those customers. In North America, the Heavy Haul Rail industry has a fairly common set of requirements across the key Class 1 customers (large railroads) that can be met with a generally standard product offering, which includes limited options offered to each customer—similar to purchasing a car in which you can customize some specific features within the model class. This North American “product family” enables common components to be used across multiple customers, which has an enormous impact on many facets of the product lifecycle cost for both the customer and the OEM (original equipment manufacturer), which in this case is Wabtec. Lower costs due to higher volume, less unique inventory, standardized assembly processes, reduced training, and common operating and maintenance practices are just a few of the things that make a product family so attractive to a business. As mentioned previously, the markets outside of North America have vast differences in requirements between different customers and regions. However, it is the desire of Wabtec to grow their business internationally and this will require creative solutions to overcome the cost and complexity challenges associated with differing customer requirements.

Sponsor Background

Wabtec: Freight Segment (NYSE: WAB, www.wabtec.com), solves the world’s toughest transportation challenges. Wabtec builds equipment that moves the rail, mining, and marine industries. Their fuel-efficient and lower-emissions freight and passenger locomotives; diesel engines for rail, marine, and stationary power applications; signaling and software solutions; drive systems for mining trucks; and value-added services help their customers grow. Wabtec Freight is headquartered in Chicago, IL, and employs approximately 13,000 employees worldwide. Wabtec has an install base of over 23,000 locomotives operating globally.

Project Scope

In a recent marketing study, the product management team determined that there is a significant opportunity in the lightweight locomotive market (less than 20 mT/axle) across multiple regions, countries, and customers. The individual customer opportunities are not attractive enough to drive a standalone product to be developed, but the combination of several customer opportunities appears to present an opportunity to develop a new product family. The regions and the relevant countries have been organized in Table 1.

Regional Locomotive Product Family

Table 1: Region/Country Summary

Region	Countries
Central Asia	India, Bangladesh and Pakistan
Southeast Asia	Thailand and Indonesia
Africa	Republic of Cote d'Ivoire (Ivory Coast), Democratic Republic of the Congo, Namibia, Nigeria, and South Africa
South America	Brazil, Colombia, Chile, Bolivia, Argentina, and Uruguay
Australia/New Zealand	Australia and New Zealand
Russia/CIS (Commonwealth of Independent States)	Russia, Kazakhstan, Moldova, and Ukraine

Each region has stringent requirements, with some of the most difficult to meet being axle weight limits (tonnes/axle), emissions, and duty cycle/usage flexibility (i.e., freight vs. passenger). The product management team is *challenging the engineering organization to research the countries in a region of your choice to determine the best system configuration and design to meet the needs of that region across multiple customers.*

Product Requirements

A North American (N.A.) locomotive typically weighs in at around 430,000 pounds (195 metric tonnes), which is far too heavy to operate in the international lightweight markets (less than 20 mT/axle). Referring to Figure 1, the product management team wants to maintain a common Platform, and Truck design (which include the traction motors) with the N.A. locomotives but recognizes that the remainder of the locomotive design will need to change to compete in the international lightweight market.

The scope of this undertaking could include developing concepts/configurations/designs for the following:

- The Power Plant or Power Source (N.A. Locomotives utilize a 52,000 lb. Diesel Engine coupled to a 10,000 lb. Alternator). This should include all the support systems such as lubrication, cooling, filtration, etc.
- A Lightweight Cab Structure (keep in mind that many International regions have stringent crashworthiness requirements, so the structure needs to be designed accordingly).
- The electronic system and associated packaging for transmitting power to the traction motors.
- The Operator Cab design including amenities and features (ergonomics, visibility, etc.)
- Offboard infrastructure systems for providing fuel or power to the system (i.e., fueling stations, charging stations, etc.).

The selected design configuration should allow the locomotive to meet all relevant requirements in the selected region, such as regulatory (e.g., in the United States this would be the Federal Railroad Association and Environmental Protection Agency), axle weight limits, and Critical to Quality (CTQ) customer requirements. CTQs can be determined through research of existing locomotives operating in the selected region.

A visual example of the available space to implement the system design is provided in Figure 1 (sections highlighted in blue). It represents a substantial portion of the locomotive, which is traditionally made up of the Operator, Auxiliary, Alternator/Blower, Engine, and Radiator Cabs. The orange highlighted section is typically where the fuel tank is located, which may or may not be required depending on how you choose to power the locomotive. The fuel tank space may be utilized for other purposes or adjusted to meet any applicable region-based requirements (i.e., weight per axle or operating range).

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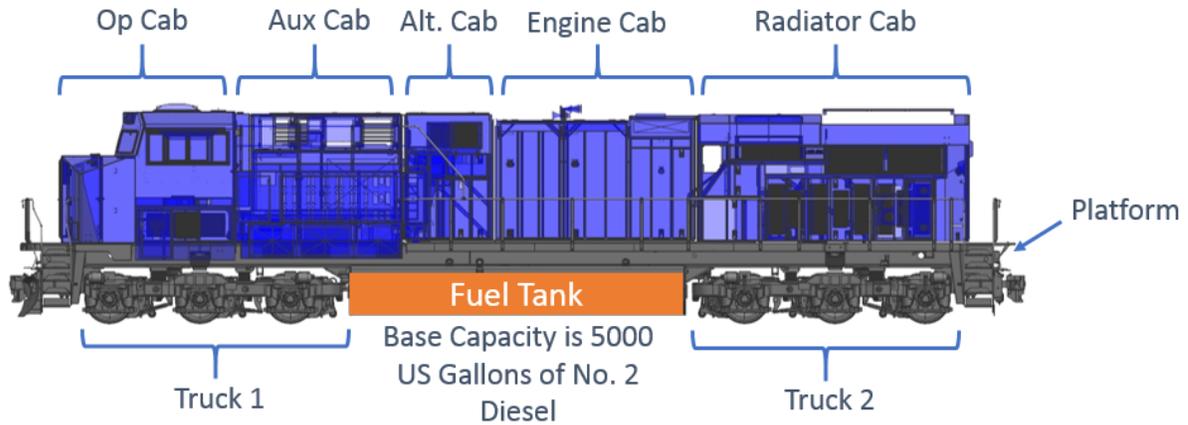


Figure 1: Locomotive Configuration & Design Space Allocations

Required Actions

The Product Management Team is establishing product families for various regions and has requested Engineering Design Teams (DTs) to develop a lightweight locomotive system. The concept should be cost competitive when compared with other OEMs offering products in the region. The key project requirements to be considered in the product family plan are as follows:

1. The design should include all the systems required to provide power to the AC Traction Motors.
2. Regional infrastructure requirements must be considered including weight limitations and servicing/maintenance capability.
3. Product lifecycle cost must be considered: cost efficiency of the selected system design and market demand are the keys to success.
4. System integration and packaging must stay within the allowable dimensional envelope. The locomotive system packaging concepts should be represented with 3D models (base locomotive model provided).
5. You are required to understand your market and provide objective evidence through documentation of regional/customer requirements. This includes understanding regional trends, future projections, and local regulations.
6. The total locomotive and axle weight of the selected arrangement must meet the regional requirements.

Project Objective

Each DT should research, develop, and submit a locomotive design configuration to satisfy the regional operational requirements for a region of your choice. The DT that offers the most comprehensive, complete, and supportable concept will be awarded the contract to execute the development, validation, and launch of their product. For your submittal, consider alternatives to traditional locomotive power sources commonly used in today's operations and think about unique ways to achieve weight targets such as deploying new materials or manufacturing methods. Consider whether your locomotive concept can utilize existing infrastructure for operations or whether something new would need to be developed (e.g., fueling or charging as mentioned above). Be sure to include ideas to address any infrastructure challenges in your proposal.

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Known Parameters and Assumptions

- a. The base locomotive geometry is assumed to meet all Track Gauge (width) and clearance requirements for any selected region.
- b. Assume that weight distribution is equal across all wheels/axles regardless of individual component weights/locations.
- c. The platform and trucks (known internationally as “bogies”) are all standard and do not require modification. The weight of these components is 40 metric tonnes.
- d. The selected energy source only needs to generate power. The power will be transmitted to the required components through an existing auxiliary cab arrangement.
- e. The space available for utilization of the system design shall be the outermost envelope of the cab structure provided in the CAD model.

Project Deliverables

Note: Your instructor will clarify her or his expectations for these deliverables and respective due dates. The key deliverables include:

- A locomotive system design concept that addresses the customer needs and requirements for the region of your choice. This should include:
 - An exploration of the region, infrastructure capabilities and needs with a focus on its rail industry. Regional CTQs should be identified.
 - Rationale for the recommendations
 - Description of alternative concepts and their evaluation
 - Environmental considerations and/or analysis
 - Assessment of important aspects of your system for feasibility and adoption, including public opinion
 - Economic viability of the system including life cycle cost (i.e., return on investment when compared with other OEMs).
 - CAD drawings
- Model or prototype of a component or the overall system

Additional Resources

- CAD model of base locomotive (in SolidWorks file)
- EDSGN 100 Project Website: <https://sites.psu.edu/engineeringdesign100/client-centered-design/current-project/>