Part I: The Importance of Wheel/Rail Interface Management on Energy Savings and Sustainability

North American railroads have about 17-million tons of rail in some 70,000 miles of track that carries more than 20 million gross tons of rail traffic. A recent railroad survey conducted by TTCI indicates that the typical rail life varies from about 1,300 MGT in tangent track to about 380 MGT in a 10-degree curved track. There are about 16-million wheels in revenue service, with about 400,000 removed each year, generally for defects such as spalls, shells, flat, out-of-round wheels, and built up treads. About 200,000 wheels approach their maximum amount of allowable wear. The numbers demonstrate that wheels and rails are major railroad assets.

Nonconformal wheel/rail profiles and hollow worn wheels do not steer properly in curves, resulting in increased fuel consumption. Instead, the trucks often warp, a situation in which the truck bolster rotates horizontally relative to the side frames such that both rails develop large angles of attack and laterally move towards flange contact with the outer rail. The rolling resistance of a warped truck is much larger than that of a steered truck. Fuel is expended to overcome wheel/rail resistance, and since wheel/rail profile mismatch increase rolling resistances, matching profiles through improved designs and maintenance in service gives savings in fuel.

Railroad wheels and rails are made of high strength steel. A steel wheel requires very little energy to roll on a steel rail; indeed, care must be taken that a car does not run away on level track on a windy day. This is because the wheel and rail deform very little under load, unlike a rubber tire rolling on asphalt.

The cross-sectional shape (profile) of both wheel and the rail also plays an essential role in steering a railroad car with minimum energy expenditure (and thus the fuel consumption). Incorrectly designed and maintained profiles can result in wheels that:

- Do not align to the track similarly to that of misaligned wheels in an automobile
- Rub their flanges hard up against the rail similarly to the side walls of the tires of an automobile rubbing along the curb

Wheelset misalignment and rubbing flanges can increase train fuel consumption significantly. In addition, poor wheel and rail profile match can cause metal fatigue, wear, corrugations, and other defects that require maintenance and untimely replacement. This requires, in turn, the expenditure of much energy to either re-machine these components or re-melt steel to cast wheels and roll rails.

Wheel/rail wear and surface fatigue depend greatly on the contact stress, which in turn is controlled by the wheel/rail profiles and the way they interact. This interaction also affects fuel consumption, derailment risk, and vehicle stability. A key part of reducing railroad costs and improving safety is through better management of wheel and rail profiles to extend life, reduce vehicle and track maintenance, and improve vehicle stability.

The increased energy dissipated at the wheel/rail interface from wheel/rail profile mismatch and friction directly affects the fuel required to haul a train. Wheel and rail replacement require not only steels to be manufactured, but transport and installation costs can also have considerable impact on environment and energy. New wheel and rail require significant recourses (raw materials, energy and transport) to be produced. Likewise, the effort and activities required to remove worn and damaged wheels and rail, install, and then transport used rail has a significant energy and environmental footprint.