Zero tolerance of derailments

There are on average 500 derailments a year in Europe, 300 of which involve freight wagons. Luca Ebree, Mermec’s director of group strategy and business development, says there should be zero tolerance of derailments because the technology is in place to achieve this.

The Intergovernmental Organisation for International Rail Transport (Oiti) ruled in November 2007 that it should be mandatory for all freight wagons carrying dangerous materials in the European Union (EU) to be fitted with a derailment detection device (DDD) by January 2011. However, this was rejected in May 2009 by the European Safety Agency (ERA).

There are several reasons for this:
- it establishes a dominant position for the few manufacturers of DDDs
- DDD tests indicate too many false alarms
- DDD would stop the train suddenly in all circumstances and in any location, without an opportunity for the driver to override it, which could cause other types of damage and be inconsistent with existing emergency procedures
- it would act only once a derailment has already occurred, instead of preventing it, as preferred by the EC Railway Safety Directive
- the benefits do not justify the investment and associated costs, and
- the overall investment is not justified compared with the damage caused by derailments. A study of 600 derailments in the EU concluded that the overall cost of freight wagon derailments was about €471 million in 2008, of which 95% was due to the railway, 2% to the environment, and 3% to human beings.

According to ERA, 38 railway accidents involving dangerous goods between 1990 and 2005 caused 27 fatalities and 75 injuries. The majority of fatalities (62%) occurred at level crossings involving trucks carrying dangerous goods, while the rest were caused by collisions (19%) and derailments (19%). The recent accident in Viareggio, Italy, which resulted in 28 fatalities is the most severe railway accident involving dangerous goods to occur during the last two decades. However, this type of severe accident is very rare.

So, should we conduct more studies or do we simply forget about trying to prevent derailments?

Railway safety is a complex issue and to date railways and institutions have concentrated almost exclusively on signalling - specifically in recent times with the aim of harmonising systems. However, there are many other important aspects of railway safety, and consequently ways to improve it. One of the most important is condition-monitoring and related condition-based maintenance and renewal planning.

The introduction of new technologies, such as the automatic recognition of rail and track surface defects using vision systems, ground penetrating radar, enhanced ultrasonic and laser-based inspection of rails for internal defects, automatic recognition of wheel defects, worn break-pads and other rolling-stock defects, has given us hundreds of parameters to control the railway from permanent way to overhead line and from bridges to tunnels.

There are terabytes of data to process if we want to know the real health of our “patient” both for infrastructure and rolling stock. And if this is not complicated enough, we also have to make a diagnosis and devise the optimum cure: a maintenance and
Measuring and testing

renewal (M&R) plan.
These and other standard measurements (such as track and overhead line (OHL) geometry, rail and OHL profile, accelerations, and ride comfort) were usually made using measuring vehicles or trains with the aim of detecting defects. Railway infrastructure managers and train operators study rolling stock behaviour primarily in reference conditions. To reduce maintenance costs, however, means not only reducing those costs related to the wear and tear of infrastructure or rolling stock and their components, but primarily those costs related to wheel/rail interaction. The analysis and control, ideally in real time, of wheel/rail interaction is the best way to prevent derailments and optimise maintenance.

A minority of train operators with inferior rolling stock generate extensive damage both to infrastructure, and to rolling stock and their components, causing an exponential rise in M&R costs and intolerable risks.

Today, in a liberalised railway market, every operator is allowed to use national and regional networks. To put it another way, the infrastructure owner has to trust that rolling stock is in good running order and that the load is balanced and within the axleload limit. However, operators and infrastructure owners have different or often opposite interests. The operator wants to transport as much as possible using any type of wagon - the cheaper the better - often with insufficient running characteristics beyond prescribed vehicle specifications. The infrastructure owner, on the other hand, wants to charge for every load and requires that these loads be transported in “rail-friendly” wagons, which generate little noise, low track forces, minimal wear, and have no risk of derailment.

The Railway Safety Directive 2004/39/EC is the main piece of EU legislation to ensure that railway safety is maintained at the highest level and improved where desirable. Several players help to maintain railway safety: the infrastructure manager, the operator, the wagon owner, the vehicle technical manager, and the wagon loader. They all have tasks and responsibilities laid down in European and national legislation, international regulations, and private contracts.

I believe strongly that these duties and responsibilities can only be fulfilled economically by using automatic systems to measure rolling stock quality either from the wayside or from on-board systems to monitor the status of the infrastructure, rolling stock and their interaction. Both systems monitor the vehicle/track interaction in service. Such systems must be accurate and generate minimum false alarms.

Charging for damage

Return on investment for the infrastructure manager is becoming an important issue along with the need to increase safety. Although it is not being done yet, it is possible to charge train operators that damage the infrastructure or might cause an accident due to:
- exceeding the maximum axleload - overloaded trains should be stopped and the operator fined
- weight imbalance
- uncontrolled changes in the wagon turning moment which increase Y forces and reduce derailment safety margins
- exceeding the strength of infrastructure elements such as rail fastenings in curves and bridges
- lack of steering capability in curves as a parameter of vehicle wear and quality, and
- wheel defects.
An accurate, reliable and repeatable measurement of wheels for out-of-roundness, eccentricity, flats, and so on represents the basis for reducing infrastructure maintenance costs, accidents caused by wheelset fatigue-related failures induced by increased accelerations and dynamic forces, and shock resistance of the rail head due to rolling contact fatigue.

It is now possible to determine intolerable derailment risk factors, undesirable track damage, wheelset fatigue risk factors and running behaviour vertically (Figure 1a) on tangent track and laterally in curves, switches, and tangent track (Figure 1b) because the following parameters can be measured:
- steady-state wheel, axle and vehicle load and dynamic forces
- load differences in wheels, running gear and vehicles
- front/rear load ratio of the same vehicle
- vertical accelerations as a parameter in relation to the causes of rail fatigue
- steady-state and dynamic Y-forces
- Y/Q-ratio derailment coefficient
- noise and ground vibration, and
- wheel defects as impact, acceleration and length.

Wayside systems are able to measure when values exceed thresholds and immediately send an alarm to those responsible, warning them about irregular running behaviour, increased derailment risks and irregular stresses caused to wheelsets and rail. However, it is necessary to decide the level of accuracy which should be adopted.

Unattended measurement systems (UMS) (Figures 2a and 2b) represent a viable alternative to dedicated measuring vehicles as the measurement results are comparable. Advances in electronics, component reliability and wireless technology make it possible for UMS to operate autonomously on standard vehicles in normal revenue service. Data is automatically collected.
and transferred via cellular or Wi-Fi networks to a central data storage where it is processed and key information is reported to staff.

UMS make it possible to dramatically increase the frequency of inspection, while significantly reducing operating costs. Data is available as often as the host vehicle runs along the track. Continuous operation over dedicated track sections provides managers and engineers with current information for making decisions and taking appropriate action. UMS provides warnings of sudden changes in the infrastructure, allows the rate of deterioration at any location to be monitored and predicted, and enables the quality of M&R works to be determined quickly. Safety can be addressed weekly rather than quarterly.

Data localisation, validation, and segmentation are still an issue for UMS, but it will become an embedded monitoring system in rolling stock. Some railways are now considering equipping new rolling stock with UMS.

Is there a good recipe for preventing derailments? The answer is yes. Too many studies have been made but very little action taken so far by either institutions or railways to prevent derailments. The target should be zero tolerance, with a clear idea of the responsibilities, rules/thresholds, and technologies to be applied. Safety must not be used as a barrier to a fully open market.

Uncontrolled excessive damage to infrastructure by a minority of vehicles outside reference conditions impedes commercial success and the ability to improve railway performance. There are strong conflicts of interests between the players involved in maintaining railway safety, and very little investment is being made to prevent derailments, apart from in signalling. Super-national institutions should provide real incentives to infrastructure managers and train operators to invest in systems truly able to avoid derailments. IRU