RAILWAY MANAGEMENT

Ted Selig highlights the significance and importance of corridor infrastructure management in the railway development sector

Railways have become an increasingly complex industry. The world’s reliance has increased on this efficient transportation mode that must run with limited resources on constrained corridors with increasing traffic. These demands can only be met by effective management of immense data and the extraction of excellent information. Technology plays a vital role in streamlining the development and modernisation of railways. Corridor Infrastructure Management (CIM) is an emerging approach for using information for improved railway safety, reliability and profitability, and for a cost-efficient transportation corridor. CIM incorporates five elements:

- Automates prediction, prioritisation and planning of the type, time and location of actions
- Low-cost data maintenance
- Connects diverse and disparate data sources
- Tunes data into information through visualisation
- Exchange of data between linear, geospatial and hierarchy forms

In this article, we will investigate the industry dynamics that require CIM and the elements required for applying CIM successfully.

Since their inception, the railways have been predicting, prioritising and planning. What the railways require is live, automated, comprehensive and precise data that pinpoints the defects that impede transportation. This is the information-driven prediction, prioritisation and planning of CIM. Railways require significant capital, a large work force and expensive equipment working over geographically disparate regions. Work is performed over days, weeks or months. It can be planned months or years in advance, and involves significant cost, requires large mobilisations and can impact revenue traffic (people or freight).

Planning is required to efficiently coordinate maintenance and renewals. It requires predicting the future and knowing how long assets will continue to safely support traffic budgeting and work planning. A database that details accurate and comprehensive assessment of type, condition, usage (traffic) and change in performance over time is required for accurate prediction of future performance. No railway has infinite resources, and compromises must be made. Prioritisation can help identify which initiatives must be undertaken first. It allows the comparison of quantifiable facts about asset performance: how long will it last, which assets are degrading the fastest and to what extent. Prioritisation shows the tasks can be combined to maximise work windows and which assets have the largest impact on performance. A CIM system delivers live, automated, comprehensive, precise planning, prediction and prioritisation for infrastructure and vehicles.

Data under management

A basic set of data is required for CIM and can be categorised. The assets include vehicle, infrastructure, real-estate assets and record type, age, weight, in-service date, asset geographical location and relative location to other assets. Financial data contains the asset value and business unit ownership, revenue, expense and cash flow. The network topology data contains the interconnectivity of the transportation network, whereas the operations data contains
the distance and direction of the vehicles travelled within the network topology and the configuration of vehicles within a train. Work data bears the history, planned maintenance and renewal work performed on the system to extend its life.

Enterprise resource planning and asset management systems

The world’s leading railways use Enterprise Resource Planning (ERP), Enterprise Asset Management (EAM) and CIM systems to maximise their operating safety, reliability and profitability. EAM systems maintain work history, work plans and resources and asset information, and manage the execution, maintenance and renewals. ERP systems maintain financial information about income, expense, capital value, finance and human resources. The railway CIM connects condition, utilisation, work and finance to optimise time-related functions.

Prioritised proactive work orders enable planned repairs before asset failure and during planned window. Ultimate limit reactive work during peak operational periods. A real-time CIM-EAM integration provides capabilities such as real-time work order management, prioritised proactive work orders based on work history and inspection. ERP maintains and manages key data related to assets, time and labour. CIM provides engineering support to analyse past work and the impact on conditions using mathematical operations designed specifically to accommodate non-overlapping characteristic changes along linear assets. The results are used to automatically trigger proactive high-priority work orders in an EAM system. An interface between CIM and ERP enables capital and maintenance work prioritisation based on best value (repair cost, traffic revenue and average speed). It also makes it possible to calculate capital value using current corridor assets inventory, condition and rate of deterioration.

The combined systems provide financially prioritised proactive work orders, project cost analysis and cost projections by building real-time integrations with ERP systems. CIM analyses measured condition, deterioration and work influences to calculate asset lifespan at each point along the track. Railways identify peak cost areas with CIM linear data of work along the track and summarise the results. ERP uses these results to develop balance sheets and capital budgets based on actual asset condition along the rail corridor.

How data turns into information?

Railway personnel interact with location data and information in three ways:

- Geographical (latitude, longitude and elevation)
- Linear (railway line and marker plus offset)
- Hierarchy (parent-child ownership)

Supporting effective CIM means information systems must model and transform data to and from these three forms of location reference. Railway track charts are a schematic representation of corridor assets with various combinations of major maintenance, components (ties, substations and signals) and attributes (like curves, grade and type of track control). A track chart is a linear representation of infrastructure assets along a rail line based upon a kilometre and metre (milepost and footage or similar) measurement system. Geographic Information System (GIS) technology is effective at mapping, but a GIS alone is inadequate to address the needs of a CIM system, because railway employees traditionally refer to location on the right-of-way using an internal linear marker system (milepost, kilometre post, engineering stations). A GIS cannot correlate specific asset condition measurement, traffic usage and work-record data, which are essential for evaluating alternative maintenance procedures. Thus, it is difficult to portray and interpret the required details to pinpoint the root cause and location of problems at the track level. Railways also perceive information in terms of hierarchy. Subdivisions, cost centres and management organisations are examples of the hierarchy of information within a railway system. The labour, materials and equipment used to repair the track must be associated with a cost centre. Ideally, when repairs cross a cost centre boundary, the costs need to be proportionally shared among the cost centres. The railway’s performance can also be reviewed through hierarchical or parent-child relationships.

Railway environment information technology considerations

Data set environment and characteristics

For effective CIM, railways require an accurate and comprehensive data set that is easy and inexpensive to maintain and retrieve information
from. Analysing inaccurate data leads to uninformative or incorrect conclusions. The steps to improve data accuracy include data collection using multiple sensors and comparison of results, correlating different types of data, establishing gatekeeper filters to validate user and machine-entered data prior to acceptance. Failing to identify a defect on either one wheel or a few centimetres of the track can mean a catastrophe. Therefore, having complete data coverage is critical.

Linking or correlating data sets in space and time uncovers another dimension of information. An example of data correlation in space: a track defect is typically located by the track, a marker (milepost, kilometre and engineering station) and marker offset or increasingly by latitude and longitude. If track defects are correlated or overlaid with a geographical map or schematic diagram, the relation between defects, features and assets becomes apparent. The trick to building an accurate and comprehensive data set is to develop a set of tools that minimise the friction of collecting, connecting and interacting with the data. Tools that collect and process data without human intervention are important in the process of improving data quality.

Architecture
The design and configuration of a system, also known as the information system architecture, influences the effectiveness of an asset information system. Different architectures are appropriate for supporting different functional objectives. Information system architecture defines the arrangement of software building blocks and data stored over a distributed network of continuously and intermittently connected computers. Information systems can be implemented following one of the many architecture forms. The distribution of data store, business logic and user interface building blocks are generally configured in an arrangement of multiple tiers (see Figure 1).

A unit of one-tier application provides a computation function or may read and write to a file, for example, a spreadsheet or a system located on a roadside site that logs data as vehicles pass. A two-tier or client-server architecture bundles the software blocks into a client tier and the Data store or database as a second or data server tier. An example of a two-tier system is a tool connected to access a database. A three-tier, multi-tier or distributed architecture divides the architecture into a thin-client user interface tier, one or more middle tiers with business logic and data filters, a data-server tier. The diverse railway users should benefit from each architecture. An ideal CIM system supports these architectures with a single system.

The world’s reliance on railways is constantly increasing. These demands can only be met by the effective management of immense data and the extraction of excellent information. CIM is an effective practice for managing a safe, reliable and cost-efficient transportation corridor.

References

The author is Director of Operations Systems, Bentley Systems