INSIDE THIS ISSUE – WHAT IS SHAPING THE RAIL INDUSTRY TODAY AND INTO THE FUTURE

Getting Value from Features - The Importance of Human Factors

Author: Patrick Carroll

Seemingly everyone has their own story of a project being held up over the slightest design oversight becoming a costly and time-consuming problem in the implementation and operation phases. This is often caused by a lack of consideration or poor understanding of Human Factors and its link with Systems Engineering. These two fields both play a key role in getting design right the first time and avoiding the cost of redesign later in the project.

The link between them and a successful design is simply attaining value from features. Feature brings no value to the system if the users are not able to use it effectively. How likely is a passenger in a car to use a new design of seatbelt if it takes 15 minutes to put on? The value of a seatbelt's safety features is tied directly to its use and if it cannot or will not be used, then it does not actually bring value. The opposite of course applies too - a seat belt that is very easy to use but does not make you safe adds next to no value.

This type of oversight is easiest to make when the design is focused on addressing system requirements. Consider a requirement for a new station platform that states "lights must be able to be set at multiple different light levels". One way to address this requirement would be to use a numeric input to specify the desired lux level of the lights. Another would be to add some pre-set 'dim' settings to the controller.

The first option is focused on how to provide the maximum additional functionality (maximizing the number of light levels). The second option instead provides a simpler use case while still meeting the requirement. It's easy to see here that maximum functionality does not always result in maximum value.

Usability can be considered an unspoken expectation, as there are often unspoken expectations within the context of a project, and these may be lost when designing purely to system requirements.

An example of this could be that it is required that someone using a train bathroom be notified if the door is not locked, but there is an unspoken expectation that this is not broadcast to the entire train.

An unspoken expectation may not impact the feature's ability to address the requirements, but it may provide a vastly different user experience and value to the feature.

Composite Timbers in Rail

Author: Tony Tadros

Over its long history, railways have progressed significantly with a focus being put on using materials with a lifespan of at least 50 years. The introduction and use of concrete sleepers have been a major factor in approving reliability and reducing operations and maintenance costs of railways all over the world.

In saying that, there are also disadvantages of using concrete sleepers mainly due to their weight and depth. Re-sleepering open deck bridges, turnouts on ballasted bridges with shallow ballast depth are just two scenarios in which concrete sleepers are not feasible and timber still needs to be used.

What if I told you that there is a material out there that has a lifespan of over 50 years, weighs the same as timber and can be used the same way as timber sleepers and bearers. Introducing FFU (Fibre Reinforced Foamed Urethane) railway sleepers. FFU is a lightweight corrosion resistant material formed of rigid foamed urethane reinforced with endless glass fibres. It is a high strength structural material, its weight is comparable to wood, and it is workable like wood, durable and water resistant. In addition, the material is resistant to shrinkage, which is a massive advantage as often, timber sleepers sitting in a yard are susceptible to shrinkage and deformation.

This year, V/Line has taken a massive step by deciding to replace all timbers on a 190m long open deck bridge with the FFU timbers. The composite timbers were imported from Japan with the whole process taking around 4 – 5 months for delivery. This uncovered yet another advantage… Lead time. With the procurement time of normal timber transoms being 9 – 12 months, we were able to save around 6 months' worth of material procurement time by using the FFU timbers.

Normal Timbers **FFU Timbers**

For more information, visit https://www.sekisui-rail.com/en/home_en.html

High Speed Rail and Electrification – Today and Into the Future

Author: Luke Cain

Globally, the strategic goals, objectives and performance drivers for railway networks and their operators vary. At their core, railways exist as a means of moving things (patrons and goods) from a point of origin to a point of destination. The key objectives of railway networks are to provide the safest, most efficient passage of patrons and goods between two points, on time regularly. This can be achieved through several different systems, network configurations and arrangements. In the context of high-speed rail, one such system arrangement is electrification.

When was electrification first introduced?
Electrification is one type of system which may be considered during the feasibility and planning stages for new or existing railway networks. Electrification of railways is not a new concept. The first known *electric locomotive* was built in 1837 by chemist Robert Davidson of Aberdeen (Wikipedia Unknown, 2020). The first *electric passenger train* was presented by Werner von Siemens at Berlin in 1879 (Wikipedia Unknown, 2020). In Melbourne and Sydney, the suburban railway lines were first *electrified* in 1919 and 1926 respectively (Wikipedia Unknown, 2020).

What is shaping electrification today?

Traction Power System
The objective of the traction power supply system is to provide reliable, uninterrupted power to an electrical railway network. Traction power systems fall into two distinct categories; alternating current (AC) and direct current (DC) systems. These systems are broken down further by their respective system voltages. Selection of an appropriate system is based on the specific network requirements and objectives during the planning stages. The following is a summary of typical traction power systems used around the globe including, but not limited to:

DIRECT CURRENT (DC)	ALTERNATING CURRENT (AC)
600VDC – *Germany*	15kV AC – 16.7 Hz – *Germany, Austria, Switzerland and Norway*
750VDC – *Germany, Norway, Thailand, USA, Canada*	25kV AC – 50 Hz – *Russia, Denmark*
1500VDC – *Australia, Netherlands, France, Dominican Republic, Hong Kong*	2 x 25kV AC – *Netherlands, Spain, France, China, Sweden, Japan, Russia*
3000VDC – *Spain, Italy, Brazil*	

Contact Line System
To ensure uninterrupted supply of power to the rolling stock further consideration of the contact line system is required based on the particulars of the operational environment. Contact line systems include:

OVERHEAD CONTACT LINE	GROUND LEVEL CONTACT LINE
Trolley Wire	Conductor Rails
Catenary Wire supporting a Contact Wire	
Conductor Beam supporting Contact Wire	

There are multiple configurations and parameters for further consideration once a contact line system is chosen for a specific application. However, for the purposes of this article, we will consider high speed lines as having catenary wire supporting a contact wire.

What is possible and what might limit high speed rail in the future?

To answer the question above, it is interesting to reflect on "Operation V150". (Rivera, 2020) explores why the maximum speed of trains seems to have stagnated at 350 kilometres per hour and discusses the limits of high-speed rail through his assessment of Operation V150.

On April 3 2007, the French TGV, V150, reached 574.8 km/h to achieve the world speed record for a commercial trainset on steel wheels. "Operation V150" was undertaken by a team formed by: French railway operator - SNCF, Infrastructure manager - Réseau Ferré de France and Rolling Stock manufacturer - Alstom. With a total expenditure of 30 million Euros it is no wonder that nearly thirteen years have passed since the world record was set.

During testing of the trainset, engineers monitored several specific details relating to the behavior of the vehicle, track and overhead contact line to determine the operational limits of each category.

"Operation V150" required a specially selected 94-kilometre section of the LGV Est line to be modified to enable the world record attempt. Key features and modifications along the route included:

- Route feature: A slight uniform downward slope
- Route feature: Sufficiently large curve radii
- Locomotive modification: adjusting the drive motors to 1000 kW (39% above their rated power)
- Locomotive modification: Increasing the wheel diameter
- Locomotive modification: The addition of larger skirts and several full body aerodynamic modifications
- Infrastructure modification: Thorough track infrastructure and alignment checks
- Infrastructure modification: Increase in maximum traction power system voltage to 31.7kV
- Infrastructure modification: Increase in mechanical tension of the electrical system from a nominal 25 kN to 40 kN

Rivera (2020) notes "Alstom engineers seemed confident that the test did not subject their train to any extreme conditions. They believed it was possible to exceed 600 km/h." He goes on to highlight that by achieving speeds close 600km/h would put the pantograph "dangerously close to that of the travelling wave disturbance of the overhead contact line". This in turn would significantly increase the risk of major damage to the overhead contact line system. Therefore, it is concluded that practical limits with current rail technology would be hit before reaching 600 km/h.

Rivera (2020) continues to examine why top speed trends seem to have plateaued at around 350 km/h. As a result of 'usual operating conditions', in which rolling stock routinely cover millions of kilometers, it is important to analyse safety, energy consumption and the need for controlling maintenance costs.
The following characteristics of the system are noted as factors in determining the viability of a high-speed system including:

- Aerodynamic affects: Due to the interaction with existing infrastructure
- Aerodynamic affects: Due to adjacent traffic
- Aerodynamic affect: Due to crosswinds in vulnerable areas
- Current technology: High-speed signalling systems (ETCS/ERTMS) are limited to ~500km/h
- Operational model: Total energy usage is determined by the number of intermediate stops required and not necessarily the target top speed of the line.

Rivera (2020) concludes “the high-speed train of the future can reach 400 kilometers per hour if it restricts its stops and moves large numbers of people at the same time.”

Into the future

Fundamentally, railways exist as a means of moving things from point A to point B. With the global population expected to increase by 2 billion people by 2050 it is reasonable to expect that our railway networks will play a significant role in the future. With key issues such as global warming and population increase dominating world headlines, now is the time, more than ever, for policy makers and industry leaders to advocate for innovative, sustainable railway solutions, both now and in the future. If 400km/h is a realistic operational speed for railways of the future, maybe it is time to start planning to decentralise cities enabling people to move between future cities in within an hour.
We need to ask ourselves, how we intend on moving large groups of people around in the future, and what we want our future railway electrification networks to look like? It is not simply up to the next generation to solve the problems of the previous.

References
(1) Wikipedia Unknown, 2020, Electric Locomotive, viewed 23rd February 2020, <https://en.wikipedia.org/wiki/Electric_locomotive>
(2) Wikipedia Unknown, 2020, Railway electrification in Australia , viewed 23rd February 2020, <https://en.wikipedia.org/wiki/Railway_electrification_in_Australia>
(3) Rivera, I 2020, The limits of high speed rail, viewed 23rd February 2020, < https://mappingignorance.org/2020/01/22/the-limits-of-high-speed-rail/>.
(4) United Nations, 2019, Growing at a slower pace, world population is expected to reach 9.7 billion in 2050 and could peak at nearly 11 billion around 2100, viewed 23rd February 2020, < https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html>

Collision Avoidance

Author: Claire Brown

Autonomous vehicles are no longer a thing of the future but the here and now. The new Sydney Metro is driverless and operating smoothly but what will happen when maintenance needs to occur on the network?

Can we rely on all this work being completed while trains are non-operational or can we look at other advances in technology to minimise the risk of driverless trains coming into contact with plant and machinery as they as working next to the live lines?

Vehicle and people detection is used on construction sites today by means of a Toolbox Spotter, being installed on a piece of plant. This technology indicates to the operator when people or vehicles are within the zone of influence, by flashing lights and a vibrating wristband to alert the operator and work crew. This safety tool means plant blind spots are reduced.

Further advances in technology could allow the trains to connect directly with machinery, when working within the rail corridor; notifying the machine operator to stop work as the train approaches. Then, relaying this information back to the control room to ensure the correct measures are taken. As the data is collated driverless trains can gain more information, to increase safety to work crews and passengers.

This tool could also be useful in accessing the rail corridor for site walks or routine inspections. With trains having the most up to date data they will be able to identify a host of objects, people or vehicles within the rail corridor and then programmed to take the correct course of action, be that reduce speed, signal to a work crew using a horn or lights or provide a live stream back to the control room to confirm the correct course of action. This can reduce the operational impact to the customer while maintenance works continue using the safest methods possible.

Digitalisation of The Railway – Rolling Stock

Author: Andrew Oliver

The rail industry is historically slow to adopt change. Solutions which have been tried and trusted over many years utilising older technology (mechanically driven) tend to be preferred over new systems which tend to be more software-driven. This mindset is slowly changing with more and more digitalised systems being adopted in line with a current, modern approach to new technology.

Digitalisation of rolling stock has many benefits for the end customer, but also for the operator and the maintainer of both rolling stock, and rail infrastructure. As rolling stock has interfaces with all rail infrastructure including track, signalling, civil (platforms), environmental, and overhead network (if electrified) this also provides benefits to maintaining, and improving the infrastructure based on the data provided by, and to the rolling stock.

But why digitalise and modernise if what is in place already works? Simple. The modern way of life involves connectivity through a number of digital means whether its social media, or cloud computing as examples, people want to be informed, and they want that information presented to them dynamically in a simple, and efficient format.

Why should the train journey be any different?

One of the critical steps in the rail journey is at the very beginning: knowing which train to catch. Pertinent questions such as: how/where do I validate my ticket? Which platform will it depart from? Is it running late? Is there free seating available? If so, in which Car? These are all simple questions which can be answered through technology providing the customer with accurate, real-time information.

Once you are on the train the next critical step becomes about the destination – which platform do I alight the train? When will this occur during the journey? What side of the train will the doors open? Again, easily answerable through digitalisation.

There are many examples of systems, both currently in use, and future options, which aim to deliver this functionality through digital means to improve the customer experience, Driver comfort and safety, and efficiency of the rolling stock and rail infrastructure maintenance – not limited to:

- Connectivity – remote access to rolling stock, condition-based monitoring for train and rail infrastructure, health monitoring for both train and Driver, faster fault rectification, autonomous travel

- Real-time Passenger data to improve customer experience/comfort – platform-based information (next Train details, seating availability, service delays), app-based information, ticketing streamlined (rewards program, smartphone capable), USB charging, wireless access point, moving network map to track journey (useful for infrequent users/tourists), PIS display with indicator arrows for alighting, external destination indicators (front, lateral), GPS positioning

- Smarter, safer, efficient operations – selective door operations (including correct side door enable) to prevent unsafe release of passengers into the rail corridor, ETCS Level 2 upwards allows closer running between trains, collision/obstacle detection inside rail corridor using forward-facing and body side cameras, smart wearables for Drivers providing health data to the control centre as secondary form of Vigilance and assistance in supporting human factors by ensuring Drivers maintain good posture, passenger counting systems to better understand the demand, assist with fare evasion, and plan railcar consists accordingly (ie put on additional services, increase consist size etc)

- Pursue renewable energy solutions - ESS battery technology replacing conventional current-collection equipment, catenary free operations to maintain aesthetics of surrounding areas/urban centres, offset carbon emissions, reduce load on existing OHW network allowing for further fleet expansion, solar panels for powering auxiliary systems with green energy

- Maintenance improvements – digital twin capability, sensor data provides basis for implementation of condition based monitoring regime, health monitoring (Train and Driver – smart wearables), fault rectification, simulations, driver training (VR technology), track improvements through wheel-rail interface data, overhead improvements through pantograph-contact wire interface, automated asset management tool which captures field data and updates database, less downtime and increased availability

- Interoperability – standardisation of the rail network in Australia between major cities ie standard gauge with ETCS allowing interoperability when transferring between RTO infrastructure, "black box" systems which are line-replaceable with standardised set of I/O and functionality usable on any rolling stock/rail infrastructure – improved maintainability

As you can see the possibilities that digitalisation can introduce for the benefit of all stakeholders is endless, with many more systems utilised currently, and under development in the future as more and more technologies are discovered.

References

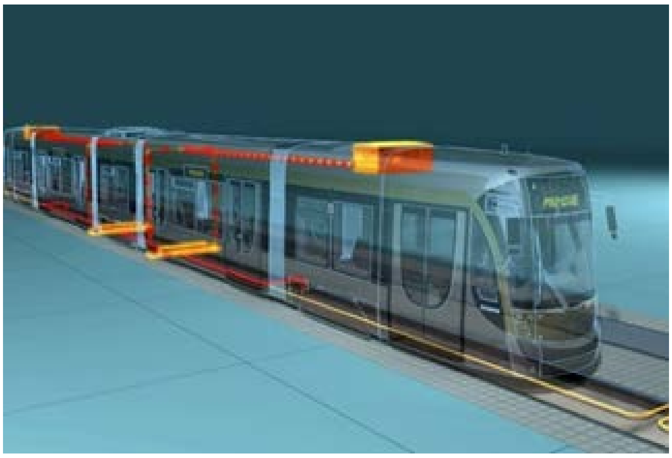
(1) Image, 2018, Digital Transformation Has Spurred an Unexpected Renaissance in the Age of Big Data, viewed 27rd February 2020, <https://www.smartdatacollective.com/digital-transformation-unexpected-renaissance-age-of-big-data/>

Catenary Free Trains

Author: Joseph Plunkett

Cities planning a tramway can today preserve their historical heritage and urban environment by dispensing with obtrusive overhead contact lines. Several manufacturers are developing ground-level power supply systems and it's a proven alternative with equivalent performance which is currently operating in seven cities on three continents and offers safe, reliable power to trams whether in short catenary-free sections or along the entire line.

Inspired by 'third rail' feeding systems present in metros, these systems use segments set into the track bed between the guiding rails to supply current to vehicles. These segments automatically switch on and off according to whether a tram is passing over them, thereby eradicating any risk to other road users. This safety principle was certified by several competent bodies all over the world.



In Melbourne supercapacitors are being developed with the vision to recharge at a station within 16 seconds whilst passengers board. They are also considering redundancy in case of an accident that the vehicle will be able to travel several stations in limp mode without a recharge. Catenary free is being considered due to the restrictions traditional infrastructure (Sub Stations) offer, being a dense city with so much growth way side power systems (storage systems) are being considered.

Climate change: Building a resilient railway network

Author: Morgan Woods

Climate Change has had an increasing spotlight in the media over the years with overwhelming scientific evidence and disastrous weather events such as the recent wildfires across the New South Wales East Coast reinforcing the detrimental effects our carbon footprint has on our planet. Climate Change is something that cannot be ignored, and the rail industry needs to actively adapt to cope with the adverse effects extreme weather has on railway networks across Australia.

Figure 1 – High temperatures resulting in speed restriction on the NSW rail network[1]

The impact that Climate Change has on rail assets is extensive; hotter and drier summers leads to pavement deterioration, rail buckling and increased need for passenger thermal comfort through the use of HVAC systems. Warmer, wetter winters leads to surface water, increased frequency of landslip, scour and washout. Extreme precipitation is putting a strain on drainage systems and extreme winds are damaging overhead wiring systems.

Figure 2 Pillars for incorporating climate change into BAU [4]

Incorporating sustainability into BAU requires a solid backbone for industry to stand on, this requires a shift to corporate strategies, for, an overhaul of legislation, industry standards and guidelines to reflect environmental targets which are defined and are backed by scientific evidence. Targets which can be measured and analysed and lastly a change to our core values.

The development of this solid backbone will create a foundation for industry to stand on and allow for further technological advancements such as hydrogen powered trains (currently running in Northern Germany)[3] and reduction of industries carbon footprint through the implementation of sustainability in every day practices across businesses.

This leads to frequent disruptions to revenue services as damaged assets or fire related speed restrictions are leaving customers stranded also resulting in negative financial impact on operators. It is necessary for governments and private businesses to build resistance into the network to alleviate disruptions caused by extreme weather.[2]

Although small changes in rail technology and the movement towards electric rolling stock, the industry still has a long way to proactively reduce the carbon footprint of transportation by incorporating sustainability into Business As Usual (BAU).

Figure 3 Hudson Bay Railway impassable after flooding[5]

References

(1) <https://www.railjournal.com/regions/australia-nz/bushfires-impact-rail-nsw/>
(2) <https://www.unece.org/fileadmin/DAM/trans/doc/2010/wp5/Workshop_PPP_05_Baker.pdf >
(3) <https://www.theguardian.com/environment/2018/sep/17/germany-launches-worlds-first-hydrogen-powered-train>
(4) <https://unctad.org/meetings/en/Presentation/dtltlbpls-AhEM2019_p11_MICHAEL%20WOODS_en.pdf >
(5) <https://www.cbc.ca/news/canada/manitoba/churchill-climate-change-port-railway-1.4193531>

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