Rolling Stock Interface Requirements with Other Systems

Presented by:
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Personal Perspective Related To Vehicle Acquisition & Rehabilitation Program Experiences:

- System Stakeholders
- Interfacing Benefits
- System Integration Process
- Categories of Systems
- Tier Levels of Stds & Requirements
- System Factors of Vehicle Design
- Maintenance System Influences
- Communicating System Interfaces
- Systems Hierarchy for Change

Governance of System Integration
System Interfacing Stakeholders

- **On Vehicle Systems Stakeholders:**
  - Carbuilder, Subsystem Suppliers, Operators & Crew

- **Non-Vehicle Systems:** A Larger Group of Stakeholders
  - Track and Infrastructures, (Tunnels, Bridges)
  - Security and Fire Protection
  - Other Transportation Modes - shared ROW autos, buses
  - Stations, Maintenance Depots, Control Centers
  - Power Energy Source including other Utilities Groups
  - Passengers

- **The “Community”** (business, industries, residences, financers) who were the rationale for this transportation vehicle mode selection
Effective Execution of Interfacing Requirements

Benefits:

• Maintaining Project Schedule and Inherently Manages Project Budget

• Increases equipment/facilities performance and higher reliability

• Minimizes possibility of service interfering events- i.e. derailments, vandalism, equipment/operator functional error due to new unaccounted environmental stress factors (infrastructural breakdowns, climate influences, traffic, passenger activity)

• Maintenance programs effectiveness contributing to life-cycle cost efficiencies

• Operational Workforce – to focus with ease on required task and availability to attend to other key functions: e.g. customer service

• Passengers – provided greater comfort and SAFER experience, results in increasing revenues due to ridership trust from a more dependable service experience

• ‘Community’ – increase business revenues, manage traffic flow that creates higher work productivity, cost-effective alternatives to road transportation
Tier Levels of Standards & Regulations

Final Vehicle Design

Operating Standards
Railway Specific
Selection for efficiency of service and costs

Rail Standards - APTA, FRA, AAR, UIC, EN
Encompass both vehicle design, maintenance & operation

Engineering Design Standards - ASME, IEEE, AISI, NFPA, etc

Standards are the Platform to Build the Vehicle Interface Awareness
These Can Rarely be Challenged Unless Scientifically Validated
Tier Levels of Standards & Regulations Process Applied to Non Vehicle Areas

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External Standards – Building Codes, Workplace Safety, Ergonomics, ADA

The Concept of System Integration is Connected by these Common Use of Standards
Due to the Trends of Interoperability and Standardization not many Requirements are negotiable!

- Historic experience was applied creating those standards to get a reasonable workable solution for today’s existing rail operations.
- Hence Technology Evolution is reasonably slow requiring closely governed testing before new technologies will be accepted for application.

Additionally, when new more demanding regulatory codes come into play, more effort and costs are exercised. (for example: Tier IV Loco Emissions, HVAC Refrigerants)

Lack of Attention to Interface Requirements with Effective System Integration usually leads to Hardships Borne by Stakeholders Primarily the Authority and/or Agency, then the Contractors and lastly the Suppliers!
System Integration Process

- Use the SIP Model Focused
  - At Project Definition Phase (PSOS)
  - With an O&M outlook
  - On Identifying All the Stakeholders

- Document Specifications
  - Write TS in the Common Language of Each System Discipline
  - Standard References May Not Be Enough, Address the ‘Specifics’!
  - Ask for CRDLs as Evidence that Design is addressing Integration

Implementation Phase
  - Create Timely Critical Gate Reviews to Ensure Integration Success i.e. PDRs, FDRs, 3rd Party Review
  - React Expediently for Resolution of Integration Conflicts
  - Have Contingency Project Funds Available to Address Those Issues
Interfacing Factors - General Layout Categories

- General Vehicle Layout is determined by various interfacing factors, here are the components and influencing factors: (not all-inclusive)

- **Operation Direction** – Bidirectional - Push-Pull - Track /Line Arrangement - Route Operation (turnabouts, loops, sidings) – Car/Train Configuration

- **Trainset Length** – Platform Length - Passenger Loading Requirements - Headway Capacities - Stabling and Existing Depot Capacities

- **CarBody Outline** - Track Gauge - Swept Envelope - Right of Way Limitations i.e. Tunnels or Shared Right of Way with Autos - Passenger Seating or Loading Arrangements

- **Floor Height** – Platform Height - Car Design - Passenger Service Requirements Truck Design (wheel size, brake and traction motor arrangements)
General Layout – Performance Factors

- **Acceleration & Deceleration Rates** - Matching Existing or New Rolling Stock
- **Operating Speeds** – Route Timing Requirements
- **Track Design** (elevation, grades, curves)
- **Headway** – Station Dwell Times
- **Equipment Limitations** (i.e. disc wheel temperatures, propulsion capacity)
- **Environmental Conditions** (i.e. wheel slip conditions,)
- **Rescue Operations** – Level of operation, fleet version (coupler interface)
- **Failed Equipment Scenario Demands** – i.e. brake cut-out operation
General Layout Evolve to Specific Design Considerations - Door System Example

- **No. of Passenger Doors** influenced by:
  - Passenger Flow Rates
  - ADA Requirements - Station Stop Dwell Times
  - Type of Service (Metro, LRV, Commuter)
  - Operator or Passenger Commanded Operation
  - Train Configuration
  - Car Layout in terms of Seating /Standing Capacity
General Layout Evolve to Specific Design Considerations - Door Type Selection

- **Doors Selection - Double or Single Leaf - Sliding or Plug Style** based on:
  
  - Type of Service - Operational Direction
  
  - ATO, operator or passenger door control
  
  - Platform and Boarding Relationships (street level, interfacing with platform screen doors)
  
  - Environmental Conditions - exposure to climate (ice, sand, sea salt), high speed operation, tunnels vs open, air / water-tightness requirements
  
  - Door Operation Features: obstruction detection, moveable step
Systems Factoring Vehicle Design Considerations

- **Civil Construction**
  - Dynamic Envelope, Structure, Track Gauge, Vehicle Static and Dynamic loads (Axle load), Train Length

- **Tunnel Ventilation**
  - Heat/Air Dissipation from Vehicle, Airflow Pressure Tube (nose profile), Rolling Stock Fire Loads

- **Traffic Signal Priority System**
  - Radio Control, Vehicle Operated, Integrated Wayside Commanded, Control Center Dictated

- **Train Control Systems**
  - Dual way Vehicle to Wayside Communication – CBTC, ATO, ATC, PTC, Transponders, Receivers, Rail Crossings and Signals, Vital Interlocking Systems
PTC Systems Interface Example
PTC System Equipment Resulting Installation
Systems Influencing Vehicle Design

- **Power Feed/ Energy Systems**
  - Catenary or Third Rail, Line Voltage/Current Ranges, Receptivity, Regenerative, Energy Recovery & Storage Systems, Rail Gaps, Diesel Fuelled, Emission Standards

- **Passenger Information Systems**
  - Integrated Displays and Announcements within train and stations, APC-Automatic Passenger Counting for Dispatching

- **Aesthetics**
  - Vehicle ‘Themed’ to Match Surrounding Aesthetics Influences

- **Derailment Prevention**
  - Rail & Wheel Profiles, Materials, Truck Carbody Suspension Dynamics, Loads, Speeds, Track Environment
Passenger/Operator Protection Systems Factors

- **Vehicle Design Influences**
  - Crash and Blast Energy Management (Structural, Materials, Anti-climbers)
  - Terrorist and Vandalism, Security (Structural, Materials, Lock Cabinets)
  - Communication Devices: PTO, OTC, Alarm Strips, Use of CCTVs
  - ATP, ATS, Vigilance Systems

- **Fire Safety & Protection**
  - Smoke and Fire Standards (Material FSTs), Burn Rates
  - Alarms, Emergency Lighting, Fire Extinguishers (Automatic, Manual)
  - Tunnel Ventilation & Vehicle HVAC Operation

**Evacuation Procedures & Equipment**

- Power Isolation, Tunnels and Elevated Track, Station Unloading
- Emergency Exiting, Ladders, Stretchers
- Emergency Lighting, Well Identified Push-Out Windows
Maintenance System Factors

- The Maintenance Operation employed by the Authority creates strong influences on the Vehicle Design hence it is a ‘System’ requiring the Integration Process!
  - Reliability Based vs. Correctional Based vs. Scheduled Based and ‘Intervals’
  - Manpower Skillsets –LRUs, On–Board Equipment Module Design Approach
  - On-Board Diagnostics, VMCS, WLAN Communication to Depot for Servicing
  - Level of Equipment Redundancy or De-rated Operational Tolerance
    i.e. no. of brake/traction units cut-out, HVAC fans and condenser motors
Maintenance System Factors - Continued

• **Material Management** - stores, repair shops, transporting of parts. Effects aspects of BTEs, spare parts, availability of shop space.

• **Depot & Service Bays Design** – mezzanine, pits, wash bay, wheel truing. Affect car design i.e. roof mounted HVAC, underfloor equipment access.

• **Maintenance Services Contracted or Authority Operated**. Owner of responsibility/risk does have a vehicle design influence.
Other System Considerations

- **Go Green & Sustainability**
  - Power energy consumption
  - Emission requirements
  - HVAC Refrigerants

- **Regulatory Codes Compliance**
  - Tier IV Locos, NFTA Fire, Noise codes, ADA

- **Disposal of Materials**
  - Recycling of brake shoes, batteries,

- **Repair-ability**
  - Seats, flooring, carpets

- **Cleaning Process**
  - Affect: seat/floor/heater designs, equipment location, use of chemicals can affect interior/exterior material selection

- **Life Expectancy & Rehabilitation Capabilities**
  - Modular vestibules i.e. toilet rooms, sleep cabins, operating cab station
Communicating System Interfaces Issue

- These Aforementioned System References Create the Competent Vehicle Technical Specification (TS) that is to be Utilized in the Proposal Award and Evaluation Process
- The TS requirements should be reflected in CRDLs Reviews, Design Review Process and Test & Commissioning Process.

Concerning Issues:
The Vehicle Review Process is Specific to Vehicle Compliance and Functional Performance as specified in the TS, with Not Much Interface Evaluation With the Other Non-Vehicle Systems

Are Those Responding to the Requirements Sufficiently Experienced or Experts in the External Systems They are to Interface With?

Not All External Systems are Represented at These Interface Review Meetings and are Appropriately Evaluated for Integration Compliance.
Systems Hierarchy– For Change Acceptance

- **Design /Gate Reviews** are necessary to identify the ‘ripple effect’ of changes on other systems – both on vehicle and non-vehicle systems.

- “Changes” involve assignment of ownership and negotiations of bearing costs, hence the requirement to create the **Hierarchy of Systems**
  - Establish the **Key Criteria** that dictate other systems to integrate with!
  - **Cost-Benefit Analysis** is often required to justify approach and/or alter the Hierarchy of Requirements

Recognize Value of the Compliance Matrix
However, be Open to Accept Alternatives and
Ensure Analysis of Impact of Adopting Them has been Performed!
Observation Remarks

- All Stakeholders and System Players Attempt to Maintain Dominance of Their Specification Requirements by Controlling Changes that may Impact Their Project Schedule and Budgets.

- There is a Common Perception that the Vehicle is Viewed as the Most Versatile and Flexible System within the Transportation Project

- For New Systems Rolling Stock is Typically the Last Constructed Required Project Piece

- Resulting in Vehicle Design Being Challenged to Make the ‘Last Minute’ Changes to Adapt to the Other Systems Requirements.

- Such Changes often occur at the Vehicle Post Contract Award Phase which Results in Change Orders and Additional Engineering Design Expense
It is Not Sufficient to Just Address the Specifications and Regulatory Requirements, ‘It’ is the Interpretation of Application that Creates Integration Success!

Governance of the System Integration Process should be handled by an open-eyed and ‘telescopic’ vision but with a ‘micro’ understanding and detailed review approach!

To Develop a Vehicle that is Well-Integrated to the Transportation System Requires Involvement of it’s Partners that is Best Steered by Expertise!
Best Regards from Michael Weiss for Your Attentive Interest