Using Simulation to Implement HRO Characteristics

Applications to the Railroad Industry

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<table>
<thead>
<tr>
<th>Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railroad as an HRO</td>
</tr>
<tr>
<td>Application of Simulation in HRO</td>
</tr>
<tr>
<td>Simulation in Railroad</td>
</tr>
<tr>
<td>Total Human-System Integration Process for Railroad New Technology</td>
</tr>
<tr>
<td>PTC Implementation and Simulation</td>
</tr>
<tr>
<td>Conclusion</td>
</tr>
</tbody>
</table>
The railroad industry strives to avoid catastrophic events, performing dynamic tasks under strict time constraints, operating technology posing large-scale physical hazards.

HRO studies in railroads divide reliability failures in two main categories (Busby, 2006):

- organizational vulnerability to disaster at any particular time
- the gradual degradation processes leading organizations into vulnerable states
Applications of Simulation

“Simulation is a technique - not a technology - to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner” (Gaba, 2004).

Examples:
- Education
- Training
- Safety
- Performance Optimization
- Designing a new System
- Analysis of existing system
- Organizational Culture
Railroad Simulators

Computer-based Simulation

Full-Mission Simulation
Simulation in Railroad

- Infrastructure design
- Safety
  - Warning Systems (Signaling)
  - Accident prevention (derailment or train-to-train collision)
- Traffic Control and Network Management
- Maintenance

Simulation can increase Safety and reduce Cost
Total Human-System Integration Process for Implementation of a new technology in Railroad and Proactive Incorporation of High Reliability Organization (HRO) characteristics
### Total Human-System Integration Process for Implementation of a new technology in Railroad and Proactive Incorporation of High Reliability Organization (HRO) Characteristics

#### Basic Design
- **Determine System Objectives and Performance Specifications**
  - Define specification
  - Determine alternative

**Definition of the System**
- Determine and describe system functions
- Define job and organizational factors
- Identify manpower and training requirements
- Establish a fluid/flexible authority structure *
- Identify local operating practices *

**Human-system Performance Requirements**
- Identify key performance indicators of a resilient organization *

**Function Allocation**
- Task analysis
- Designing work modules
- Identify margins of safety

#### Interface Design
- Human – computer interaction requirement
- Workload analysis

#### Standard Operating Procedure and Emergency Operating Procedure
- Identify potential for deviance *
- Anticipate unexpected events and define failure analysis procedures*
- Establish general risk reduction strategies

#### System Testing and Evaluation
- Define system evaluation and review procedures
- Identify proper feedback mechanisms
Positive Train Control (PTC)  
An Example of A New Technology
PTC, An Example of A New Technology

- Fully integrated technologies
- An overlay on top of already existing safety systems to improve safety
- Linking communications network, components on locomotive, along the wayside, and in control center to prevent collisions (Ditmeyer, 2011)
- PTC calculates time needed to stop a train before it exceeds its authority and will intercede if the locomotive engineer fails to take action (Ditmeyer, 2011)
PTC Implementation and Simulation

Simulation could be used to:

- Design and implement PTC technology
- Develop and execute training sessions
- Performance analysis and optimization
- Evolve new system
- Coordinate teamwork and communication practices
Conclusion

- Train accidents are rare but not unique, there are Low Probability-High Consequence events.
- Simulation could be used to detect and highlight precursors that could lead to potential accidents in order to improve already existing system and prevent such events from happening in future.
- Actual accident or close-call scenarios should be used in training procedures as lessons learned.
- Simulators have primarily focused on training for events, not for whole system changes.
“Simulation will be an important “bottom up” tool for creating and maintaining a culture of safety and for fostering changes in work procedures and systems”

(Gaba, 2004)
References


References (Cont.)


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