A SURVEY OF FUTURE RAILROAD OPERATIONS AND THE ROLE OF AUTOMATION

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MIT Man Vehicle Lab

FRA/Volpe CTIL

Imagination at work.

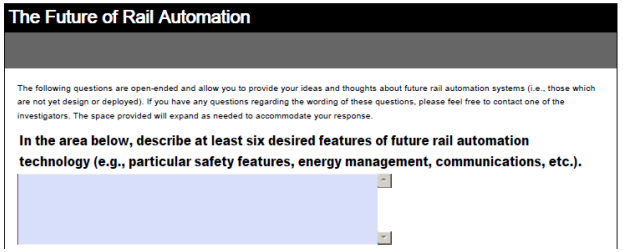
Survey Overview

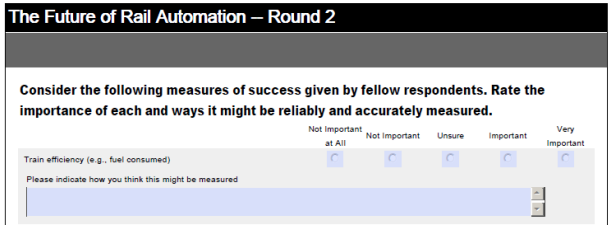
Goals:

- Elicit view of future automation in rail industry: Generate discussion!
  - Features, success metrics, new operational configurations, adoption
  - Automation concerns

Methodology:

- Delphi Survey Method (Helmer, 1967)
  - Round 1: open-ended questions
  - Round 2: ranking of prior responses + research team options
    - Modified to reduce time to complete





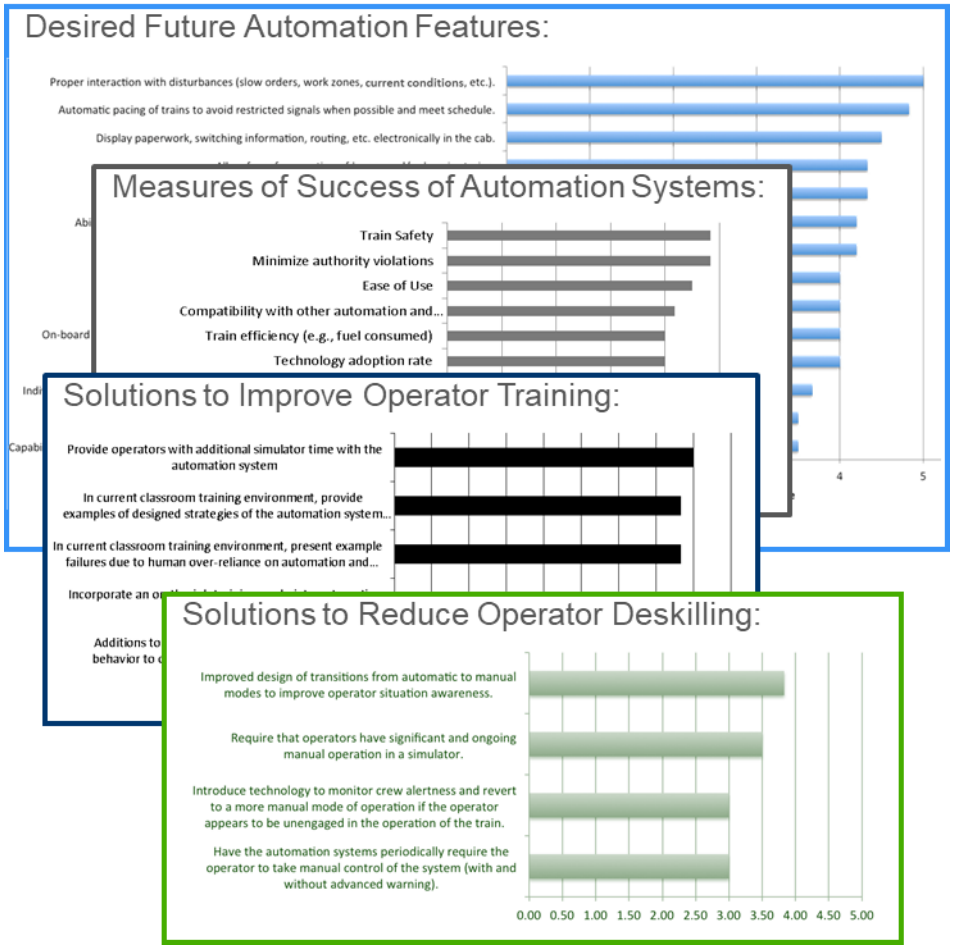
Survey Participants & Topics

7 in first round (3 GE, 4 RR), 8 in second round (3 GE, 5 RR)

Current Roles: senior controls/systems engineers (GE), directors of operations, locomotive productivity, operating technology, and safety (Class 1 RRs)

Experience as Crew Member	Mean	Range
Engineer	12.8 years	0 – 25 years
Conductor	13.8 years	0 – 31 years
Dispatcher	0 years	0 years
Foreman	8 years	0 – 18 years

Results Summary

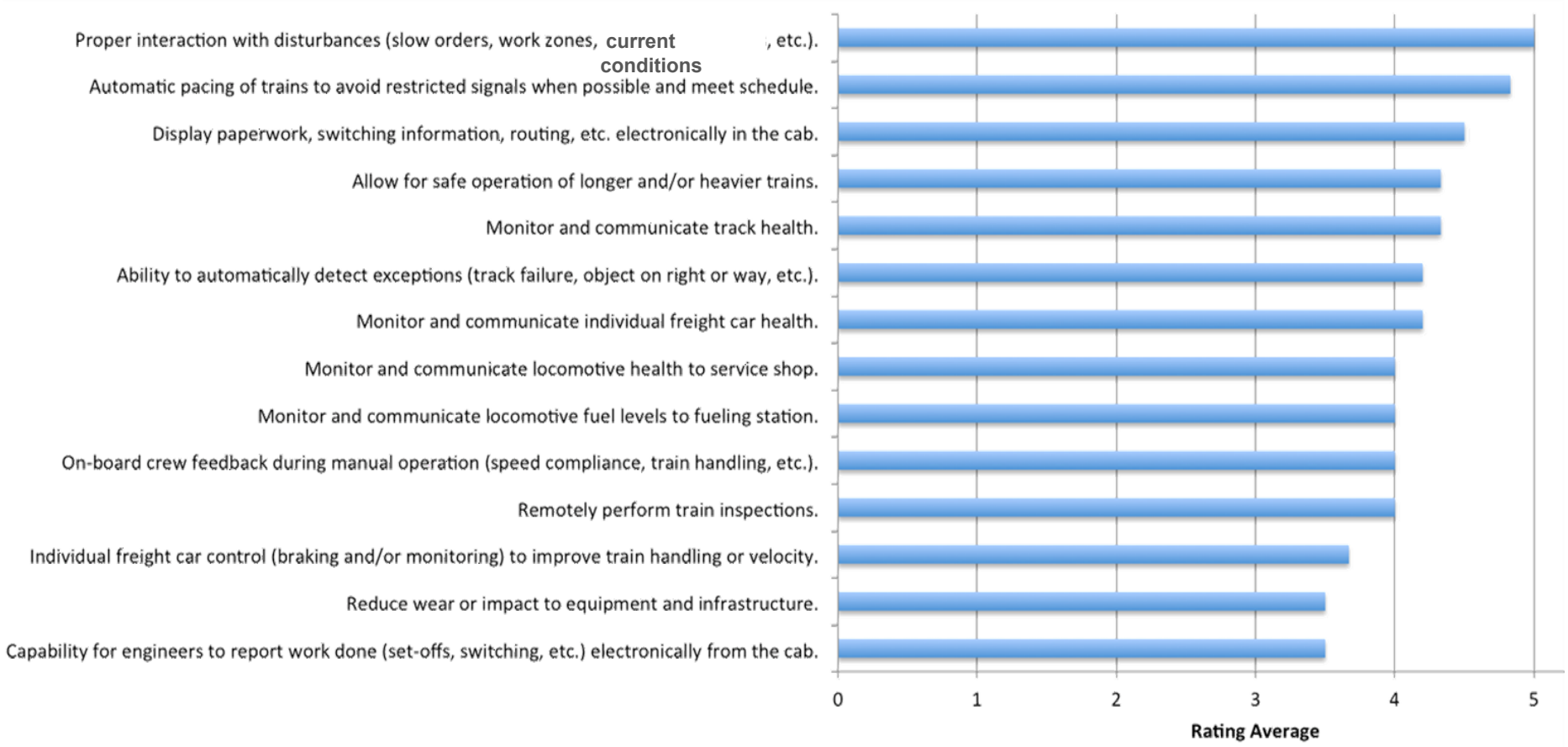


Highlights:

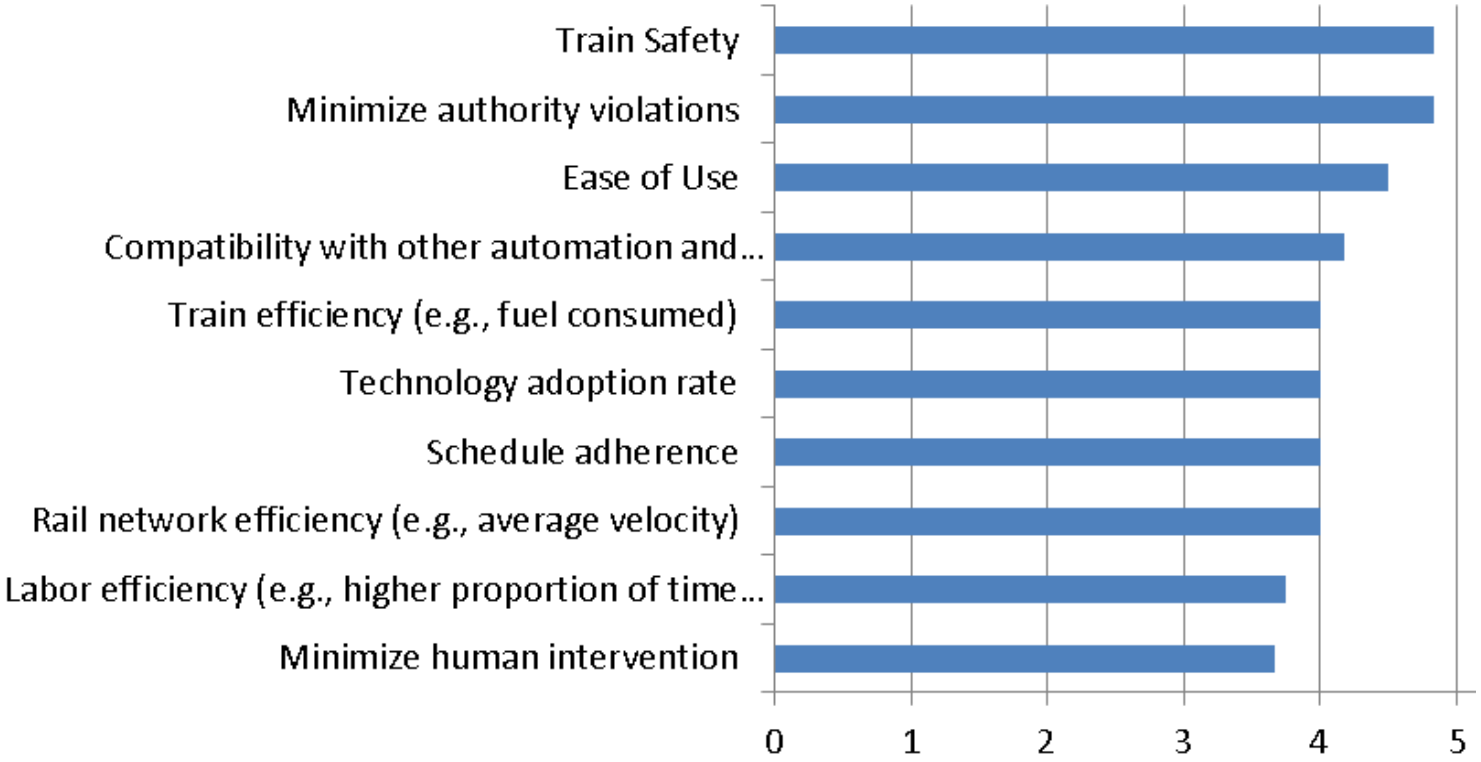
- Desired: additional automation, longer/heavier trains, more information in cab
- Key success metrics: Ease of use and compatibility
- Need to provide more comprehensive training
- Work to improve operator situation awareness after auto-manual transitions

Desired Features, Success Metrics

Importance of Desired Future Loco Automation Features



Importance of Measures of Success of Automation



Details of ideas about how to measure each in full paper (DOI: 10.3141/2608-02

Alternate Operating Configurations

New Operating Configurations

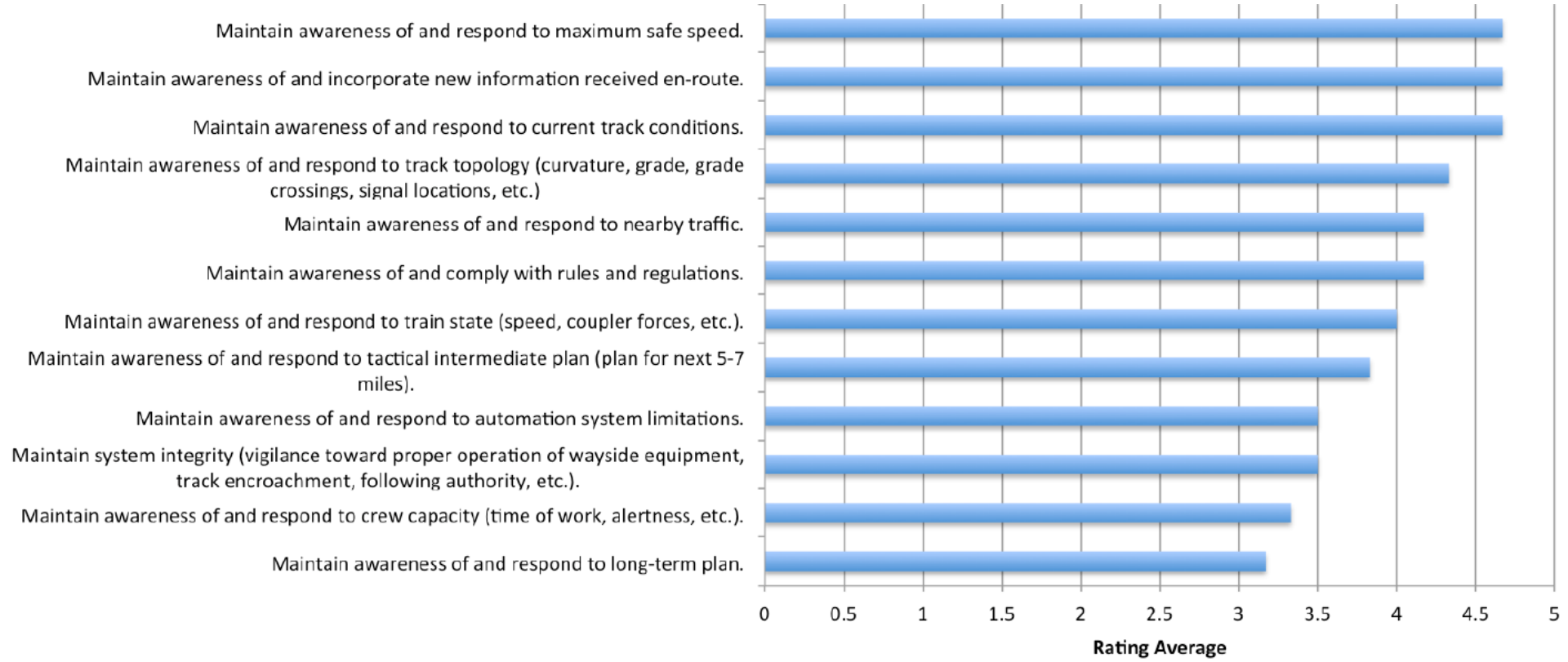
Question motivated by recent proposals for single-person crews with roving “conductors”

Responses for tasks which can be effectively done remotely:

Tasks Performed by Remote Crew	Tasks Retained by Local Crew
Handle train movements through territory.	Exceptions requiring manual interventions (i.e., automatic switch failure, other mechanical failures).
Train inspections.	Switching activities, coupling, and uncoupling.
Track inspections.	Assembly/disassembly of trains.
Remotely operating train on main line with no en-route switching, operating more than one train.	Guidance over unprotected public crossings.
Pull back of tracks in yard switching.	Horn and bell operation.
Monitor signals.	Monitoring environment for emergency situations.
Air brake application.	Air brake application.
Speed control.	Monitoring gauges.
Alert button application.	Checking that siding is clear.
Monitor train location.	

Consensus: technically feasible (though some current gaps), unsure of public/regulatory feasibility

Automation Benefits by Task



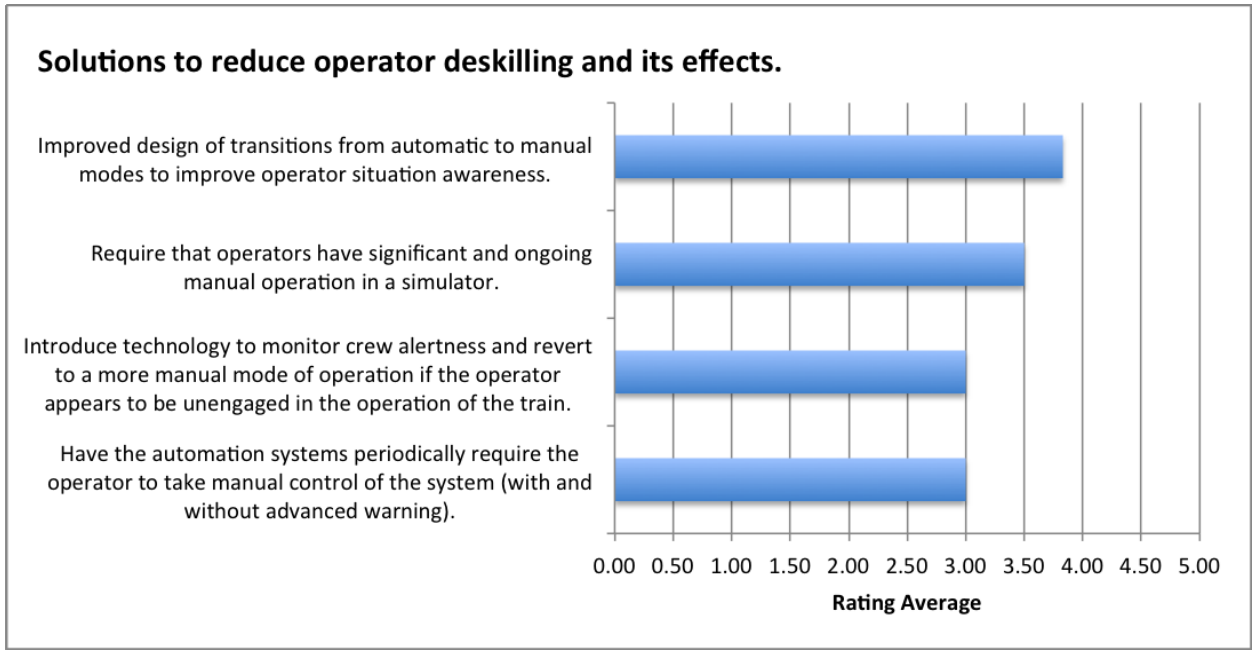
All average ratings are positive – industry sees net benefit of increased automation

Automation Concerns

Operator Deskilling

"users of the technology…feel they are being sidelined….made redundant"

Feasibility of possible solutions:



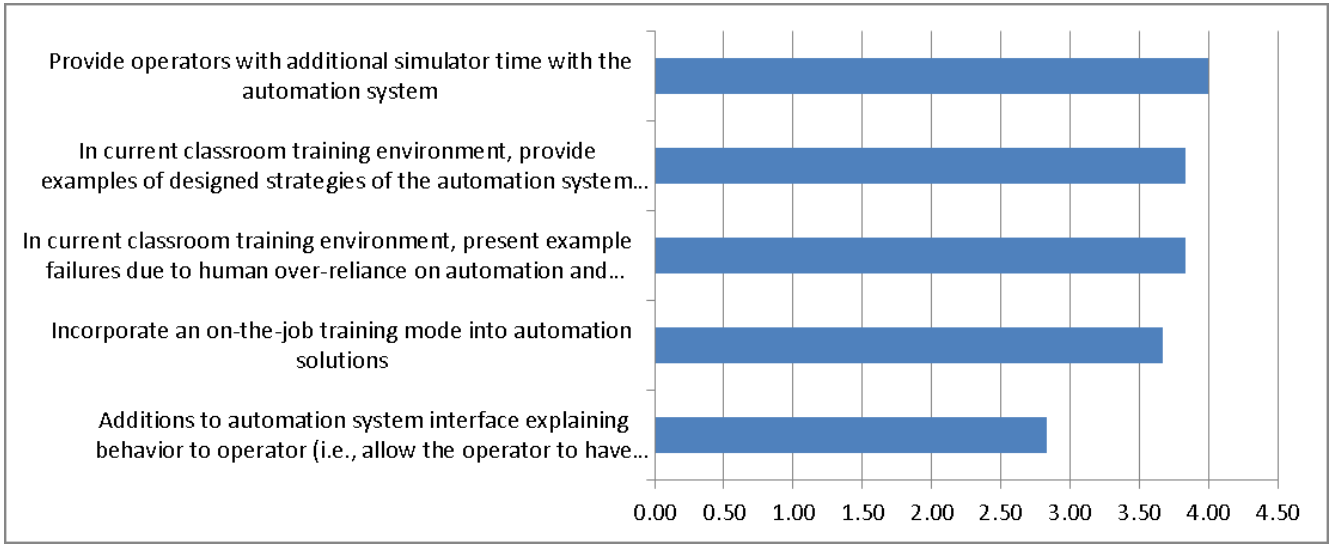
Operator Training

Need “continuous training with respect to updates”

“PowerPoint [not effective]….having simulator capability….in classroom”

“if crew understands why system does what it does…they will accept the system more readily”

Feasibility of possible solutions:



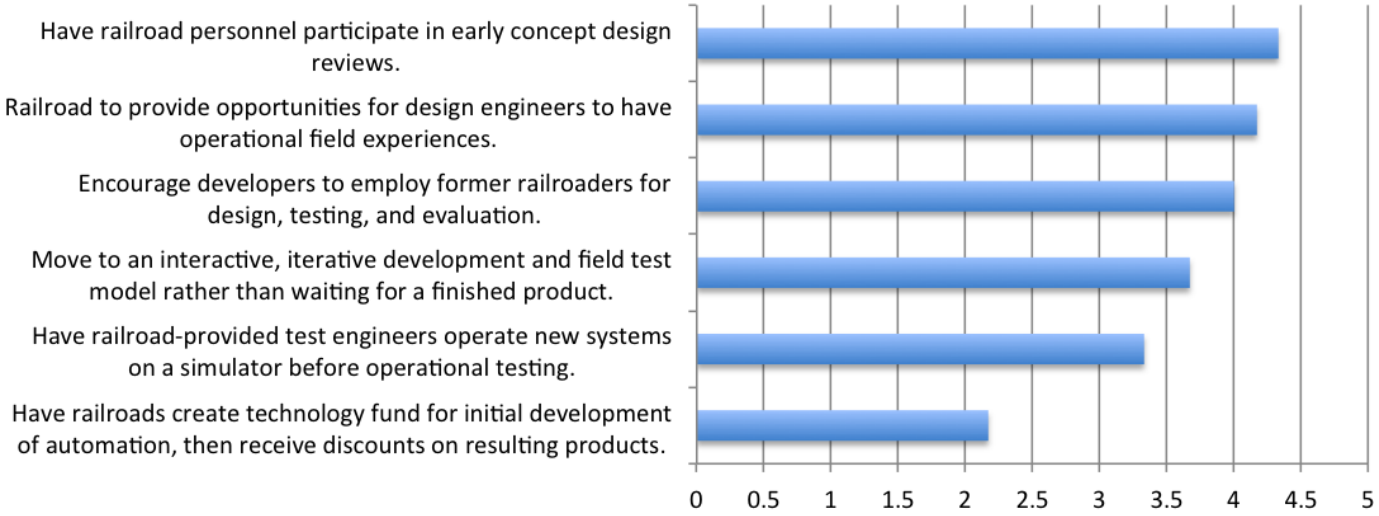
Automation Development

"designers are too far removed from the train crews' environment…start thinking like a locomotive engineer"

"products tend to be sold before developed…[have to wait] for production…

"[results in] systems that do things we didn't need and won't use…counter productive…complications"

Feasibility of possible solutions:



Takeaways

Rail industry sees net benefit of increasing automation and wants to explore alternate operating configurations

Opportunities to improve training effectiveness, design process

Questions? brooksja@ge.com

Related Publications

A. J. Brooks, H. Groshong, A. Liu, P. Houpt, C. Oman, “Survey of Future Railroad Operations and the Role of Automation,” Transportation Research Record, Vo. 2608, pp. 10-18, 2017.

B. A. Liu, J. Brooks, N. Subrahmaniyan, B. Miller, C. Oman, “Measuring the Time Course of Engineer Workload During Automation Mode Transitions,” Proceedings of the Human Factors and Ergonomics Society Annual Meeting, Vo. 63, No. 1, pp. 1555-1559, 2019.

C. J. Brooks, N. Subrahmaniyan, B. Miller, A. Liu, H. Groshong, C. Oman, P. Houpt, “Human-Centered Automation Design: An Application to In-Cab Rail Technology,” Proceedings of the 96th TRB Conference, 2017.

D. H. Groshong, “Task Modeling and Assessment for Human-System Interaction in Freight Rail Operations,” MS Thesis, MIT, 2016.