



Transportation
Safety Board
of Canada

Bureau de la sécurité
des transports
du Canada



Understanding the factors contributing to human behaviour leads to systemic safety improvements

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Senior Human Factors Investigator / Analyst





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TSB 25 BST

Investigating human and organizational factors involved in the September 2013 crash between an OC Transpo double-decker bus and a VIA passenger train.

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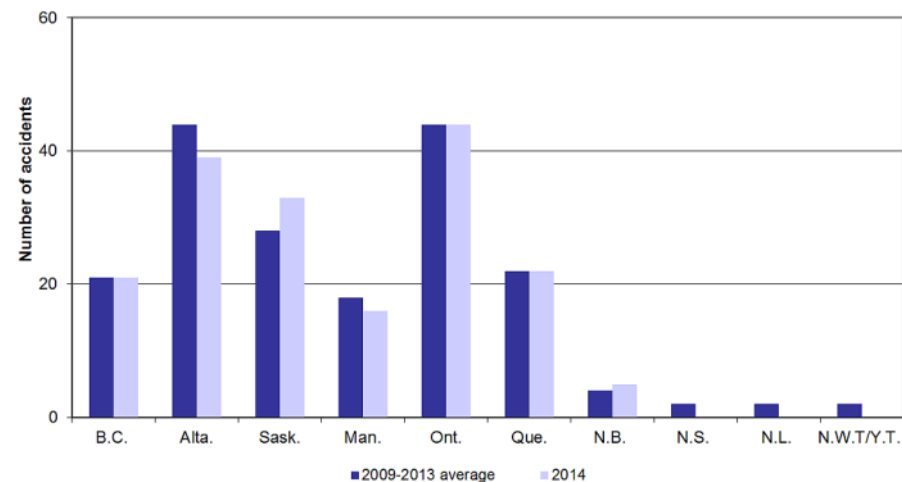


Something to consider...

- ‘System safety’ vs. ‘**safe system**’ approach to road safety (Australia)
 - “Vision zero” (Sweden)
 - “Sustainable safety” (Netherlands)
 - **“Road safety strategy 2025: Towards Zero: The Safest Roads in the World” (Canada)** <http://crss-2025.ccmta.ca/en/strategy>
- Advocates for system that is adaptive to the physical tolerances of its users.
- Accepts that human error is inevitable.
- Aims to create a transport system that makes allowance for errors and minimizes the consequences - in particular, the risk of death or serious injury.

Introduction

- Although crashes at level crossings are relatively uncommon (<1% of road fatalities), outcomes are substantial → top priority worldwide
- About 16,000 public level crossings in Canada
- From 2005 to 2014 there were 2,044 level crossing crashes, with...
 - 265 fatalities
 - 295 serious injuries.



Level crossing accidents by province, 2009 – 2014

September 2013 crash between OC Transpo double-decker bus and VIA passenger train

[Video: http://www.tsb.gc.ca/eng/medias-media/videos/rail/r13t0192/index.asp](http://www.tsb.gc.ca/eng/medias-media/videos/rail/r13t0192/index.asp)



Outline

- Who we are
- How we investigate accidents at the TSB
- How we assess human and organizational factors when investigating accidents at the TSB
 - Our philosophy
 - Our process
 - Our tools
- How we investigated the human and organizational factors involved in the September 2013 crash between an OC Transpo double-decker bus and a VIA passenger train.

Who we are

- The Transportation Safety Board of Canada (TSB)
→ independent agency that investigates air, marine, pipeline, and rail occurrences.
 - Conduct independent safety investigations
 - Establish what happened and why
 - Identify systemic safety deficiencies
 - Make recommendations for safety action
 - Communicate publicly



Who we are

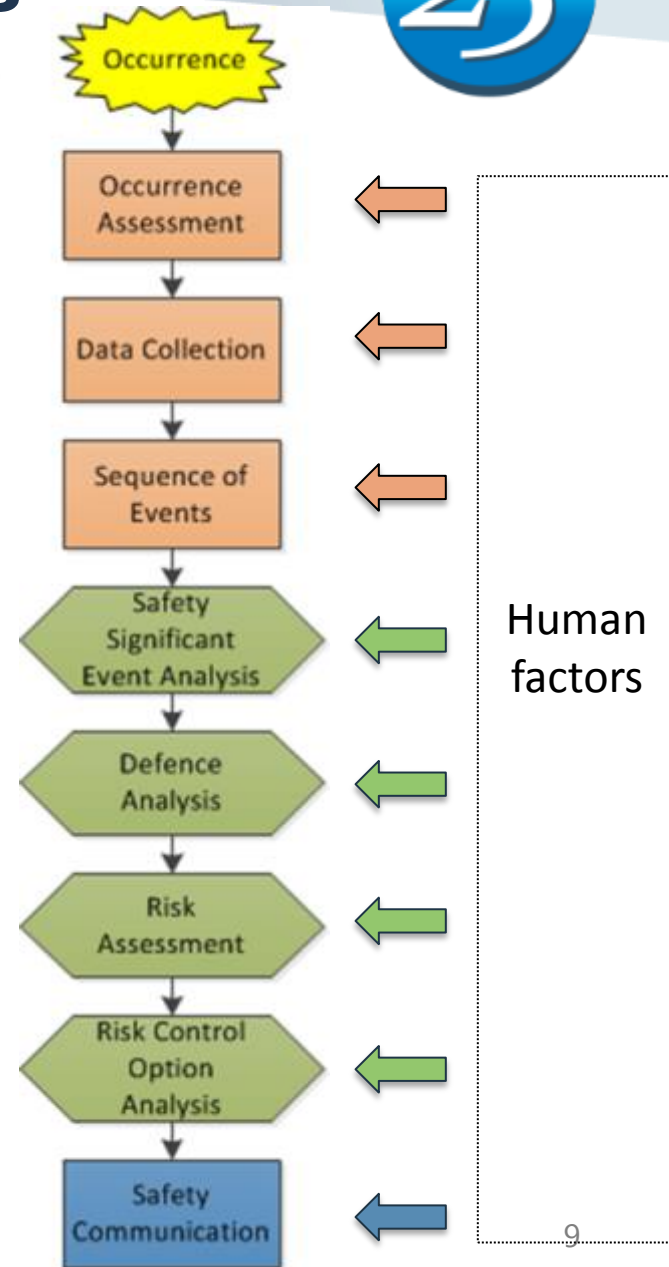
- Board - up to 5 members, including the Chair
- Approximately 230 employees
- Organized by mode
- Operational services
 - includes 6 Senior Human Factors Analysts / Investigators



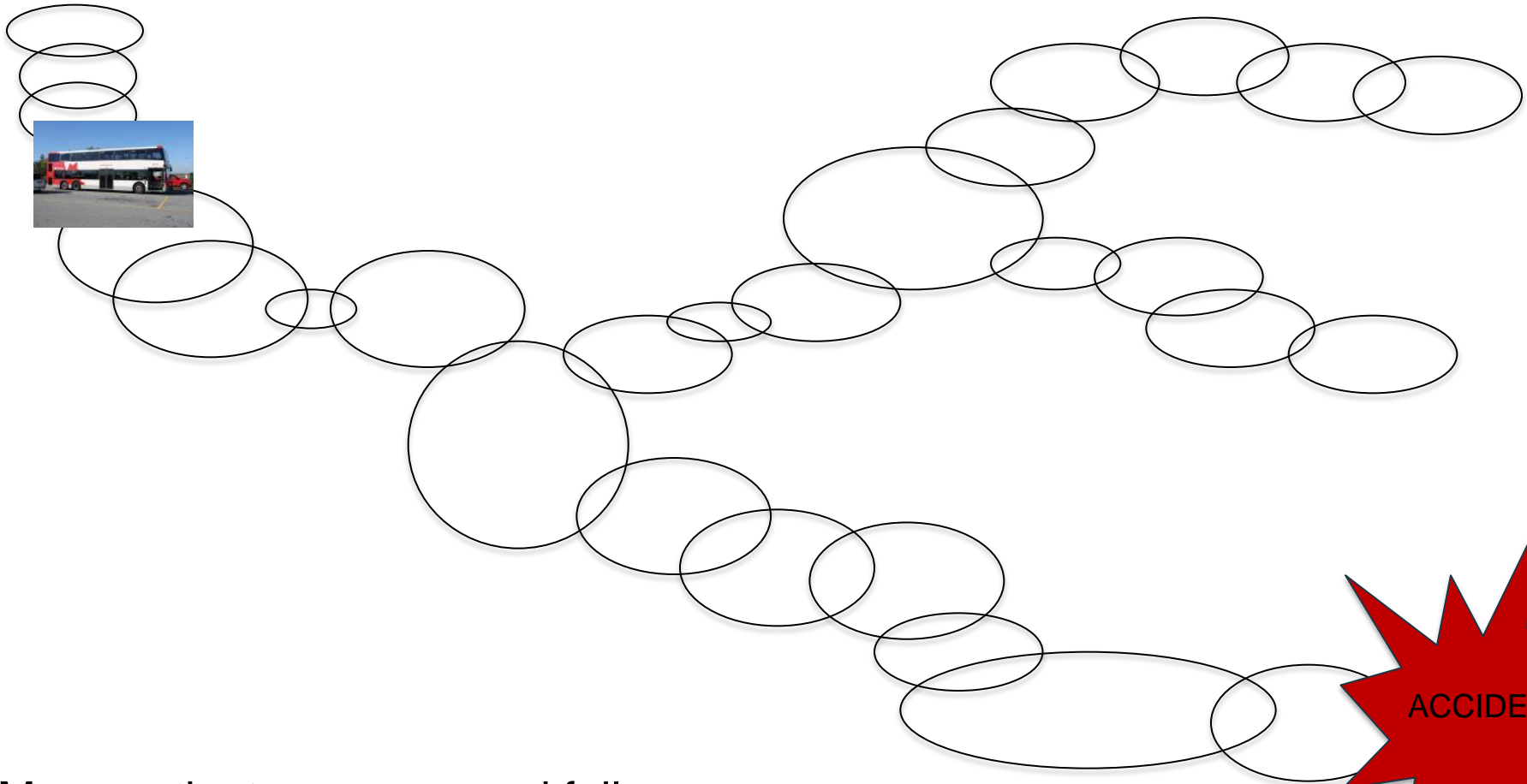
How we investigate accidents

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- Integrated Safety Investigation Methodology (ISIM)
- Allows us to return to a previous step, or drill deeper in a step as our understanding of the occurrence and safety deficiencies unfolds.
- based on a multi-causality model of accident causation, and not a primary cause.



Multi-causality

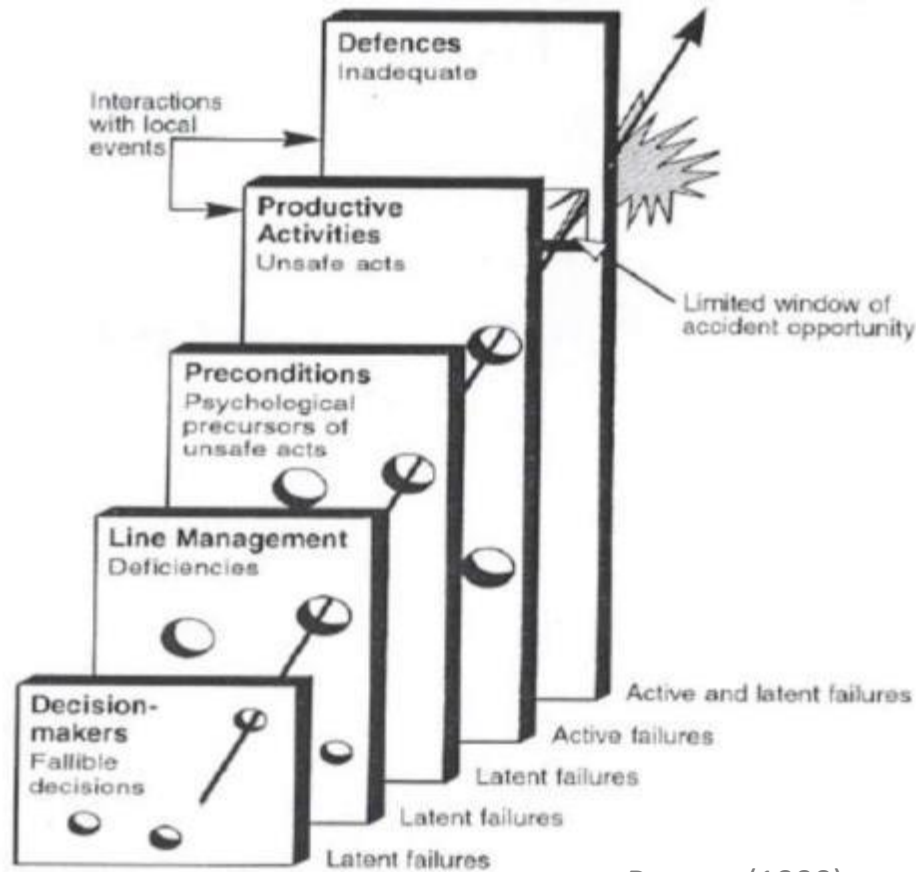


Many paths to success and failure

Many causal and contributing factors to success and failure



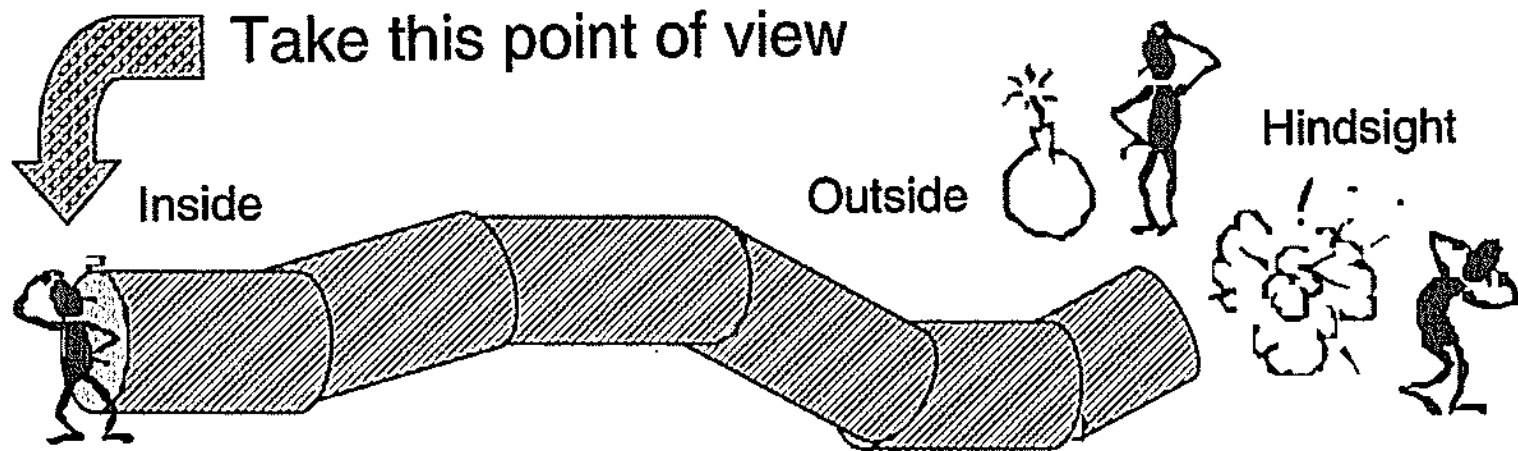
Multiple conditions / unsafe acts line up



Reason (1990)

Our philosophy...

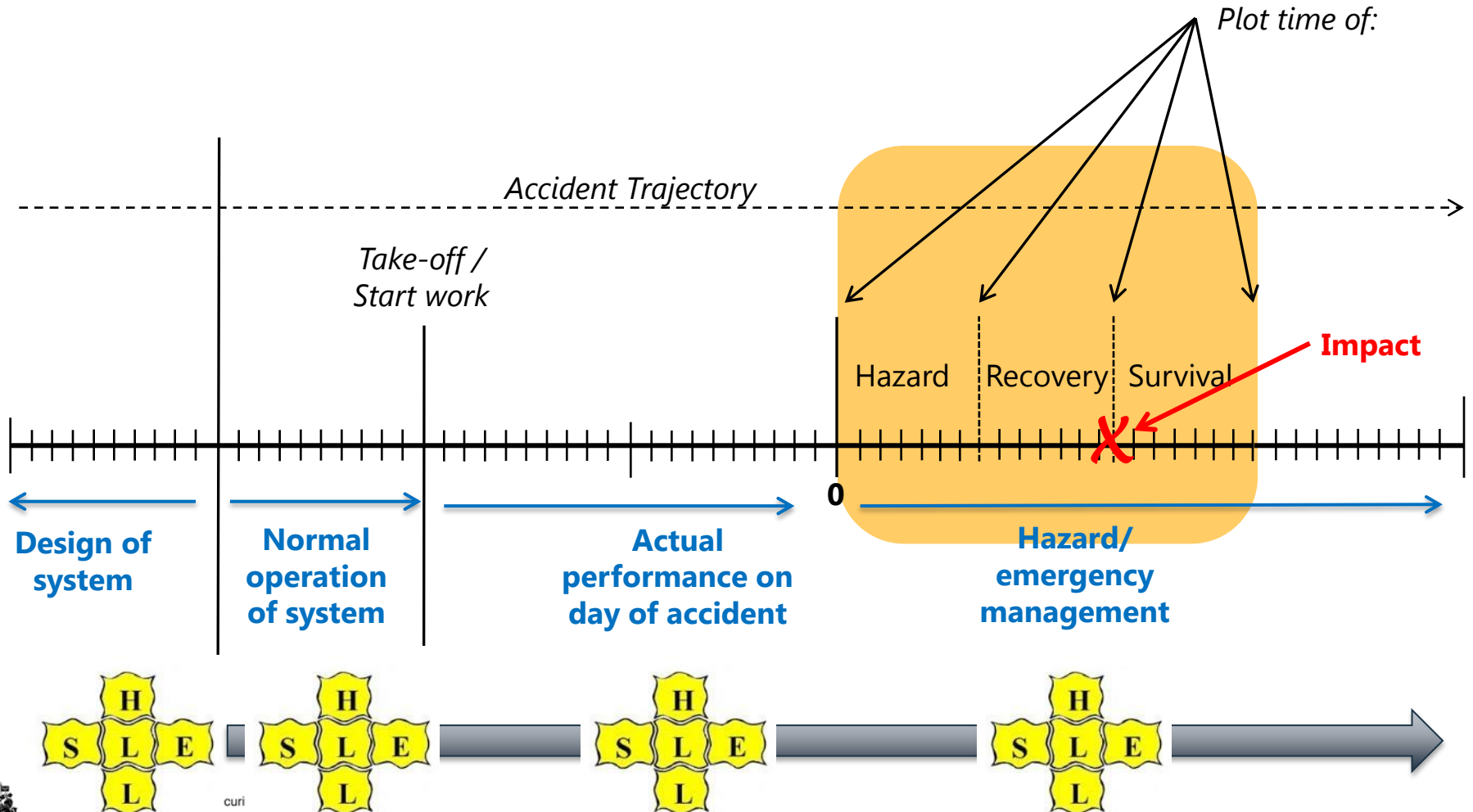
Why did their actions and assessments made sense at the time given the conditions and circumstances present?



Dekker, S. (2002)

Have you ever looked back on an event and said 'why didn't I see that ahead of time?' When inside an unfolding situation signals are weak and what is important and unimportant is not always obvious...

Scope of human factors investigation...



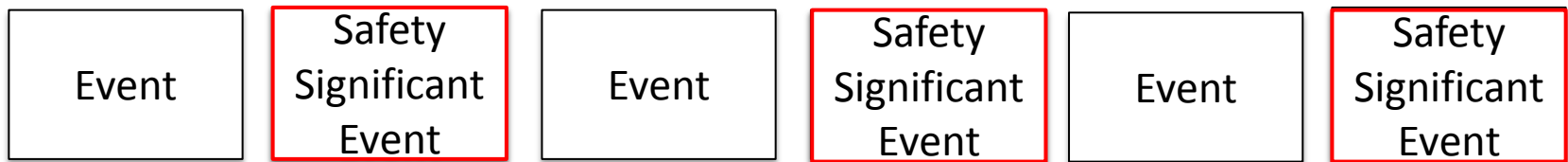
SHELL model



- **S – software** (*e.g., policies, training*)
- **H – hardware** (*e.g., vehicle*)
- **E – environment** (*e.g., weather, road*)
- **L – liveware*** (*e.g., driver*)
- **L – liveware** (*e.g., passengers*)

Edwards(1972)

An example – sequencing actions and assessments



Safety Significant Event Analysis

Safety Significant Event Determination

	Yes	No
Q1. Is the event undesirable?	<input checked="" type="radio"/>	<input type="radio"/>
Q2. Is the event potentially linked as an antecedent to an undesirable event?	<input checked="" type="radio"/>	<input type="radio"/>
Q3. Is the event non standard?	<input checked="" type="radio"/>	<input type="radio"/>
Q4. Is the event one of alternative actions or options available?	<input checked="" type="radio"/>	<input type="radio"/>

Data collection tools used in OC Transpo investigation

1. Accident re-enactment (September 28, 2013)
2. Passenger / eye witness interviews (over 100)
3. Next-of-kin interviews
4. Bus driver interviews
5. Review of driver records
 - Medical
 - Infractions
 - Training
6. Ergonomic assessment of bus driver workstation
7. OC Transpo / City of Ottawa interviews



Data collection tools

1. Accident re-enactment (September 28, 2013)

- Weather, position of sun, bus type & configuration
- Photos; video; braking analysis
- Speed of bus, train



Data collection tools

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Data collection tools

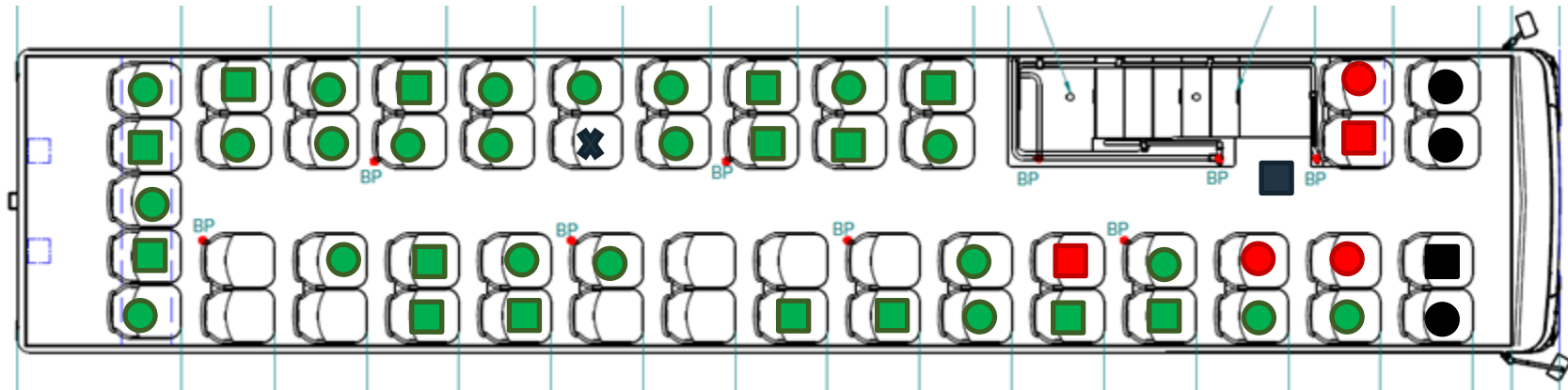
2. Passenger / eye witness interviews

- Worked closely with police, Coroner
- Bus passengers
- Other motorists
- Other bus drivers
 - Eye witnesses
 - Those who saw driver that AM
 - Those who knew driver
- Train crew
- Train passengers

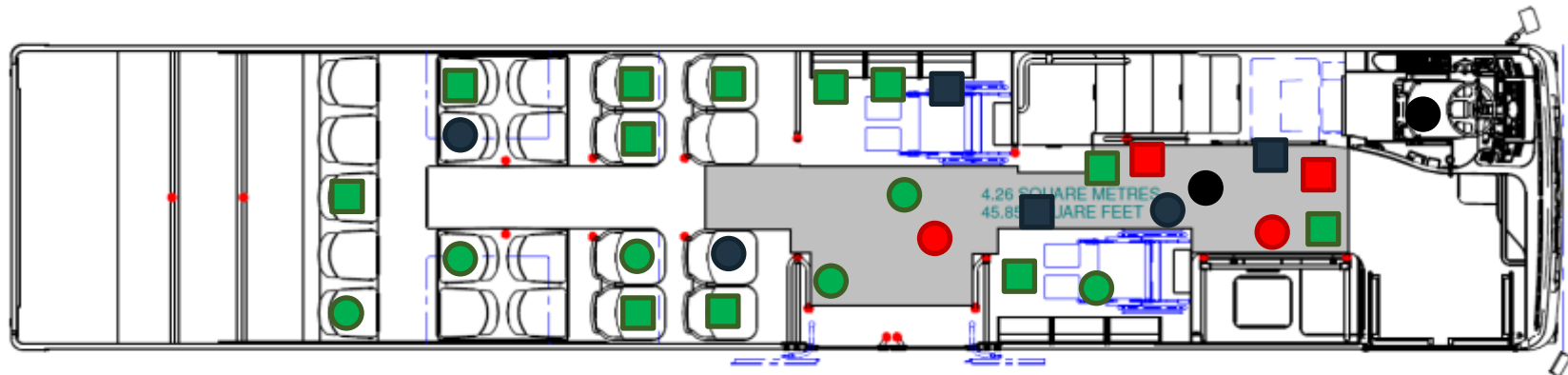


Passengers / eye witness interviews

Upper level



Lower level



Data collection tools

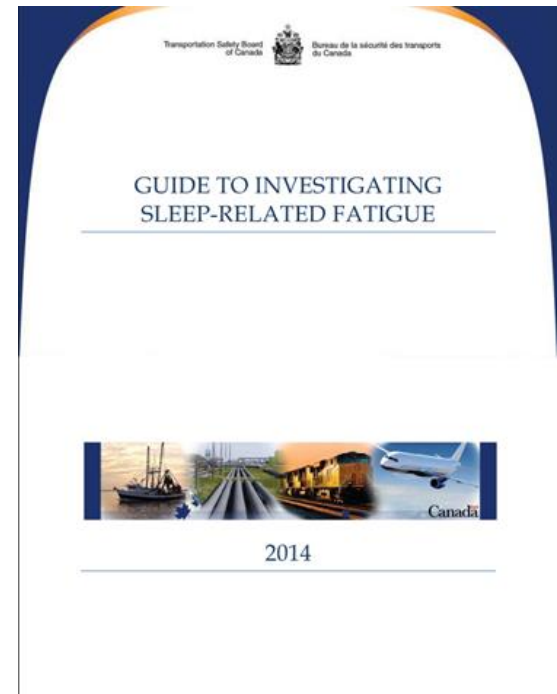
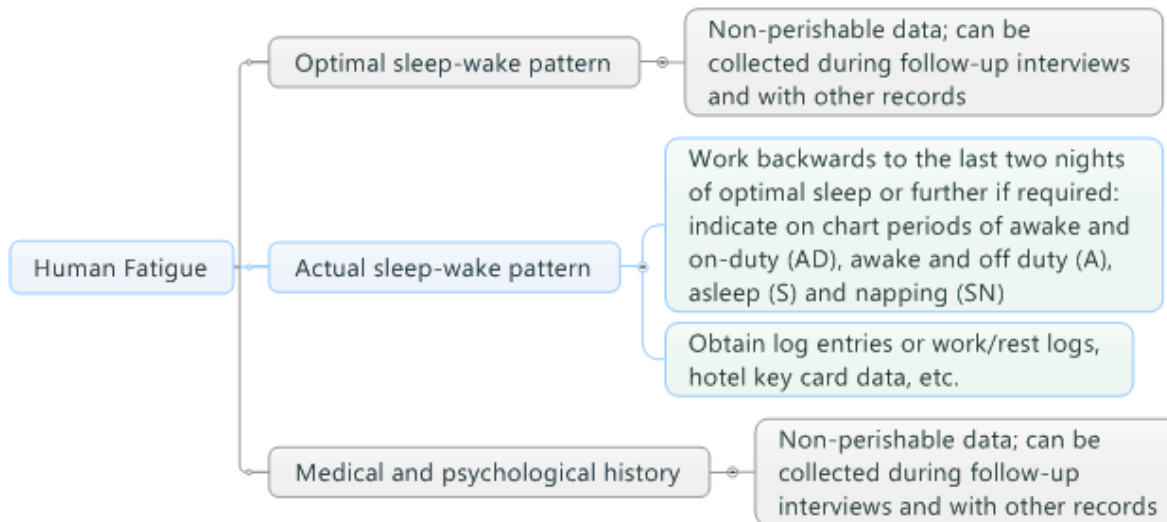
3. Next-of-kin interviews

- Spouse, other relatives of driver
 - Hours of work and rest
 - Medical factors
 - Psychosocial factors
 - Habits
 - Personality



Data collection tools

Fatigue analysis



Data collection tools

Fatigue analysis – *Fatigue Avoidance Scheduling Tool (FAST)*

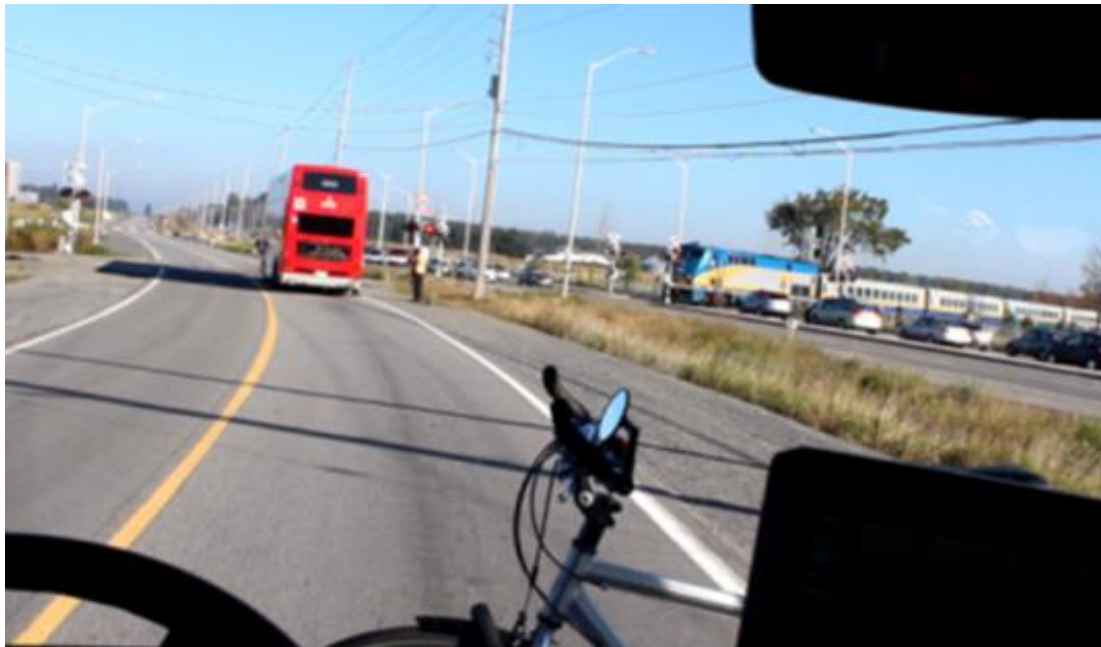
<http://www.fatiguescience.com/fast/>



Data collection tools

4. Bus driver interviews

- Sample of other bus drivers who use crossing, drive similar routes, double-decker bus



Data collection tools

5. Review of driver records



*Colour vision deficiency
- evaluation of
polarized sunglasses:*



Data collection tools

6. Ergonomic assessment of driver workstation

- Driver-vehicle cab assessment and measurements to in-vehicle displays and controls
- Double-decker
- 3 other types of OC Transpo bus
- OC Transpo drivers and maintenance
- Assessed:
 - accommodation and adjustability
 - visibility from the driver's seat;
 - driver's reach to, and use of, controls; and
 - positioning and use of in-vehicle displays.



Data collection tools

6. Ergonomic assessment of driver workstation

- accommodation and adjustability



Data collection tools

6. Ergonomic assessment of driver workstation

- visibility from driver's seat



Data collection tools

6. Ergonomic assessment of driver workstation

- Driver's reach to, and use of, controls

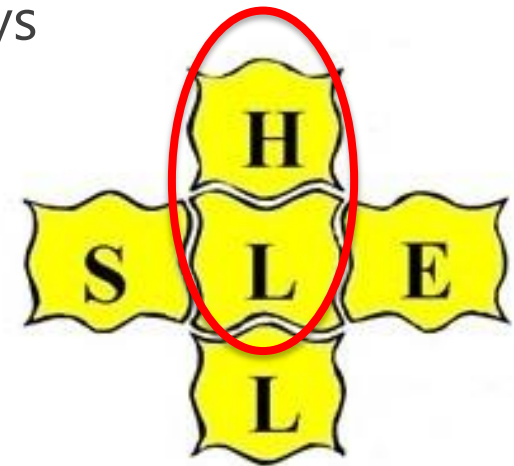
E.g., accelerator / brake pedal configurations in the double-decker (left), hybrid (centre) and diesel (right) bus models:



Data collection tools

6. Ergonomic assessment of driver workstation

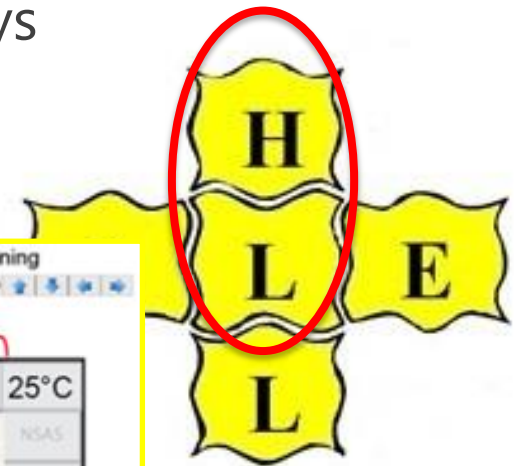
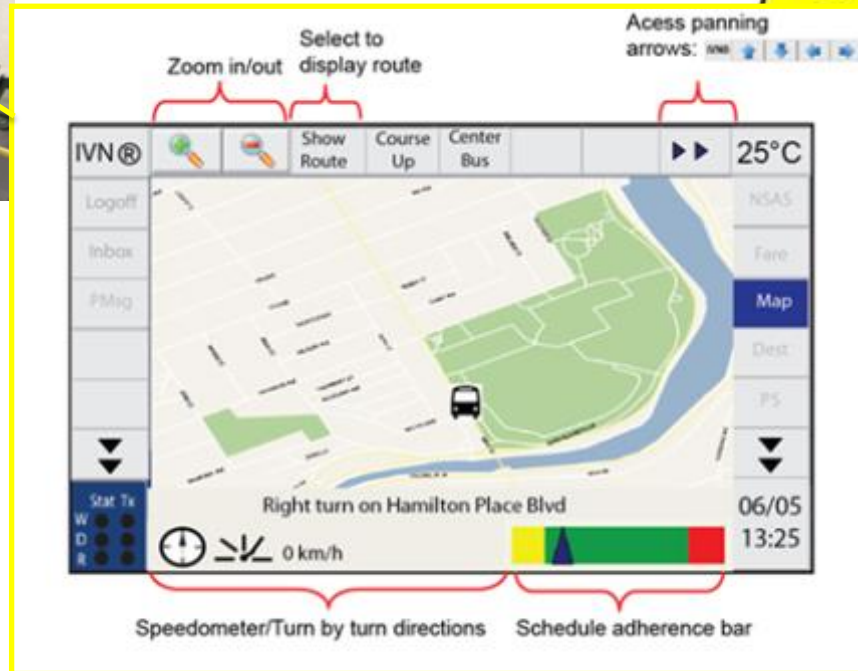
- Positioning and use of in-vehicle displays



Data collection tools

6. Ergonomic assessment of driver workstation

- Positioning and use of in-vehicle displays



Data collection tools

7. OC Transpo / City of Ottawa interviews

- Training department
- Enforcement
- Operations
- Risk management
- Technology
- Union
- CEO

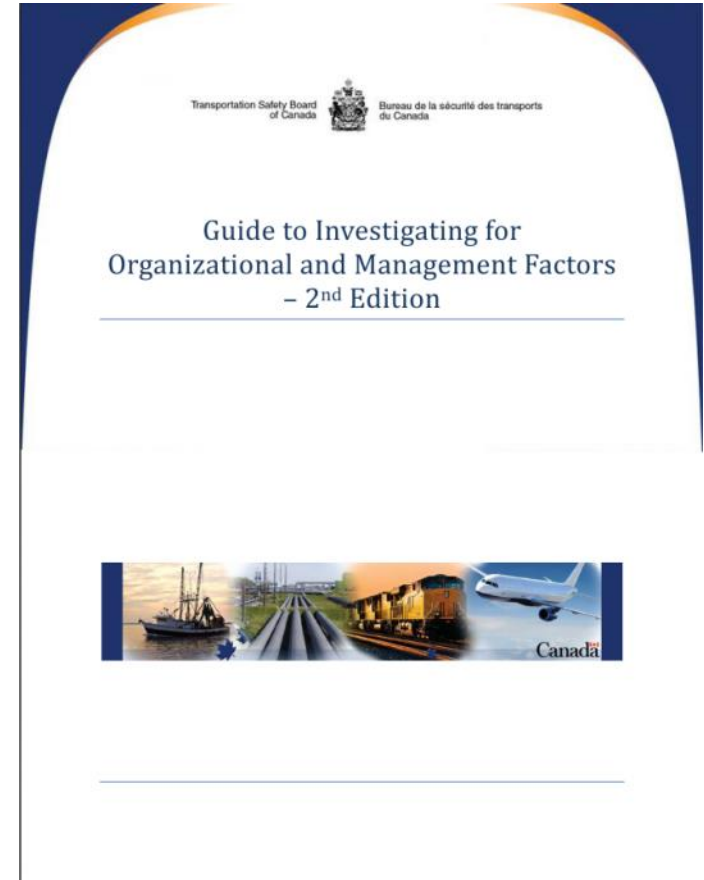


Data collection tools

7. OC Transpo / City of Ottawa interviews

Organizational / Management factors:

1. Agency-controlled driver distractions
2. Ongoing driver performance monitoring
3. Route scheduling
4. On-time performance; speed enforcement



How do we analyse the data???



Analysis -

Data

Theory that
could explain
behaviour

Degree of
match – data
and theory

Conclusion –
degree of
probability

- Writing our analysis and findings allows us to support the existence of identified safety deficiencies.
- We compose it using the sequence of events and underlying factors diagram.

Safety deficiency: Distraction / inattention

- Significant cause of traffic crashes
- Has been identified as contributing factor to grade crossing crashes
- External (to driver) distractions unique to level crossings tend to divert drivers' attention during periods in which they must be making, or have made, a decision (Eck, 2002)
- Other distractions:
 - Engagement in secondary tasks at crossings common (Ngamdung & daSilva, 2012; 2013)
 - Can be cognitive (thought) distractions

Distraction / inattention of bus driver

- Multiple driving distractions... visual AND cognitive.
- **Visual distraction:** Use of on-board video monitor
 - company required drivers to check the monitor at station stops and while the bus was in service.
 - risk that company did not effectively manage.
- **Cognitive distractions:**
 1. heavier workload of negotiating left-hand curve,
 2. nearby passenger conversations about upper deck seating,
 3. perceived need to make a 'no-standing on upper deck' announcement

Findings (distraction) R13T0192:

- “The driver was likely visually distracted by looking at the video monitor during the critical driving sequence of negotiating the left-hand curve and approaching the crossing.”
- “Conversations between the driver and a passenger and among passengers near the driver, as well as the perceived need to make an announcement to passengers standing on the upper deck, created a situation where the driver was likely cognitively distracted in the seconds before the accident.”
- “OC Transpo did not identify or mitigate the risks arising from driver attention being inappropriately directed at the video monitor when the bus was in motion and from the need to make announcements if passengers were observed standing on the upper deck.”

Safety deficiency:

Expectancies / Mental model / Schema:

- Internal, largely **unconscious**, representations or “mental short cuts” → expectations and knowledge about a given situation.
- Can be to particular crossing or *type* of crossing
- Discordance, impaired situation awareness when schema and situation do not match (Smith & Hancock, 1995).
- Many drivers have “**negative expectancy**” at **grade crossings** (Eck, 2002)



Mental model / Schema / Expectancies:

- When drivers receive info they expect, tend to react quickly and error-free, BUT...when info violates expectancies (or 'schema' or 'mental model'), drivers tend to react slowly or inappropriately (Alexander & Lunenfeld, 1986)
- Where expectancy of no trains has been reinforced many times...'no trains' schema will be activated on future approaches (Dewar & Olson, 2002).
- Driver "*familiarity with crossing*"...
 - negatively correlated with looking behavior and speed reductions (Sanders, 1976)
 - common factor in accident statistics supports "faulty activation (of schema)" hypothesis (e.g., Pajunen, 2002; Salmon et al., 2013)

Finding (expectations) R13T0192:

- “As it was common for drivers to use the section of the Transitway immediately following the crossing to make up time, and because the driver did not expect to encounter a train, the bus was accelerated beyond the posted speed limit.

Findings



Conclusions

- Multiple Perspectives + Application of Process = **Solid Analysis!**



- **Safe system?** How could it be improved?
 - Grade separation (of road and rail)

Recommendations

The Board recommends that:

the Department of Transport, in consultation with the provinces, develop comprehensive guidelines for the installation and use of in-vehicle video monitor displays to reduce the risk of driver distraction.

“Satisfactory intent”

the Department of Transport develop and implement crashworthiness standards for commercial passenger buses to reduce the risk of injury.

“Satisfactory in part”

the Department of Transport require commercial passenger buses to be equipped with dedicated, crashworthy event data recorders.

“Satisfactory in part”

the Department of Transport provide specific guidance as to when grade separation should be considered.

“Satisfactory intent”

the City of Ottawa reconsider the need for grade separation at the Woodroffe Avenue, Transitway, and Fallowfield Road level crossings.

“Satisfactory intent”

2014 TSB Watchlist issue – Railway crossing safety

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The screenshot shows the Transportation Safety Board of Canada website. The main navigation bar includes 'The TSB', 'Investigations', 'Safety', 'Media', and 'Contact us'. A large banner image shows a train collision with a red maple leaf overlay. Below the banner, there is a 'Headlines' section with several news items, including 'Transportation Safety Board of Canada deploys a team to the site of a derailment involving a CP freight train near Banff, Alberta' and '2013 Train collision near Dunmore, Alberta, stresses need for action on Watchlist issues'. A red circle highlights a 'Watchlist' button in the right-hand sidebar, which also contains buttons for 'Report an occurrence', 'Map', and 'Careers'. The website footer includes the TSB logo and the text 'Transportation Safety Board of Canada' and 'Bureau de la sécurité des transports du Canada'.



Questions?

Thank-you!



Canada

