Through a different lens: applying contemporary systems analysis methods in road safety

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Content

- Complex systems, accident causation and accident analysis
- Kerang tragedy
- Systems analysis methods: Accimap, Cognitive Work Analysis, STAMP
- Kerang systems analysis
Background

- Road transport is a complex sociotechnical system (Larsson et al, 2010; Salmon et al, 2012)

- “Complex systems cannot be understood by studying parts in isolation. The very essence of the system lies in the interactions between parts and the overall behaviour that emerges from the interactions. The system must be analysed as a whole” (Ottino, 2003)
Accidents as emergent phenomena resulting from interactions across the system.

Behaviours may be normal; it is the interaction of them that create accidents.

“Safety is impacted by the decisions of all actors – politicians, CEOs, managers, safety officers and work planners – not just the front-line workers alone” (Cassano-Piche et al, 2009)
Accident analysis

- Hunt for the broken component approach flawed (Dekker, 2011)

- Go ‘up and out’ rather than ‘down and in’ (Dekker, 2011)

- Road traffic crash analysis reductionist (or ‘down and in’)

- Various systems analysis methods available

- Systems-driven countermeasures/interventions more appropriate than individual component driven ones (Dekker, 2002; Reason, 1997)
Case study aims

- Are systems analysis methods applicable in the road/rail safety context?

- Can they provide additional insight over reductionist methods?
Kerang

- Semi-trailer truck collided with V-Line passenger train

- 11 killed, 15 injured

- OCI Investigation

- “for reasons not determined the truck driver did not respond in an adequate time and manner to the level crossing warning (OCI, p. 72)
Key points & Warnings

<table>
<thead>
<tr>
<th>Warning</th>
<th>Distance from crossing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train activates track circuit, which in turn activates crossing warning devices</td>
<td>665 metres (24.87 seconds) from crossing</td>
</tr>
<tr>
<td>Train driver sounds horn</td>
<td>450 metres from crossing; active for .35 seconds</td>
</tr>
<tr>
<td>Train driver sounds horn</td>
<td>140 metres from crossing; active for 7 seconds</td>
</tr>
<tr>
<td>RVail crossing</td>
<td>Approx 260 metres</td>
</tr>
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</table>

No boom gates

Same route for 7 years without a train

Driver reported looking at FL assembly here
Questions

1. Why did the truck driver proceed towards the ‘activated’ crossing in the presence of a train?

2. How can this be allowed to happen within the road and rail system?
The reductionist approach

1. Level crossing becomes activated as approaching train passes over track circuit

5. Lack of full active protection (e.g. boom gates) + trees obscuring train, sun glare and truck A pillar prevent inappropriate schema from being over-ridden

2. Approach to crossing triggers schema of crossing Y2943 in non-activated state, based on extensive experience of crossing in this state; factors such as trees obscuring vision augment activation of inappropriate schema

3. Truck driver perceptual exploration does not support perception of crossings active warnings causing look-but-failed to see error

4. Truck driver proceeds toward crossing perceiving it to be in non-activated state
Systems analysis methods: Accimap, Cognitive Work Analysis (CWA) and STAMP
Accimap

Hazardous process

Government
- Laws
  - Regulators, Associations
    - Company
      - Management
        - Company Policy
          - Plans
            - Staff
              - Action

Govt Policy & Budgeting

Regulatory Bodies and Associations

Company Management

Technical & Operational Management

Physical Process & Actor Activities

Equipment & Surroundings

□ = Failures, decision, actions etc
## CWA - Work Domain Analysis

<table>
<thead>
<tr>
<th>Stage</th>
<th>Question</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Functional Purposes</td>
<td>Why does the system exist?</td>
<td>Reasons, goals, objectives, aims, intentions, mission, plans, services</td>
</tr>
<tr>
<td>2. Values and Priority Measures</td>
<td>How can we tell whether the system is achieving its purposes?</td>
<td>Criteria, measures, benchmarks, tests, assessments, appraisals, outcomes, results.</td>
</tr>
<tr>
<td>3. Purpose-related Functions</td>
<td>What functions must be performed to achieve the purposes?</td>
<td>Roles, responsibilities, tasks, jobs, occupations, positions, activities, operations.</td>
</tr>
<tr>
<td>4. Object-related processes</td>
<td>What are the functions of the physical objects in the system?</td>
<td>Uses, applications, characteristics, limitations, processes.</td>
</tr>
<tr>
<td>5. Physical objects</td>
<td>What physical objects are in the system?</td>
<td>Tools, equipment, technology, kit, gear, buildings, facilities, infrastructure, staff, people, terrain.</td>
</tr>
</tbody>
</table>
Work domain analysis

Functional Purpose

Values and Priority measures

Purpose-related Functions

Object-related Processes

Physical Objects

Why

What

How

MONASH University
Injury Research Institute
Methodology

- Systems analysis of Kerang rail level crossing ‘system’ using Accimap, Work Domain Analysis, and STAMP

- OCI report and court transcripts primary data inputs

- One HF analyst conducted analysis initially, two HF researchers reviewed analyses

- SME review (two rail safety practitioners + Lead analyst from OCI team)
Multiple actors involved

Contributing factors across all levels of the system
Objects inadequate and/or new objects needed

Physical objects all worked

Various functions & purposes were not fulfilled

= Unfulfilled function, purpose, failed component etc
Discussion

- Systems methods applicable, usable, and useful

- Various factors across system meant that crossing Y2943 had not been upgraded to fully active controls

- Various factors across system facilitated truck driver’s failure to see and perceive active crossing status and train

- New data systems required to support systems analysis

- Culpability?
Thanks for the opportunity!

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