Using STPA trend analysis to determine key system drivers

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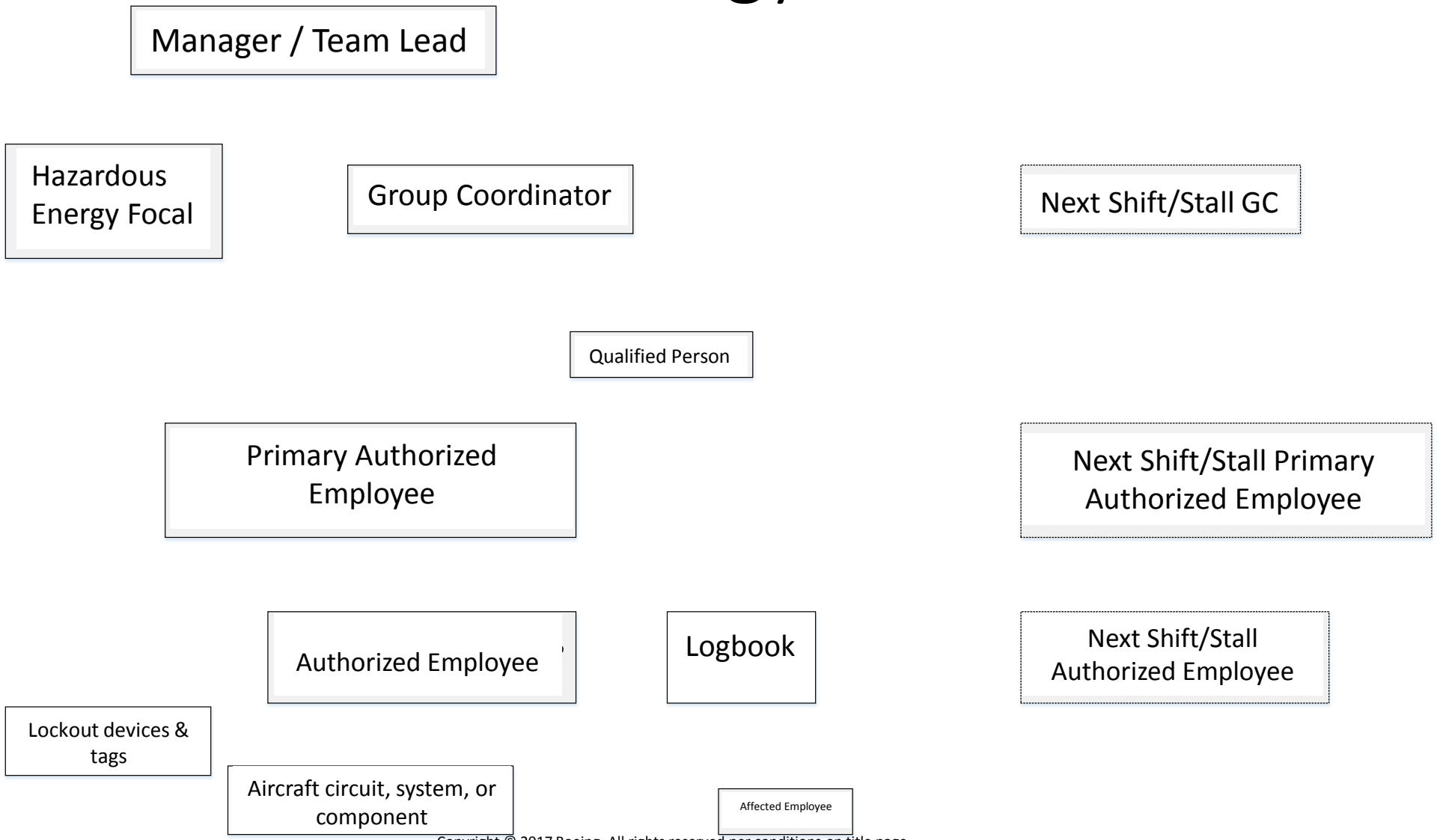
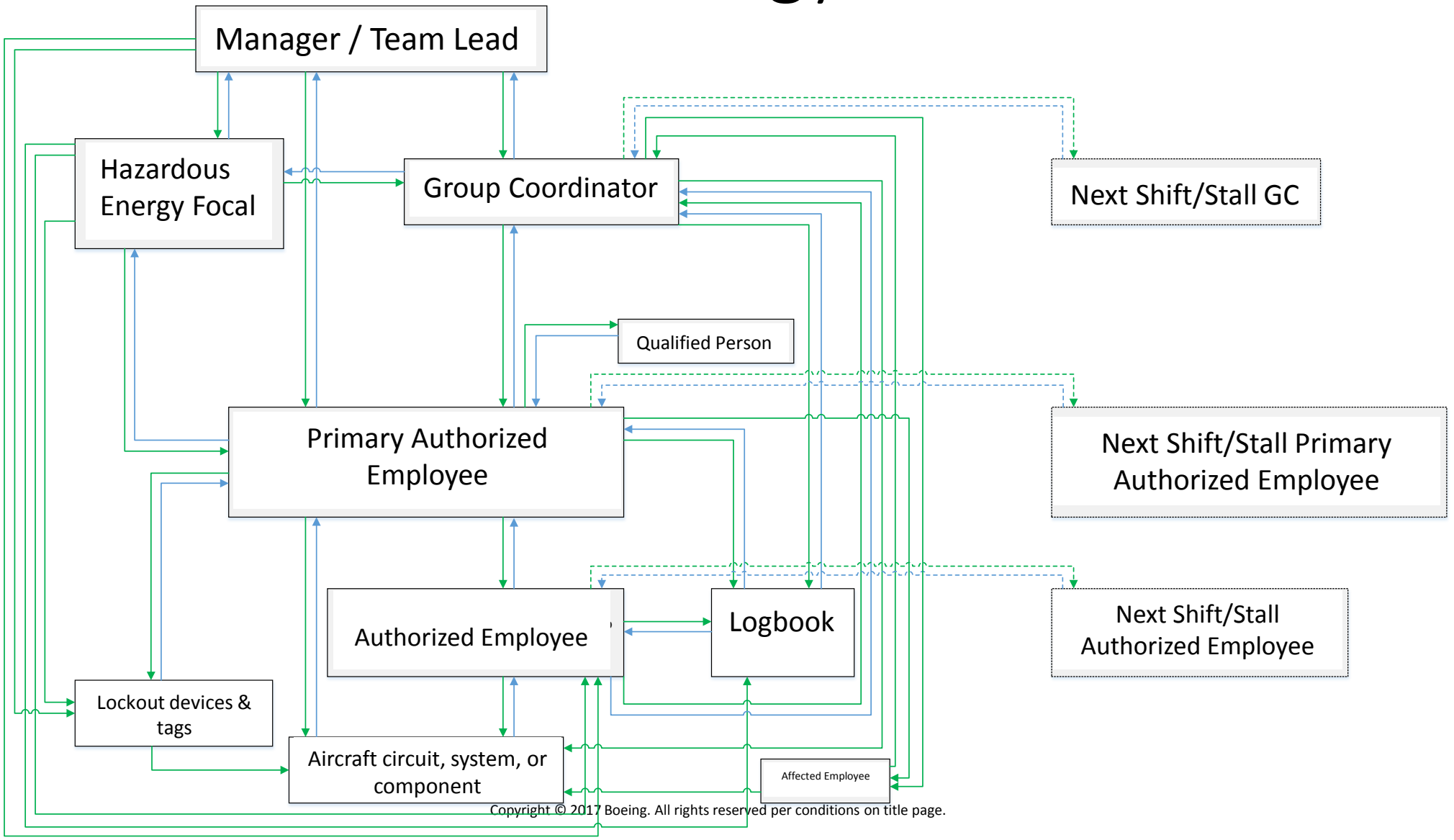
Introduction

- Aircraft production is complex and can be hazardous
- Hazardous energy managed via Lockout-Tagout (LOTO)
  - Group Coordinator
  - Primary Authorized Employee
  - Authorized Employee
- Why do LOTO-related incidents and injuries occur?
- STPA method applied to LOTO
- Goal: Implement the most effective solutions

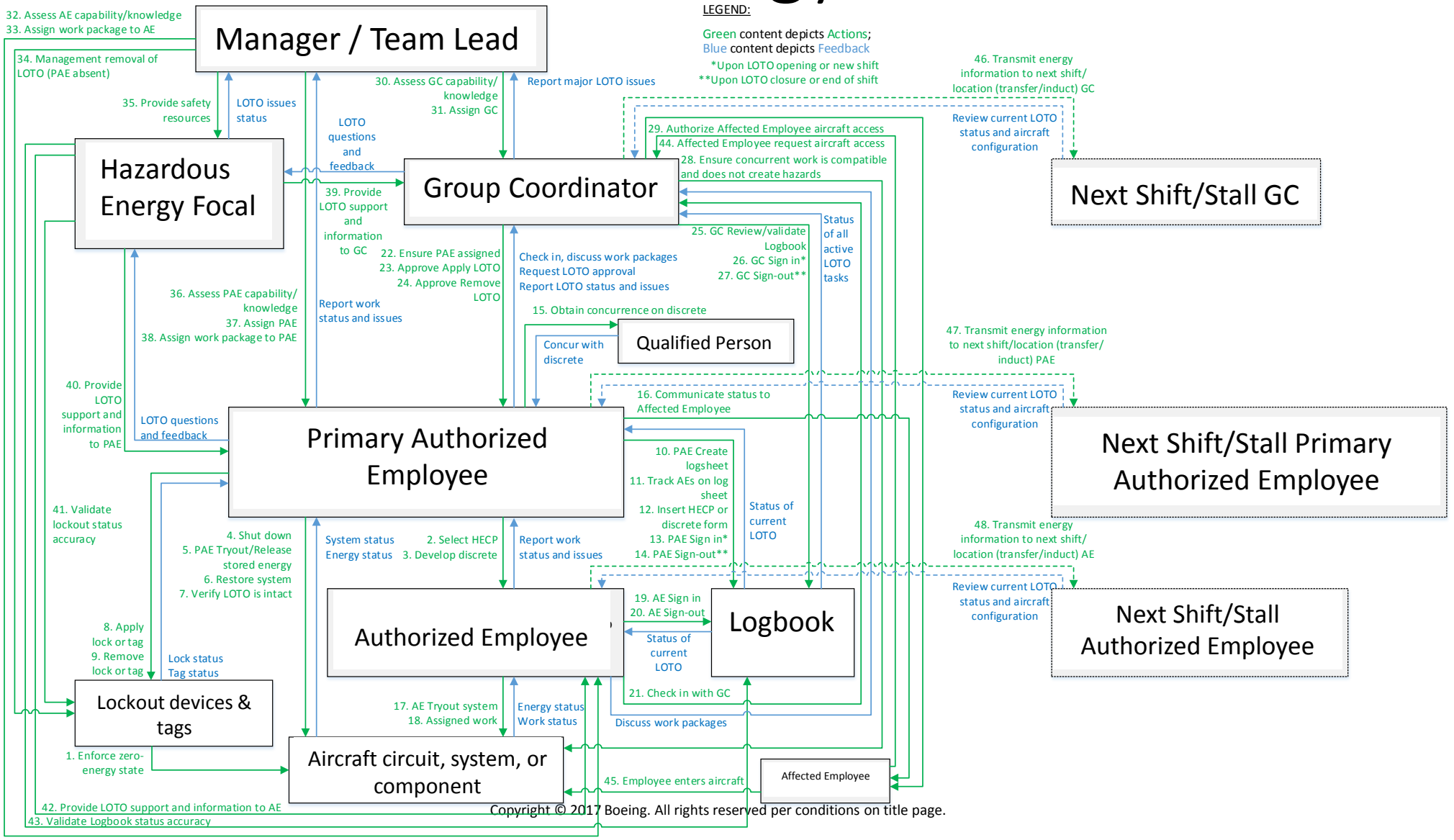
STPA for Hazardous Energy Control



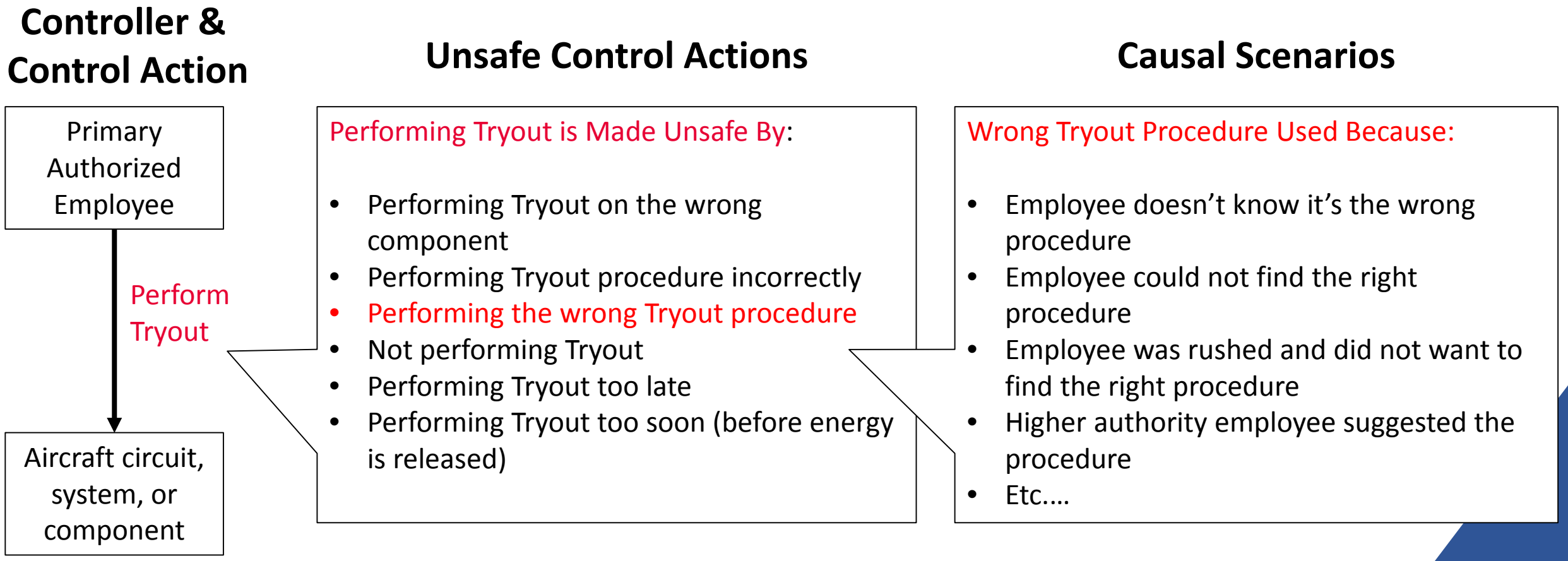
STPA for Hazardous Energy Control



STPA for Hazardous Energy Control



STPA Example



STPA Limitations

- Analysis results in too much data for easy comprehension
  - Controllers: 13
  - Control actions: 48
  - Unsafe control actions: **200**
  - Causal scenarios that could result in incidents or injury: **958**

Challenges

- How to put all of this data into context of the “bigger picture”?
- How to translate that knowledge into business decisions?

Applying Trend Grouping

Three categories of system drivers:

- Mental models
- Inadequate information or resources
- Process deficiency

Which of these causes the greatest systemic impact?

How are they related?

How to prioritize and estimate improvement?

Category Drivers by Group

Mental Models	Resources / Information	Process
Reacting to time pressure	Required people cannot be located	Inadequate training / experience
Believed to be inconsequential	Production complexity	Unclear role assignments
Belief that another employee did / will perform task	Unavailable information	Unclear requirements
Attention was diverted	Required resources cannot be located	Process unenforced
Situational misperception	Device failure	Unclear authority

Trend Grouping Example

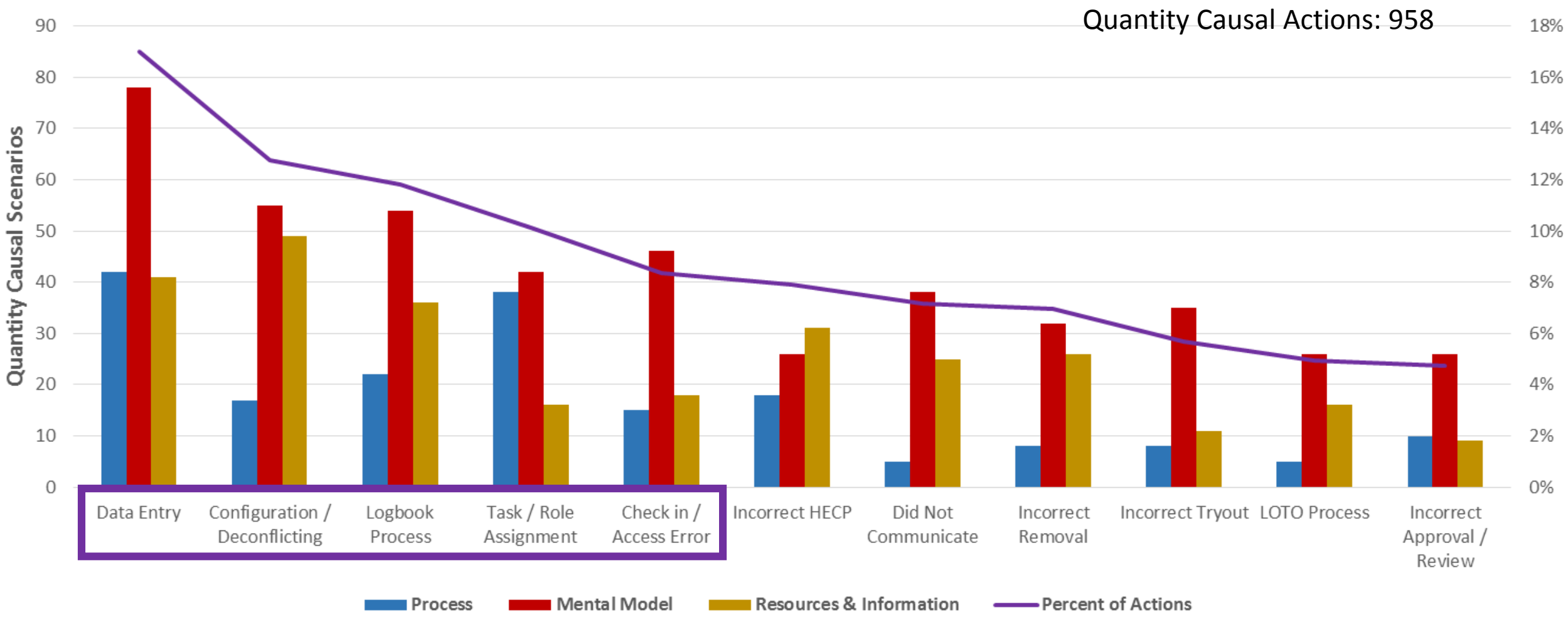
- Controller: Primary Authorized Employee (PAE)
  - **Unsafe Control Action**: Performs incorrect Tryout procedure because…
    - **Causal Scenario**: … PAE was given an incorrect procedure, does not know where to find procedures and believes that taking the time to find a correct one would result in unacceptable production delay.

    - **Trend Grouping: Assigning Key Drivers**
      - **Causal Action: Incorrect Tryout**
      - **Mental Model: Reacting to Time Pressure**
      - **Resource / Information Deficiency: Required resources cannot be located**
      - **(no process driver)**

Results

Actions Breakdown

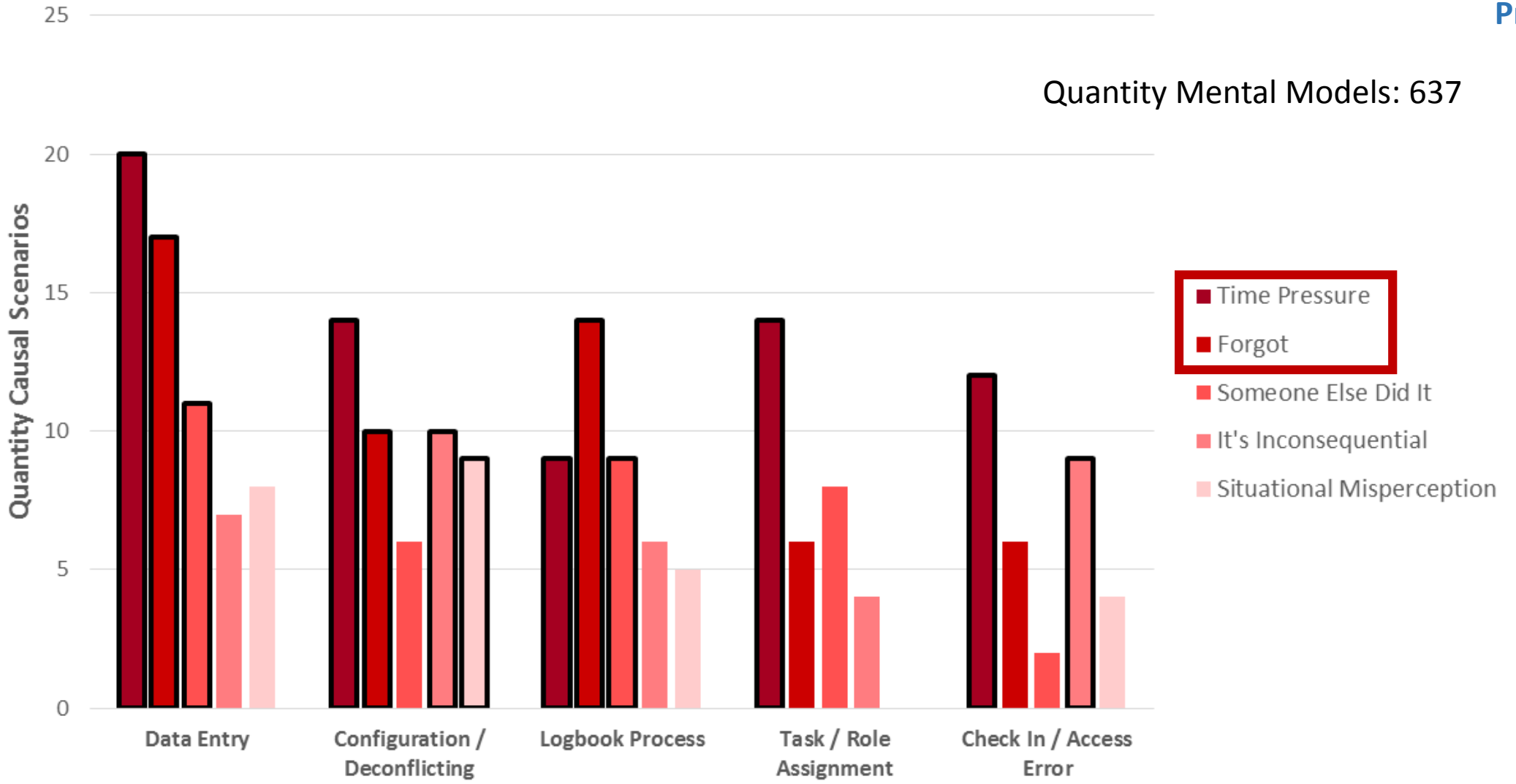
Actions
Mental Model
Resources & Information
Process



Top Mental Models by Action

Actions
Mental Model
Resources & Information
Process

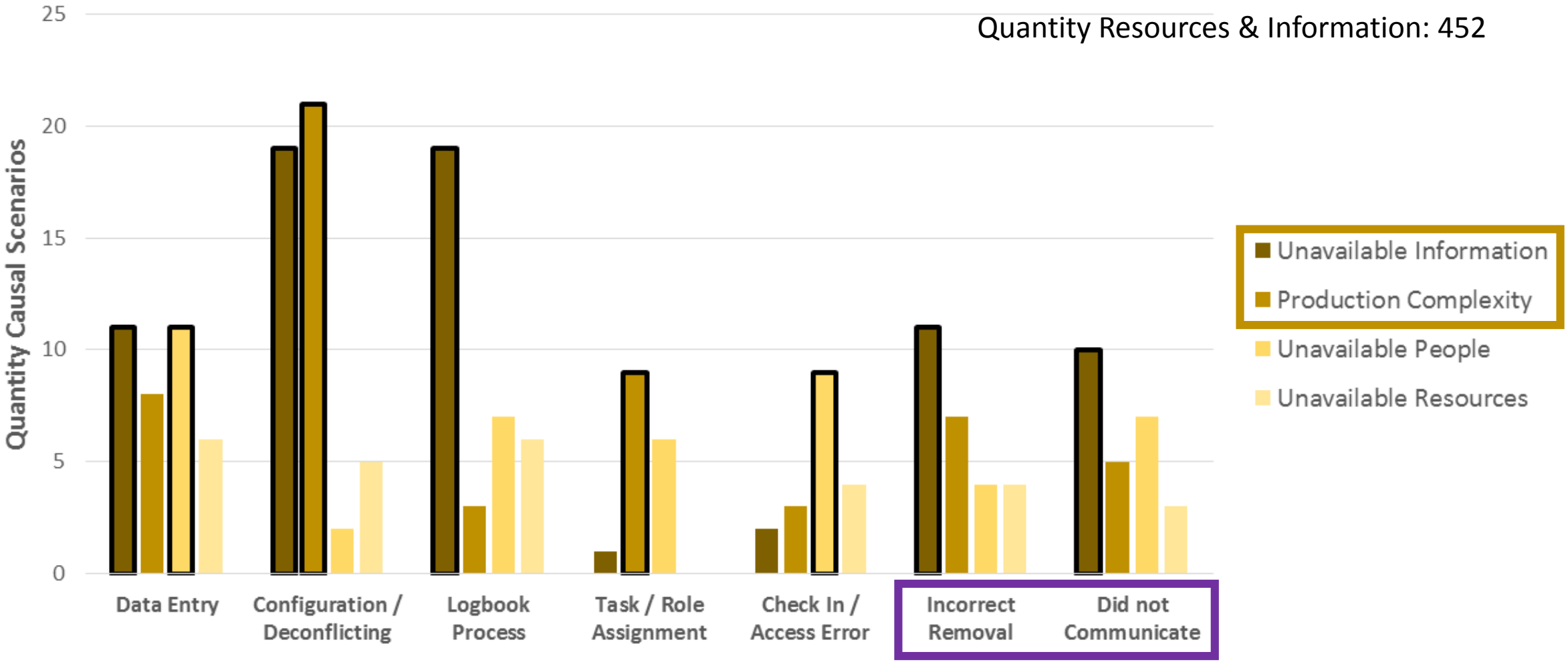
Quantity Mental Models: 637



Top Resources & Information by Action

Actions
Mental Model
Resources & Information
Process

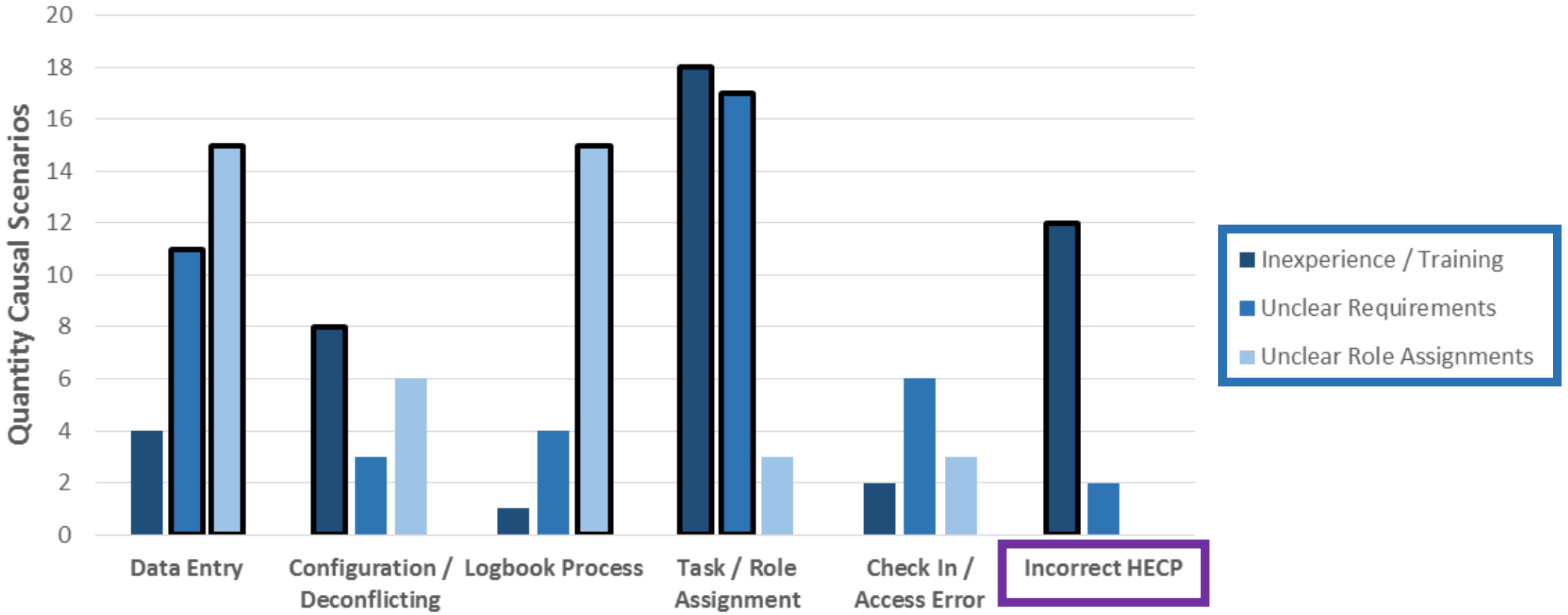
Quantity Resources & Information: 452



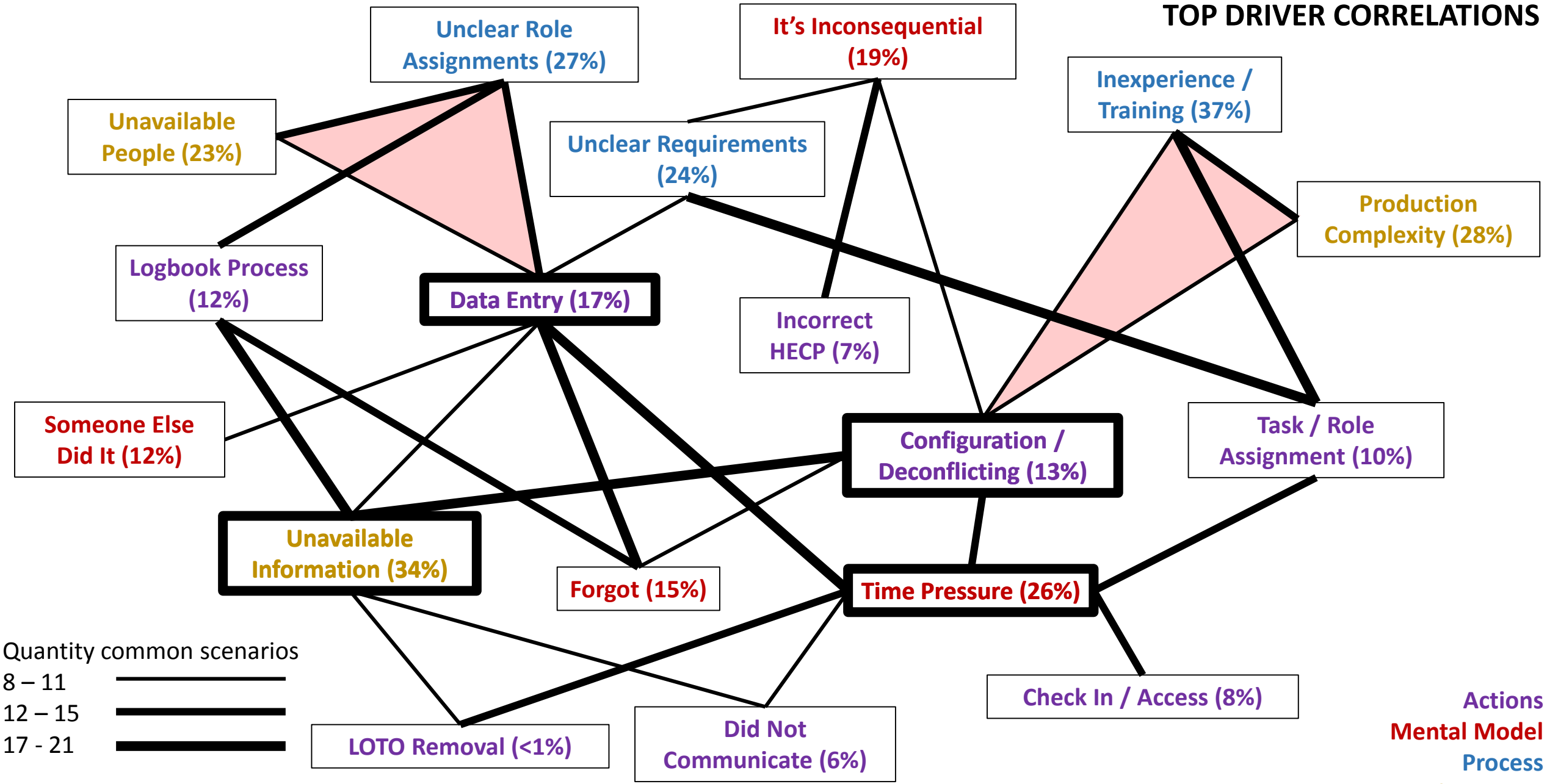
Top Processes by Action

Actions
Mental Model
Resources & Information
Process

Quantity Process: 295



TOP DRIVER CORRELATIONS



How STPA Results Translate to Business Priorities

Main Message: Focus on Areas with Greatest Systemic Impact

Highest Priority Actions

- Focus on Reduction in Data Entry
  - Correlated with over **half each** of Mental Model *and* Resource & Information drivers
- Improve Accessibility to Information
  - Strong relationship with Configuration / Deconflicting errors
- Simplify Administrative Tasks
  - A **third** of causal actions are correlated with Time Pressure driver

Lowest Priority Actions

- Revamp LOTO process: Smallest group of assigned drivers
- Heavier emphasis on “compliance”

Summary

- STPA provides detailed insight to incident and injury causality mechanisms
- Large quantities of data are generated
- Cut through complexity with trend grouping
- Enables prioritization of improvements based on estimated impact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