

# Applying STAMP to Occupational Safety

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RESEARCH INSTITUTE FOR SAFETY

# Liberty Mutual Research Institute for Safety

*generating knowledge to help people live safer and more secure lives*



## Mission:

*To advance scientific, business-relevant knowledge in workplace and highway safety, and work disability*

- Center for Injury Epidemiology
- Center for Physical Ergonomics
- Center for Behavioral Sciences
- Center for Disability Research



# Overview

- The current state of workplace safety
- Emergence of new perspectives on sociotechnical systems
- The Hopkinton Conference on Sociotechnical Systems and Safety
- Key themes related to STAMP, human factors engineering and workplace safety
- Recommendations for research and practice

# The Level of Analysis Problem

- Science frequently struggles to determine the correct level of analysis at which to operate
  - One reason why theory is important
- The practice of workplace safety has also struggled with the level of analysis problem
  - Component reliability
  - Behavioral based safety
- In workplace safety there is one level that has been underexplored – the *sociotechnical systems* level
  - “The idea of a sociotechnical system is that the conditions for successful organizational performance ... are created by the interaction between social and technical factors” (Hollnagel, 2009)
- We have become convinced that STAMP affords a proper and productive level of analysis for workplace safety

# Workplace Safety – Current Conceptions



**85-95% OF JOBSITE INJURIES ARE THE RESULT OF HUMAN BEHAVIOR.**

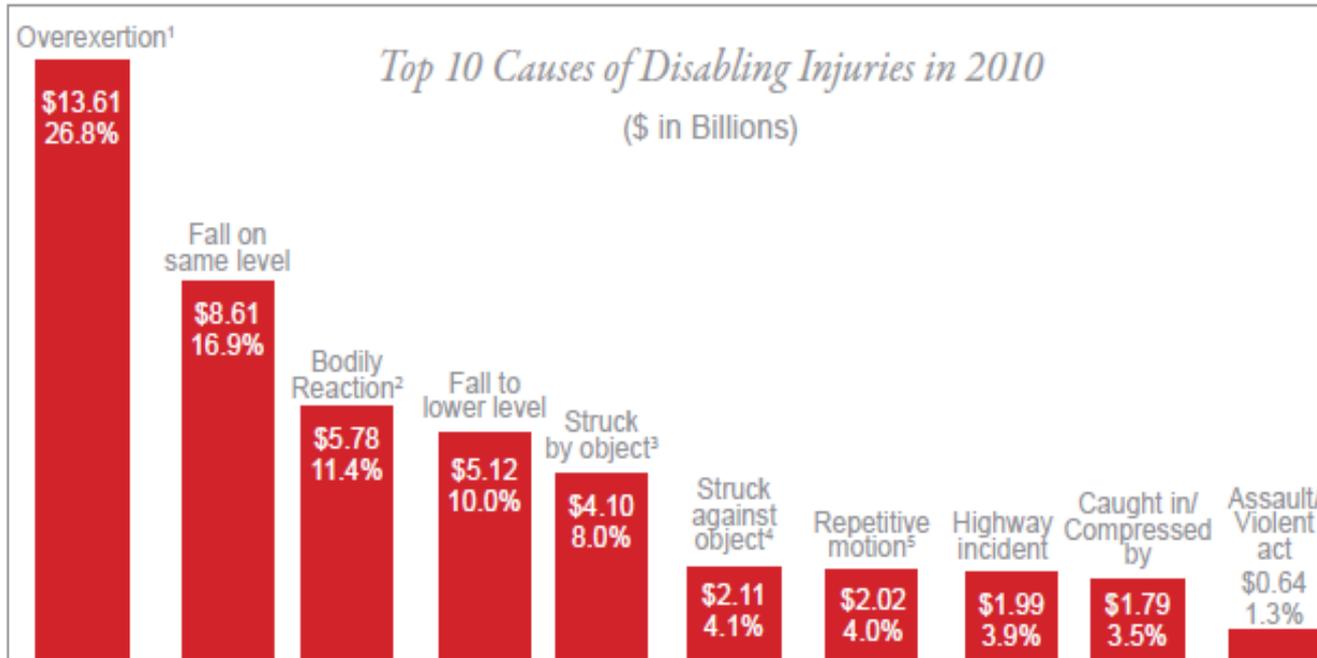
**MAKE [REDACTED] PART OF YOUR SAFETY PLAN**

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# 2012 Liberty Mutual Workplace Safety Index



<sup>1</sup>Overexertion – Injuries from excessive lifting, pushing, pulling, holding, carrying, throwing

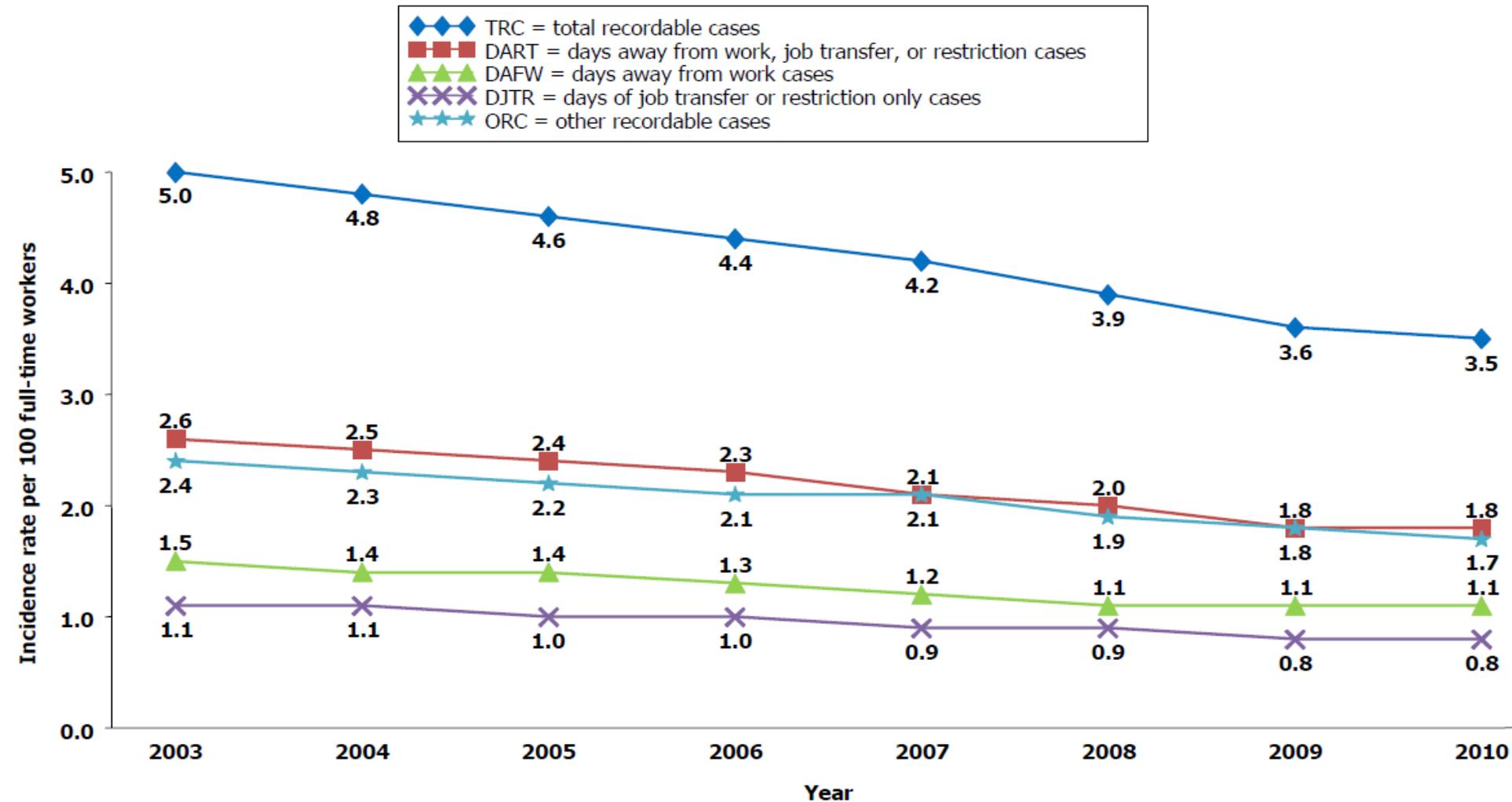
<sup>2</sup>Bodily reaction – Injuries from bending, climbing, reaching, standing, sitting, slipping or tripping without falling

<sup>3</sup>Struck by object – Such as a tool falling on a worker from above

<sup>4</sup>Struck against object – Such as a worker walking into a door

<sup>5</sup>Repetitive motion – Injuries due to repeated stress or strain

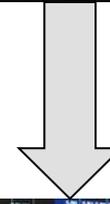
## Nonfatal occupational injury and illness incidence rates by case type, private industry, 2003-2010



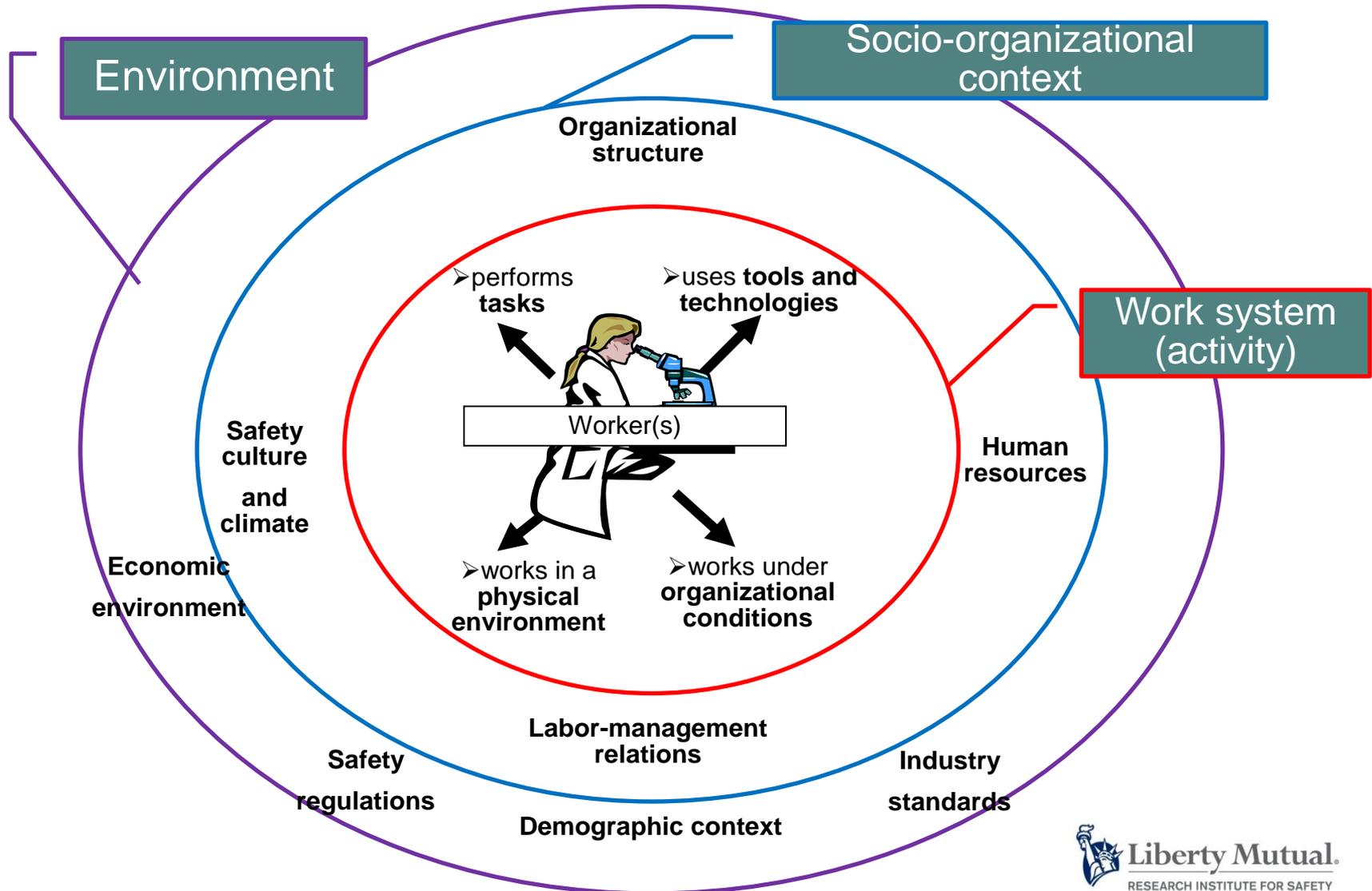
Incidence rates for total recordable cases (TRC) and for other recordable cases (ORC) declined in 2010, while incidence rates for other types of cases remained unchanged from 2009 at the level of detail at which estimates are presented in this chart. The TRC rate has declined every year since 2003.

# Emergence of Sociotechnical Systems Thinking

- 1950s - Sociotechnical Systems Theory
- 1980s - Macroergonomics
- 1990s – Cognitive Systems Engineering, Human Systems Integration
- 2000s – STAMP, Resilience Engineering



# Model of STS for Occupational Safety



# Hopkinton Conference on Sociotechnical Systems and Safety – October 18-19, 2012

- Gathered 25 researchers and practitioners focused on a sociotechnical level of analysis
- Created a set of manuscripts for a special issue of *Ergonomics*, focused on the following:
  - Concepts, definitions and frameworks
  - Defining research methodologies
  - Modeling and simulation
  - Communications and decision making
  - Attributes of safe vs. unsafe sociotechnical systems
- Manuscript objectives:
  - What is the current state-of-the-art?
  - What are the major research issues?

# Asynchronous Evolution and Joint Optimization

- AE - Out of phase modifications within and between personnel and technical systems
- JO – Design successfully meets the needs and employs the capabilities of the personnel and technical subsystems
  - How to achieve that is an interesting problem
  - Highly context specific and frequently a moving target



# Function Allocation

- Assignment of operational functions within and across technical and personnel resources
- Paul Fitts (1951) proposed initial list of functions best performed by humans or machines
  - Occasionally updated to reflect evolving technical capabilities
- Nothing has been developed to cope with complex sociotechnical systems
  - Attempts appear to be based on heuristics, prior experience or educated guesses
- Particularly critical in avoiding dysfunctional, overlapping safety control structures

# The Operator's Process Model

- The level of correspondence between an operator's process model and the system's process model is critical to workplace safety
- "Situation Awareness"
- Limiting factors on process model accuracy
  - Sufficiency of information
  - Training
  - System complexity
  - Fatigue, stress, recall failure, etc.
  - Population stereotypes



# Process Model Example: Police and Fire Response to WTC Attack – 9/11

- Police and Fire response exhibited multiple symptoms of sociotechnical system dysfunction
- Minutes after the south tower collapsed, police helicopters hovered near the remaining tower to check its condition.
  - "About 15 floors down from the top, it looks like it's glowing red," the pilot of one helicopter, Aviation 14, radioed at 10:07 a.m. "It's inevitable (that it will collapse)."
- Seconds later, another pilot reported:
  - "I don't think this has too much longer to go. I would evacuate all people within the area of that second building."
  - The North Tower collapsed approximately 20 minutes later
- Police safely evacuated north tower along with additional civilians
  - FDNY personnel (and associated civilians) never received the message and were killed in the tower's collapse

# Sociotechnical Factors Impacting Responders' Process Models

- Technical: FDNY radio system failed during WTC response
  - Same radio system that had also failed during the 1993 WTC bombing and which was known to repeatedly fail in high-rises
    - “There were problems with the radios at virtually every high-rise fire”
  - Radios were over 15 years old – “symptom of FDNY’s culture of resistance to change”
    - “We’re dinosaurs” – R. Scheier, Director of NYC Office of Emergency Management
- Organizational: FDNY and NYPD ‘barely spoke’ to one another during response effort
  - Even if FDNY radios had worked, they were not compatible with NYPD radios – information could not be and was not shared
  - FDNY and NYPD had ‘talked for years’ about establishing a common radio framework but ‘could not reach agreement’

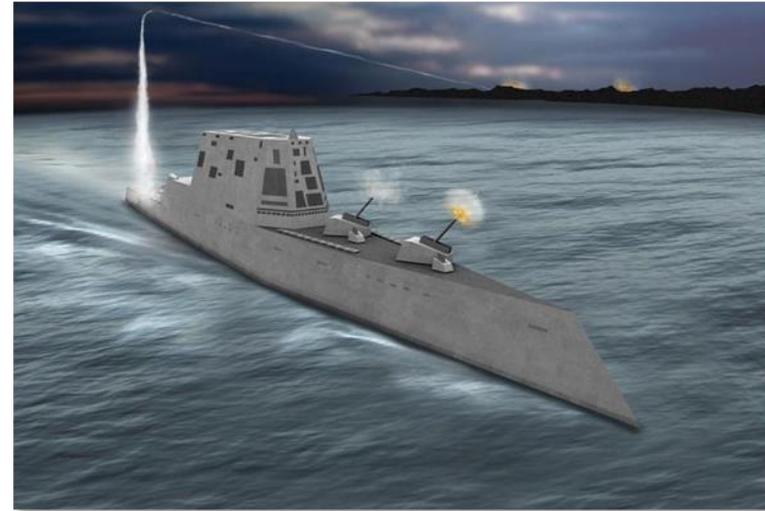
# Safety Climate

- Defined as employees' shared perceptions of their organization's policies, procedures and practices as they relate to the value and importance of safety within the organization
- Safety climate taps critical aspects of the *psychological experience* associated with work
- Management communications and decision-making are central elements
- Safety climate shows promise as
  - A leading indicator
  - Key aspect of workers' process models



# Participatory Design

- Incorporation of worker input into work system design and assessment
- Considered a somewhat radical idea until the 1980s
- Workplace safety has been a late adopter, but it's getting there
- Important issue for STPA and CAST



# Research Directions

- Assessment of STPA and CAST in workplace safety settings
- Communications and decision making
- Safety Climate
- Modeling and simulation of complex sociotechnical systems
- Impact of behavior shaping mechanisms
  - Stress, emotion, fatigue, etc.
- Principles of Joint Optimization
- Function allocation
- Work as a complex, adaptive system

# Summary

- The practice of workplace safety has been dominated by behavioral approaches for quite some time
  - Beginning to change – situation is ripe for a systems perspective
- STAMP distills and builds on sociotechnical and cognitive systems approaches
  - Clearly relevant to workplace safety design, assessment and accident investigation
- When we are here next, we will report out on our assessments of STPA and CAST in workplace safety settings

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