STAMP and Workplace Safety

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60 YEARS
HELPING TO REDUCE INJURIES AND DISABILITY

MIT STAMP/STPA Workshop
March 23-26, 2015

Liberty Mutual Research Institute for Safety

generating knowledge to help people live safer and more secure lives

Vision:

To be the premier research organization in the world dedicated to the reduction of injuries and disability

Mission:

To advance scientific knowledge in workplace, built environment and driving safety, and work disability

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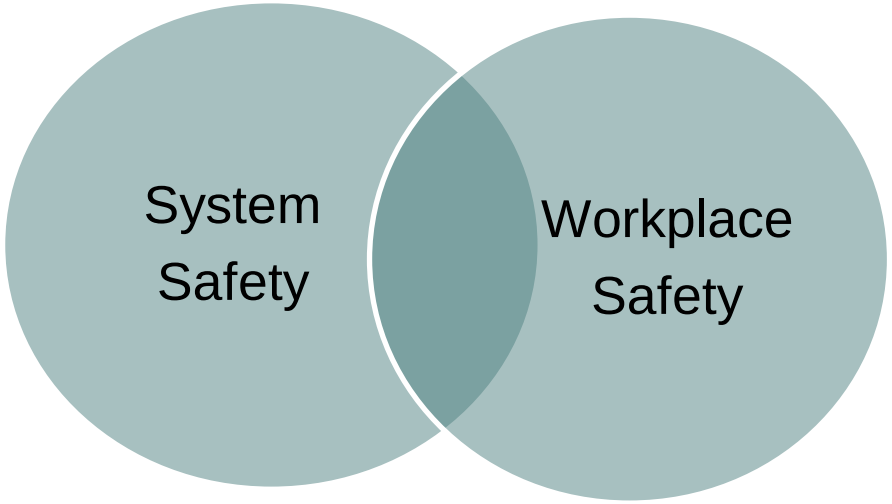
Overview – Workplace Safety

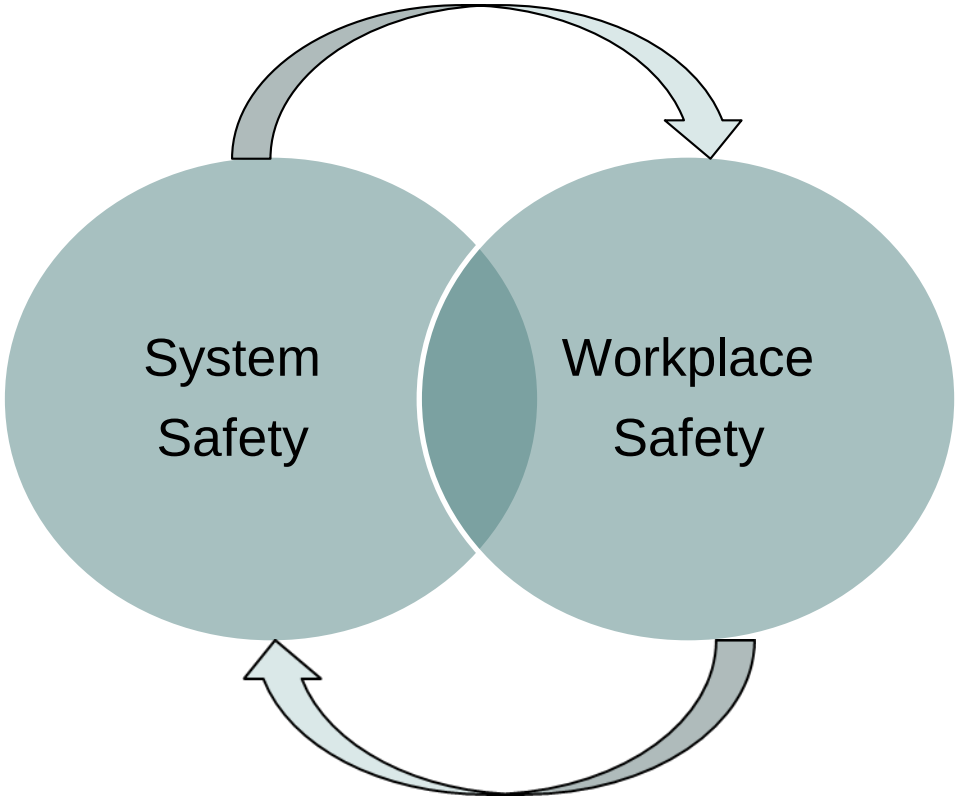
- “The science of the anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well-being of workers, taking into account the possible impact on the surrounding communities and the general environment” (Alli, 2008)



- The same types of complex, sociotechnical systems features underlie system and workplace safety hazards

There’s a great deal more to workplace safety than hard hats and goggles!

System-Workplace Safety Reciprocity



- Human values, behaviors, decisions, communications, policies, beliefs, etc. clearly impact workplace safety, which in turn influences overall system safety
- We cannot understand the full scope of factors impacting system safety if we do not understand the sociotechnical factors that underlie worker behavior, decision making, etc.

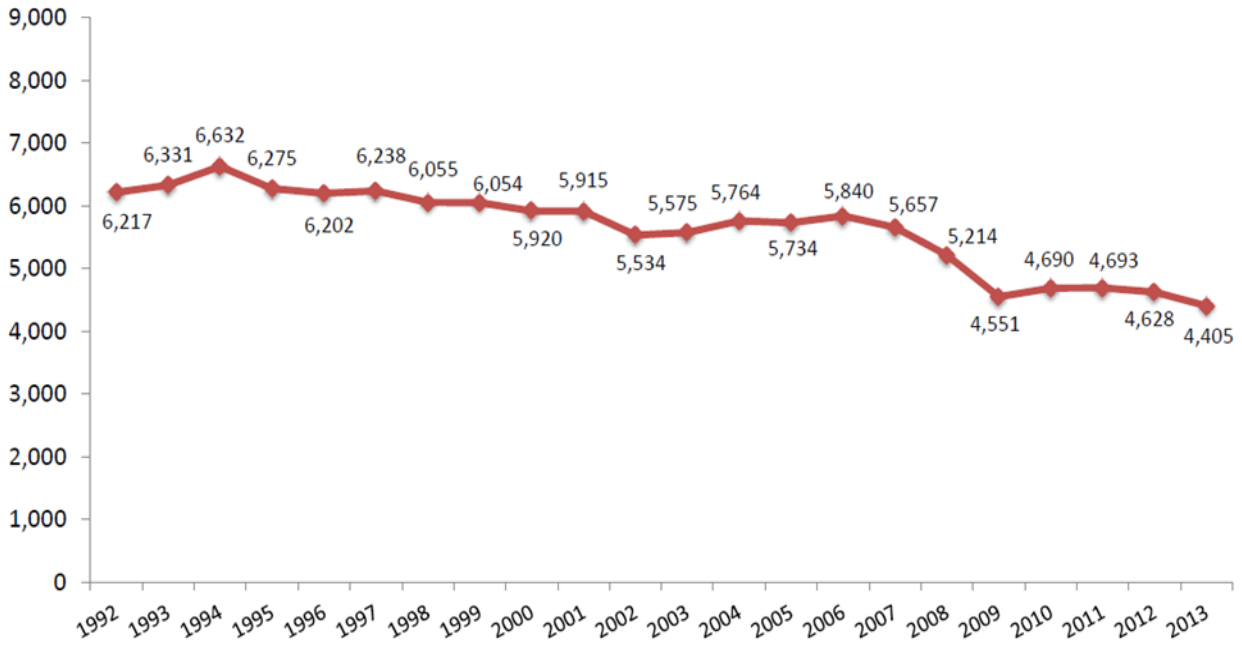
Global and US Occupational Accident Data

Global Fatalities and Serious Injuries

Year	Fatal Accidents	Occupational Accidents ≥ 4 days absence
1998	345,436	263,621,966
2001	351,203	268,023,272
2003	357,948	336,532,410

Hamalainen et al, 2006

US Fatalities



US Bureau of Labor Statistics, 2014

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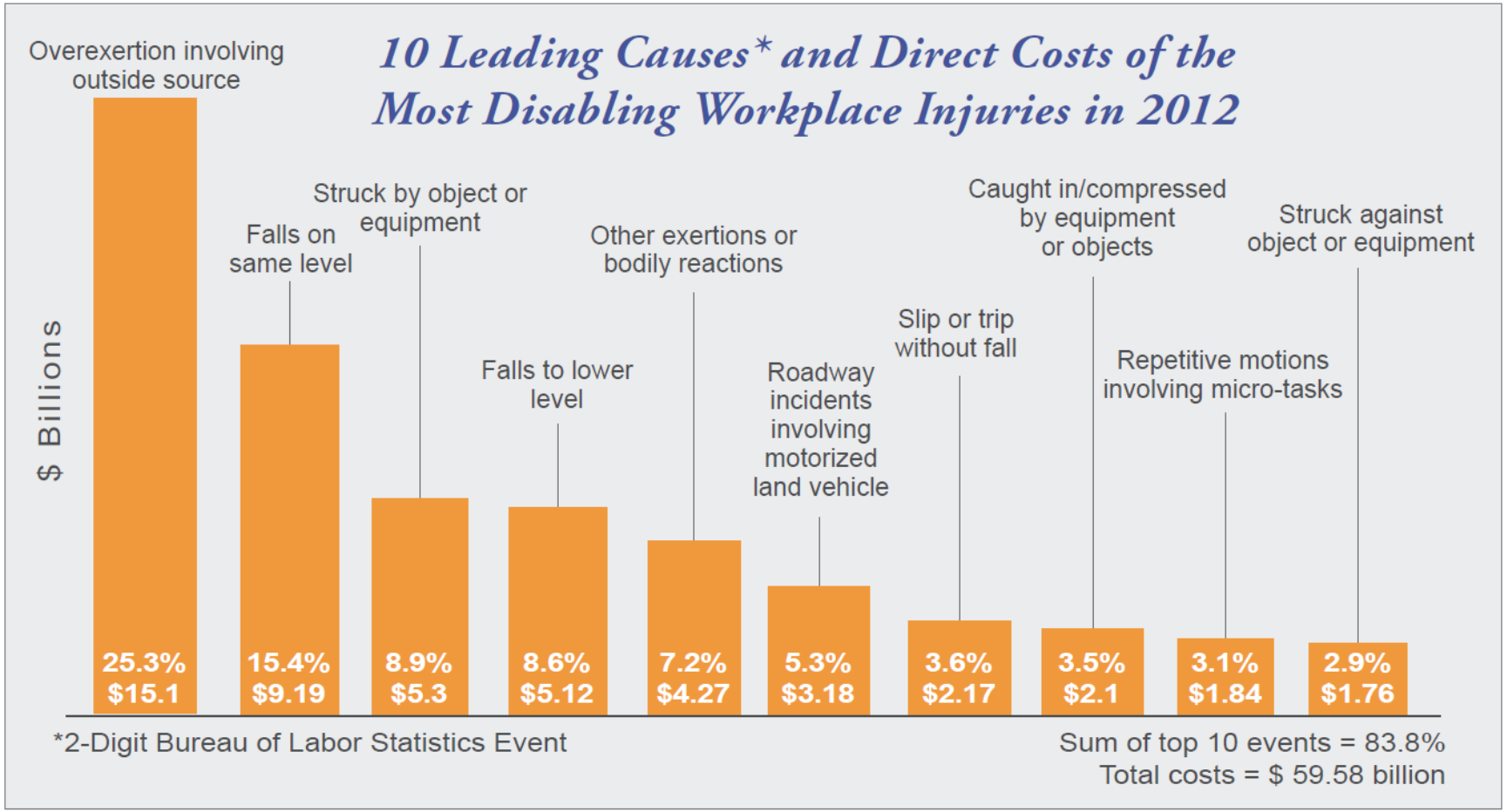
LM Workplace Safety Index 2014



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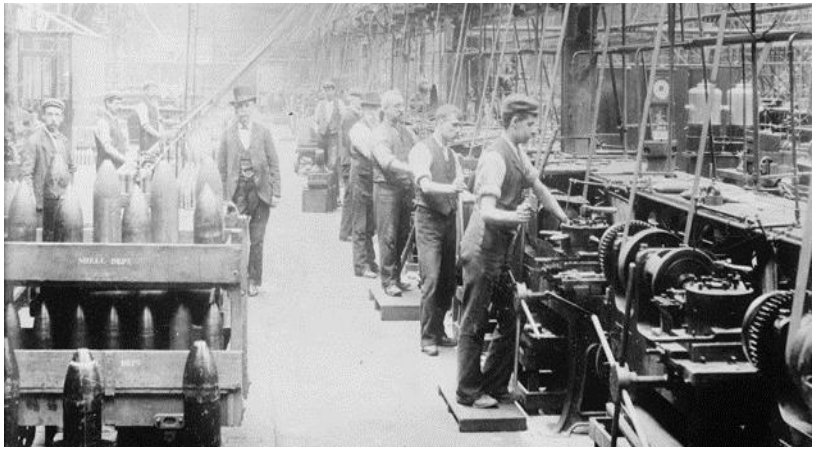
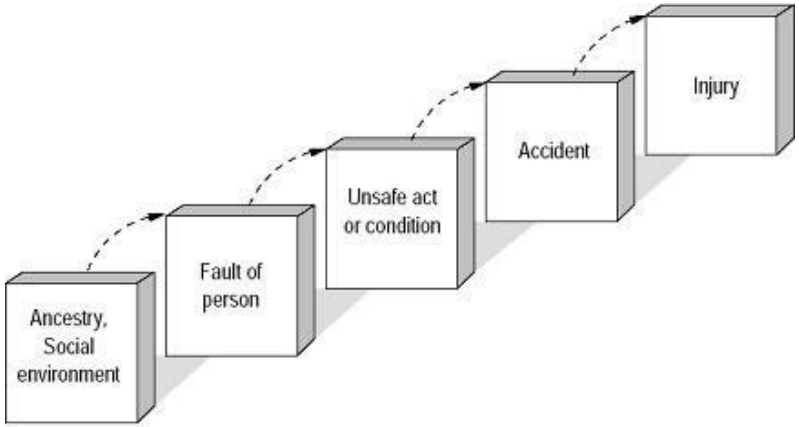
Traditional Approaches to Workplace Safety

- Scientific Management – "Taylorism" (1909)
  - Decomposed work process into components to increase efficiency
  - Influential in trends toward procedural standardization and "one best way" thinking
  - Encouraged the scientific study of work, albeit from a reductionist perspective



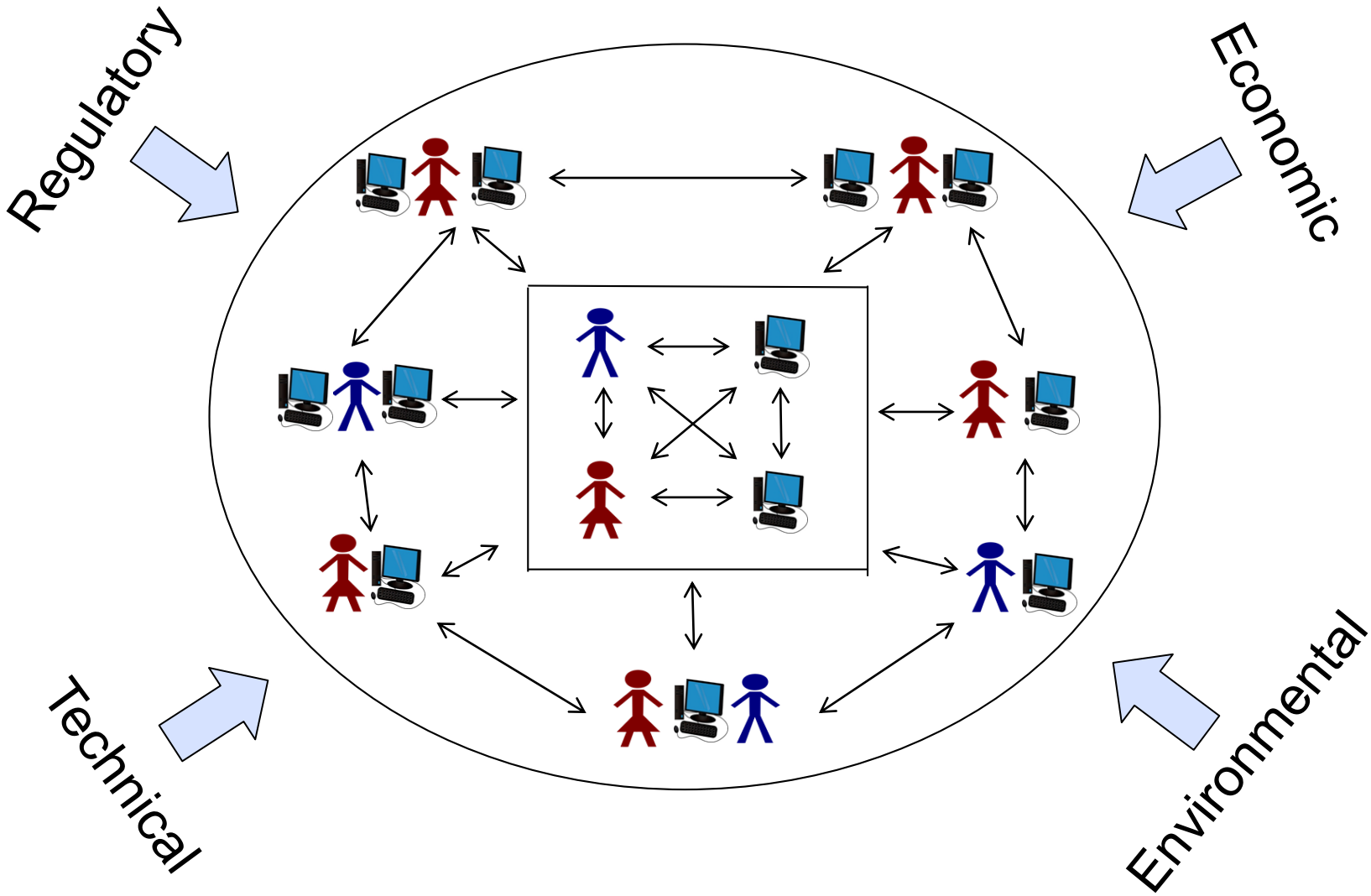
- Heinrich's Domino Theory (1931)
  - Viewed accidents as a highly deterministic, linear sequence of events
  - Foundational aspects viewed as characteristics of the worker
  - Groundbreaking for the time – encouraged assessment of underlying conditions
  - Reason's "Swiss Cheese Theory" is in some senses a derivative
    - Replaced "causal dominoes" with imperfect layers of defense



Behavior-Based Safety

- Perhaps the most dominant approach to workplace safety management of the recent past
- Based largely on principles of Skinnerian Behaviorism
  - Accidents seen as the result of worker behaviors
  - Goal is to modify behavior based on variables of reinforcement and punishment
  - 1970s - Earliest applications involved the development of “token economies” to promote safety in open pit mining
- Has come under severe criticism in recent years
  - Insufficient attention to the “why” of unsafe behaviors
  - Insufficient appreciation of broader influences on behavior

Sociotechnical complexity: Why we need a new approach



Tosco Refinery Explosion, Martinez CA, February 23, 1999

- Four workers burned to death after igniting leaking gas during maintenance
  - Plant shut down for several months and subjected to formal investigation by Contra Costa County and Chemical Safety Board
- Investigation revealed safety issues that cut across the sociotechnical spectrum
  - Human-machine system design
  - Fatigue, workload, morale issues associated with cutbacks and layoffs
  - Habitual unsafe work practices
  - Cynical safety culture, productivity valued over safety
- These problems had existed for years

Problems uncovered at Tosco are typical of those observed in other complex work systems

Other Catastrophic STS Failures

- Lack of maintenance plan to detect anomalies in track current signal
- Failure to respond to previous warning signs and near-misses
- Inadequate maintenance training

- Cost-cutting pressures
- Safety-productivity tradeoffs
- Insufficient system to ensure well safety
- Emphasis on OSHA recordables vs. system safety

- Downsizing and training cutbacks related to cost-cutting
- Safety equipment not designed to cope with volume, temperature and location of escaping gas
- Poor human-machine interface design

- Inadequate safety culture
- Failure to distinguish between occupational safety and process safety
- Cost/profit pressures influenced decision against modernizing safety-critical equipment

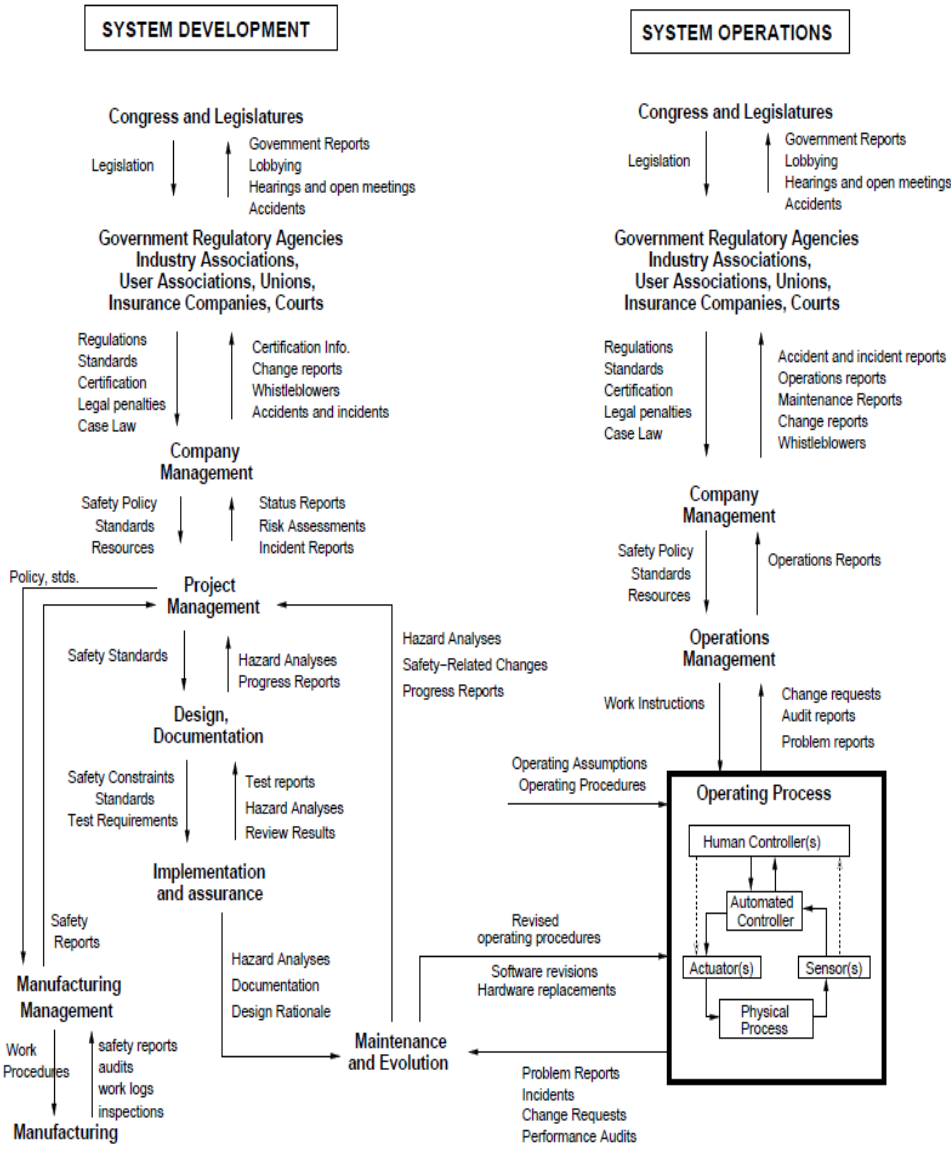
While representing very different domains, complex sociotechnical systems share many common points of potential failure

General Systems Theory and Complexity Theory

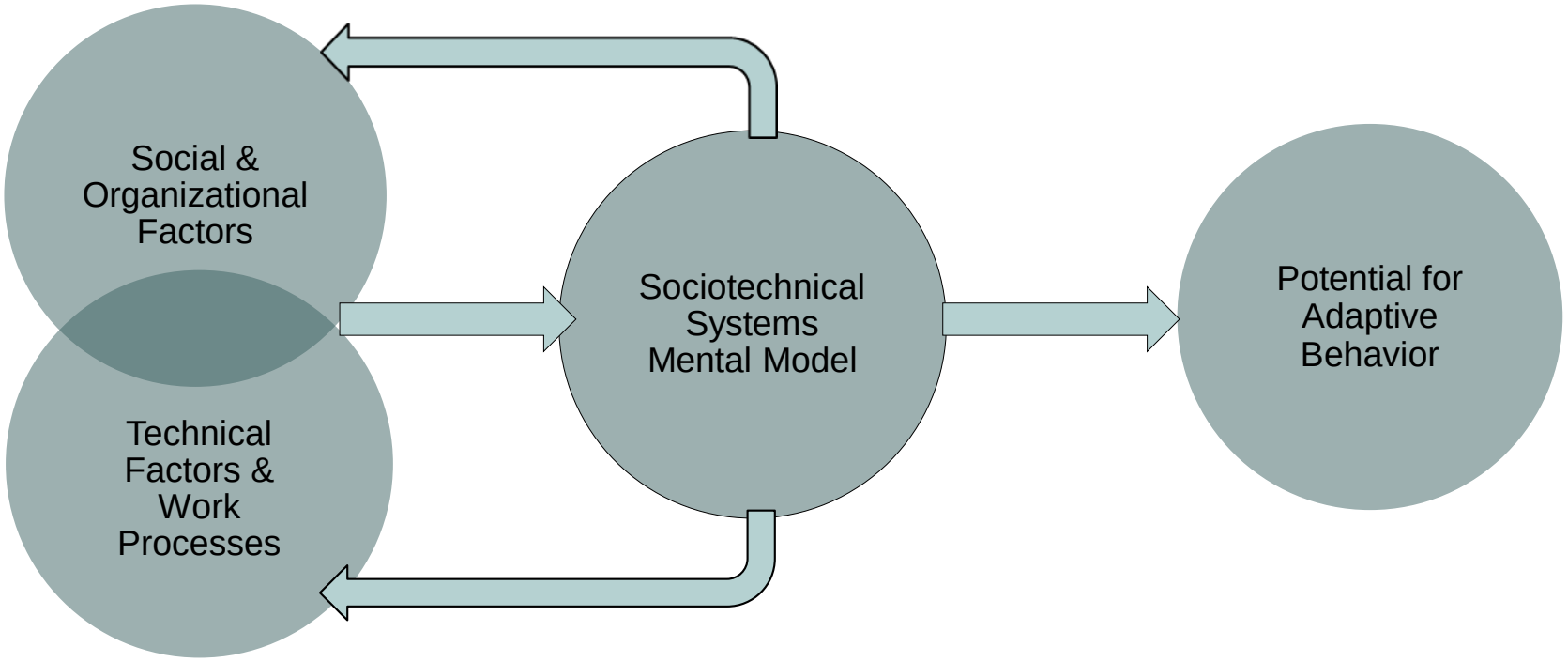
- Emerged as frameworks for envisioning and studying complex physical systems
  - Now increasingly applied in the social sciences
- Until recently these ideas have not found their way into our thinking about workplace safety
  - Leveson, Dekker, Hopkinton Conference on Sociotechnical Systems and Safety
  - ORC-HSE: Academic/corporate consortium exploring applications
- Resonant themes
  - Safety emerges from a complex pattern of component interactions
  - Humans are an especially critical, variable component set
  - Seemingly minor inputs can have unexpected and major outcomes
    - At the human level, these inputs correspond to decisions, communications, behaviors, policies, etc. *across the organization*, not just on the work floor.

What more do we need to understand?

- The human contribution to the dynamics of safety control systems
  - Decision making
  - Communications
  - Conflicting and/or inaccurate mental models
  - Values, Leadership and Motivation
  - Human-System Interface
- All of these issues impact system behaviors at the macro-, meso-, and micro-levels
- All are impacted by traditional human-system performance factors
  - Stress, fatigue, uncertainty
  - Constraints on individual and team performance
    - Cognition, perception, problem solving



Sociotechnical Systems Mental Model and Operator Safety



Likelihood of safe, adaptive behavior may be a question of "*can* we do it" *and* "what could the social/organizational consequences be *if* we do it"

Conclusions

- Systems safety and workplace safety mutually enable and constrain one another
  - The same sociotechnical system dynamics that underlie system safety also underlie workplace safety
- Workplace fatalities, while declining in the US, may be on the rise internationally
  - Data are frequently unreliable and hard to come by, but best estimates show a negative trend
- Systems theory and complexity theory are only recently being introduced to the science and practice of workplace safety
  - The practice of workplace safety is still strongly influenced by Tayloristic assumptions, domino theory derivatives, and behavior-based safety models
- The changing nature of the workplace requires safety approaches that can cope with problems associated with complex, adaptive swork ystems
- How system properties impact human behavior, and how human behavior in turn impacts system outcomes, are key areas of concern for research and practice