Understanding the Skill-based Error Problem

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Types of Errors

Knowledge Based (novel situations)

Perform the wrong step because of a lack of knowledge
(e.g., Don't know which medication is appropriate)

Rule Based (familiar situations)

Perform the wrong step because of the misapplication of a rule
(e.g., I think it is medication x)

Skill-based (experienced situations)

Perform the wrong step because of a slip or lapse
(e.g., intend to give the correct medication, but mistakenly give medication x)

(Rasmussen, 1982)

Skill-based (automaticity) errors

- Occur despite having the correct knowledge of how to perform the task
- Occur even with hundreds (or thousands) of hours of experience
- Occur on simple tasks (making coffee) and complex tasks (surgery, flying an airplane)

Prevalence of Skill-based Errors

Domain	% Accidents/Incidents due to skill-based errors	Dataset & Source
Aviation (Military)	**50%**	US Navy incidents from the Navy Safety Center (1990-1998) (Shappell & Wiegman, 2004)
Aviation (Commercial)	**60.5%**	199 accidents in the United States from 1990-1996; data from NTSB and FAA (Wiegman & Shappell, 2001)
Aviation (Maintenance)	**48%**	Survey of 550 aircraft maintenance personnel in Australia (Hobbs et al., 2007)
Mining	**~58.9%**	508 cases from Australia (2004-2008) (Patterson & Shappell, 2010)
Medical Intensive Care	**~53%**	120 adverse events in 79 patients; 54 preventable adverse events. In total examined 391 patients with 420 unit admissions in 1490 patient days (Rothschild, 2005)
Railways	**63%**	19 rail accidents in Australia (Baysari et al., 2009)

Approaches to Dealing with Errors

- *Person Approach*: Focus on the **errors of individuals** and **blame them for failures** of memory and attention

- *Systems Approach*: Focus on the **conditions under which individuals work** and **build defenses** to **avert errors** or **mitigate their effect**

Reason (2000)

Types of Errors

Knowledge Based (novel situations)

Perform the wrong step because of a lack of knowledge
(e.g. Don't know which medication is appropriate)

Training

Rule Based (familiar situations)

Perform the wrong step because of the misapplication of a rule
(e.g. I think it is medication x)

Skill- based (experienced situations)

Perform the wrong step because of a slip or lapse
(e.g. intend to give the correct medication, but mistakenly give medication x)

Not prevented by training, discipline or policy

(Rasmussen, 1982)

My Goals for Today

- (1) Convince you that no matter how capable we are, there is variability in our performance

Errors are going to happen

- (2) Demonstrate how human factors and our understanding of cognition can help predict where errors might occur

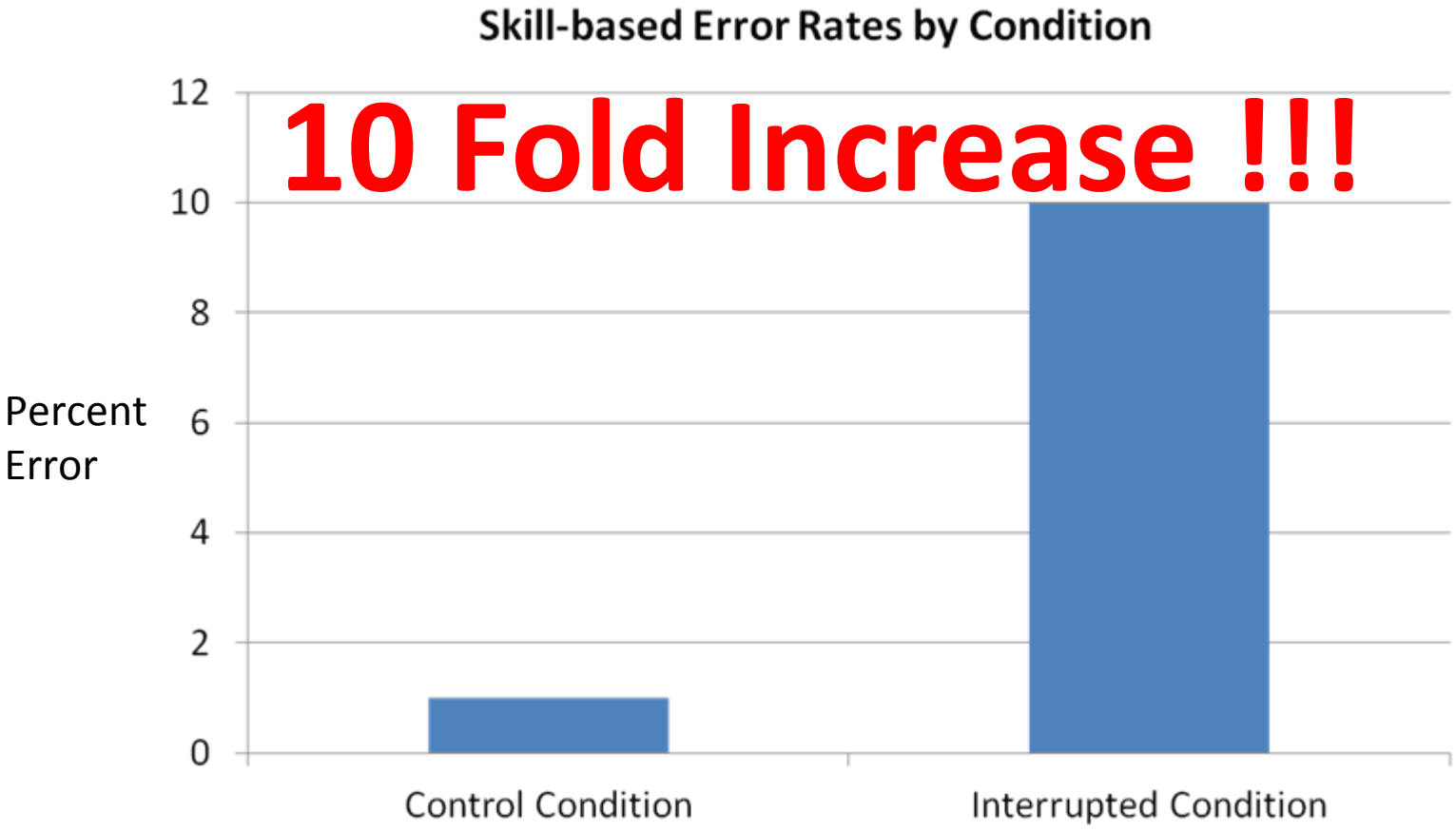
Build robust systems

Our Work Conditions

- All of us come to work with intentions to perform at our highest levels, but:
  - Our work environment is full of interruptions
  - Workload is generally high
  - Fatigue and stress are *real* issues

- How do we perform given these conditions?
  - Research is VERY limited, but we have some info…

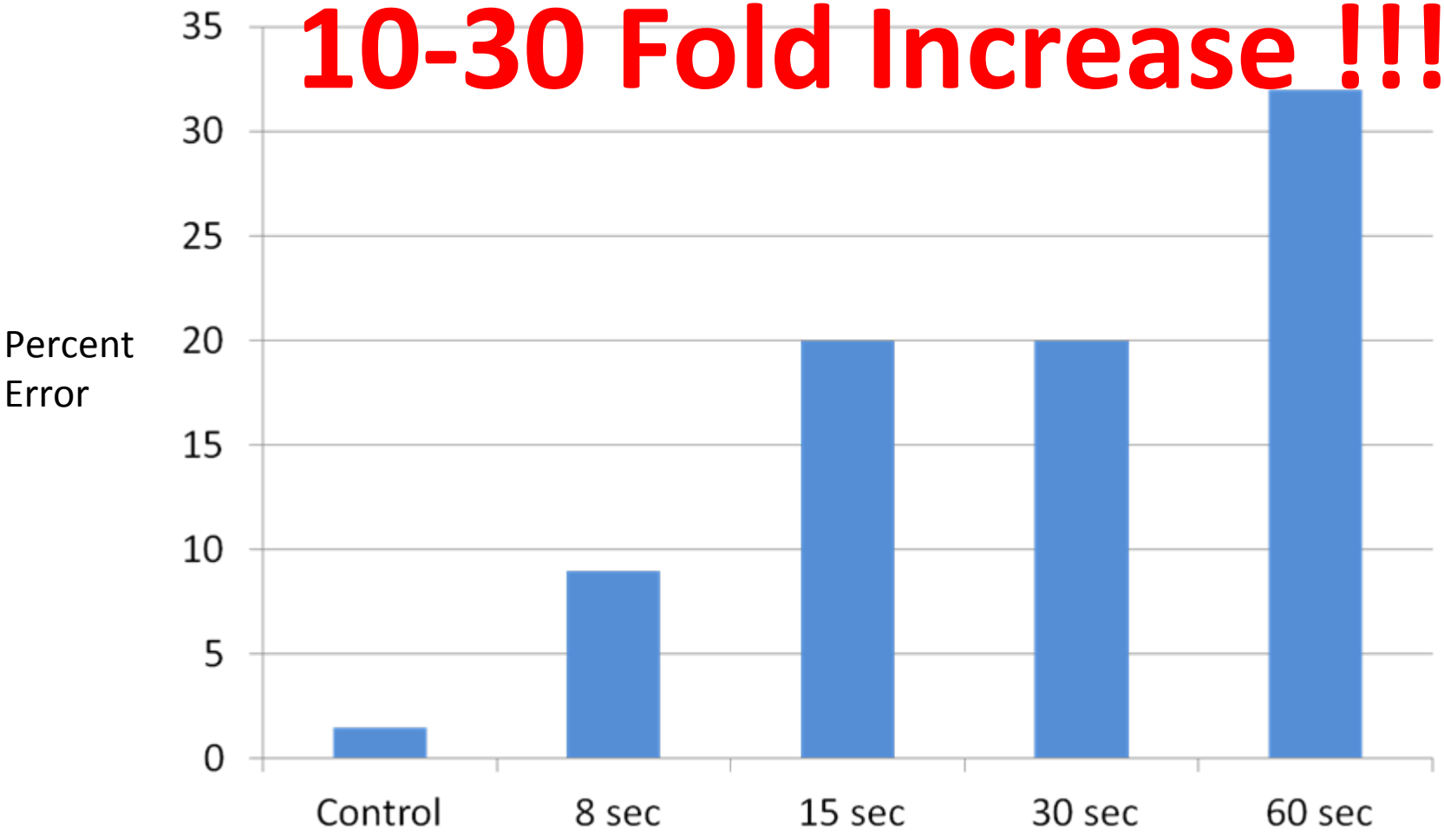
How Disruptive are Interruptions?



(Ratwani & Trafton, 2008)

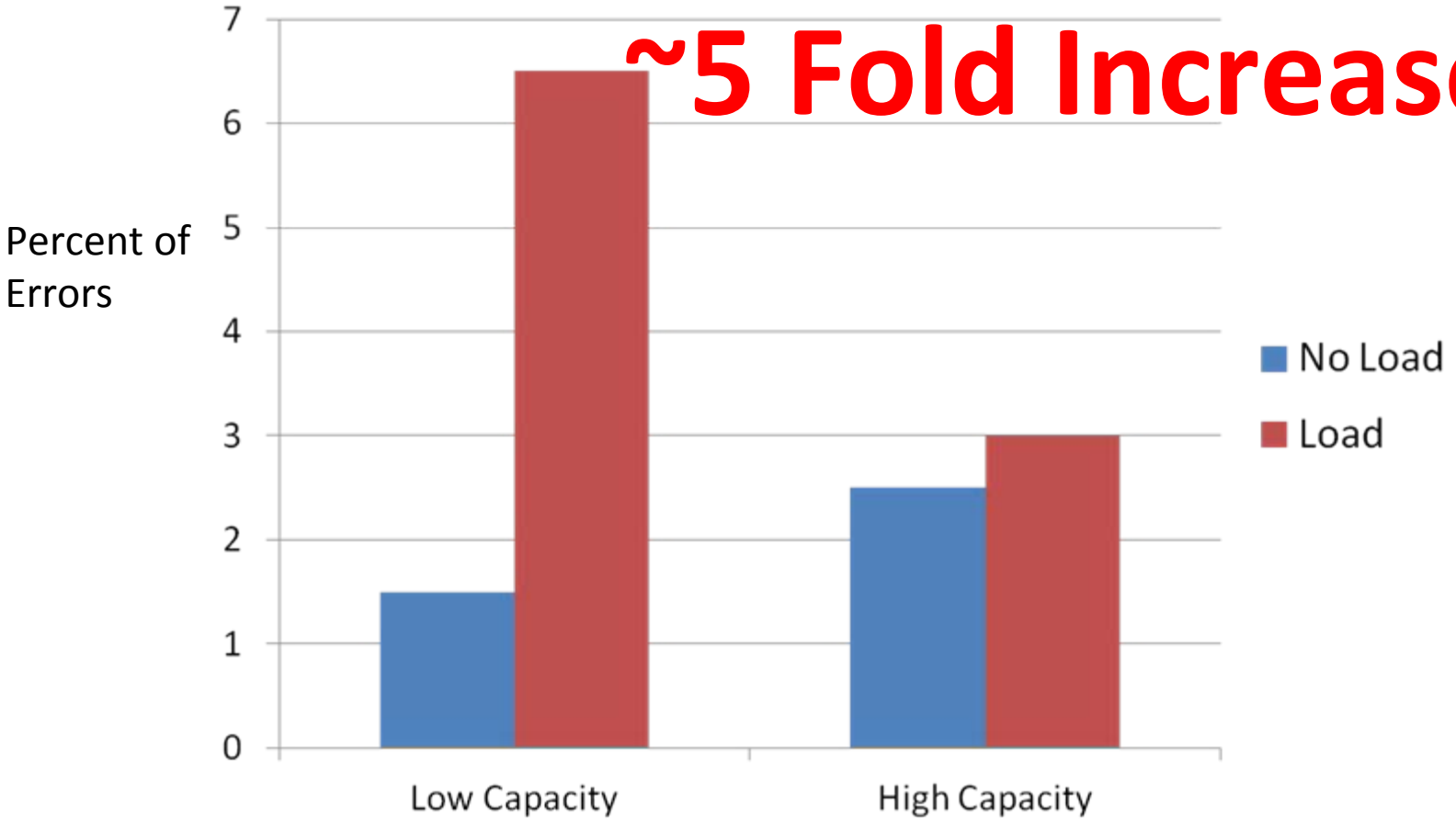
Errors by Interruption Length

10-30 Fold Increase !!!



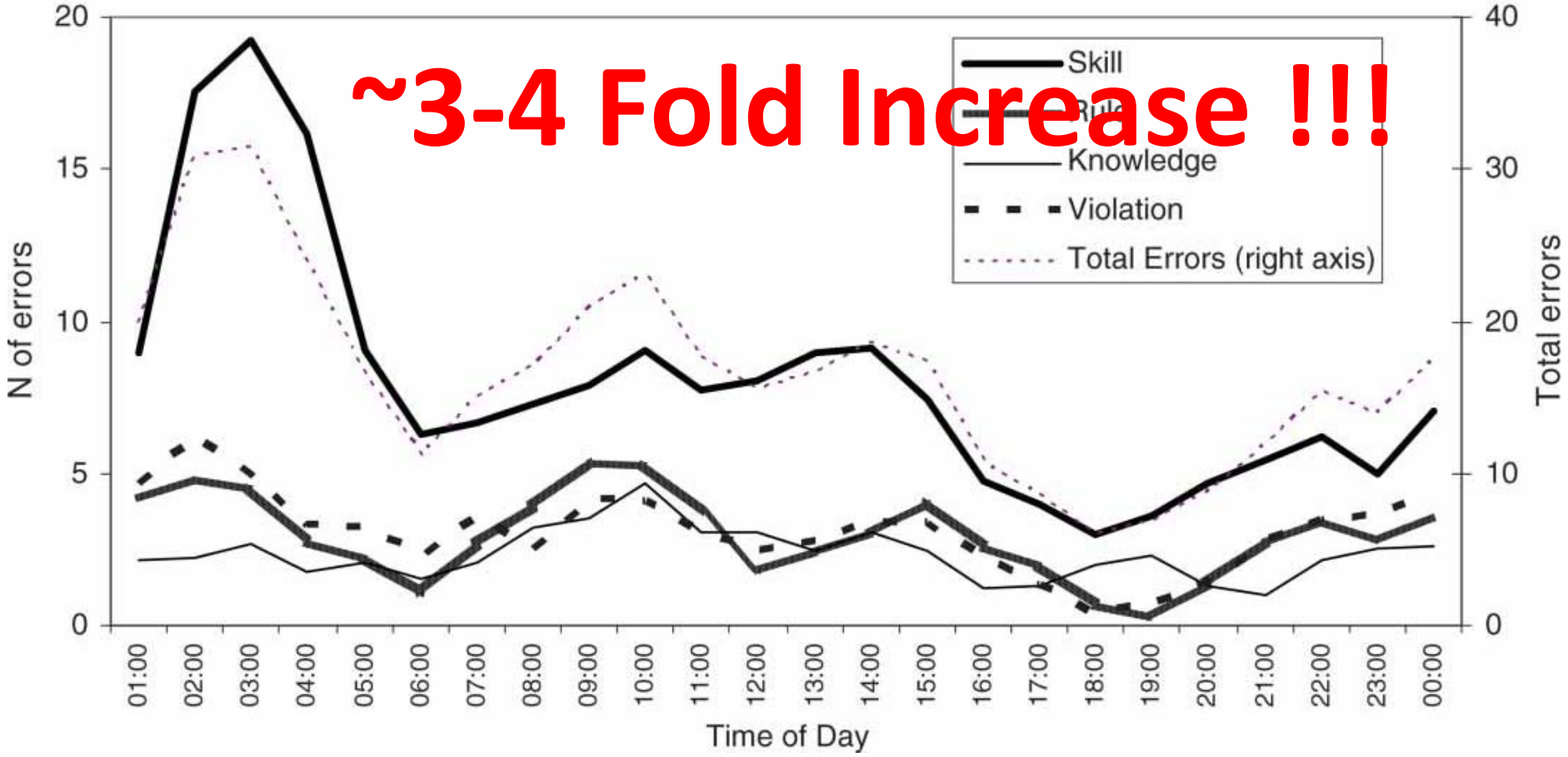
(Ratwani & Trafton, 2010)

Workload and Error Rates



(Byrne and Bovair, 1997)

Fatigue and Skill-based Errors



Errors in airline maintenance crews by circadian rhythms
(Hobbs et al, 2010)

Accept these Conditions as Normal

- None of us are resistant to the influence of interruptions, workload, or fatigue!

- Begin to accept that there is natural variability in our performance– plan accordingly

How do we Leverage a Systems Approach?

- Focus on our interaction with the environment and design for error

“Make it easy to do the right thing”

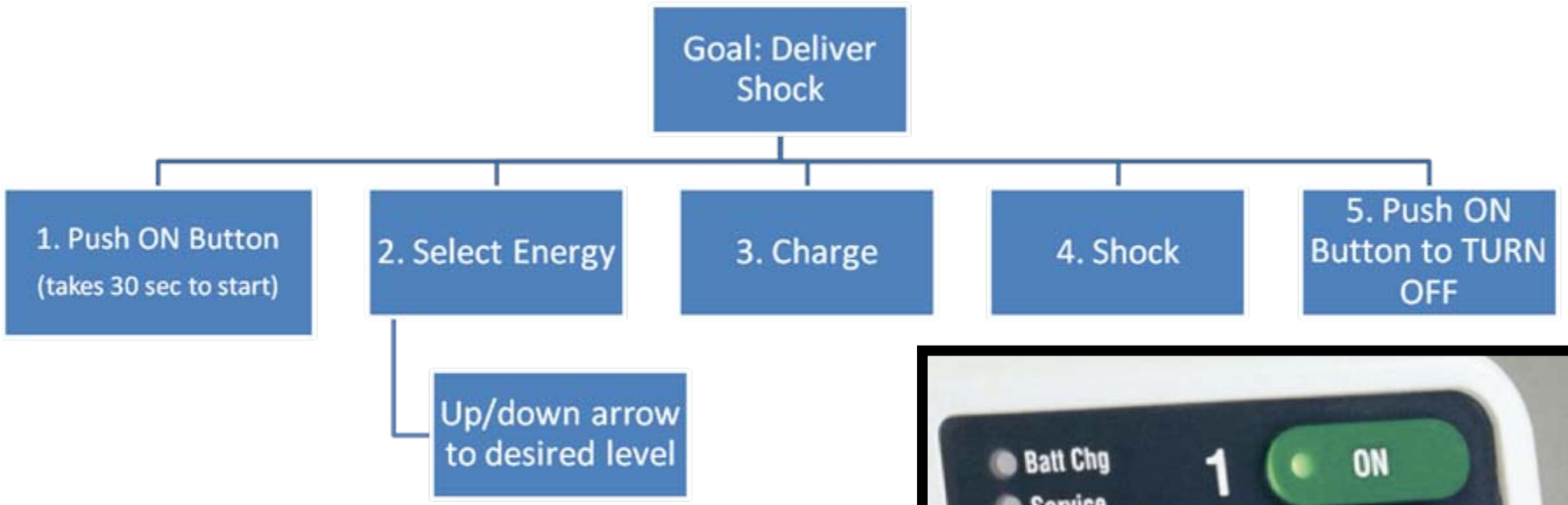
How do we Design for Error?

- Study the work environment , work conditions, and **dissect the tasks to be performed**
- Focus on understanding **human capabilities in context**
- Identify high risk areas and mitigate risk

Defibrillator Example

- Cardiac Arrest Work Conditions
  - Interruptions?
  - High workload?
  - Fatigue, stress?

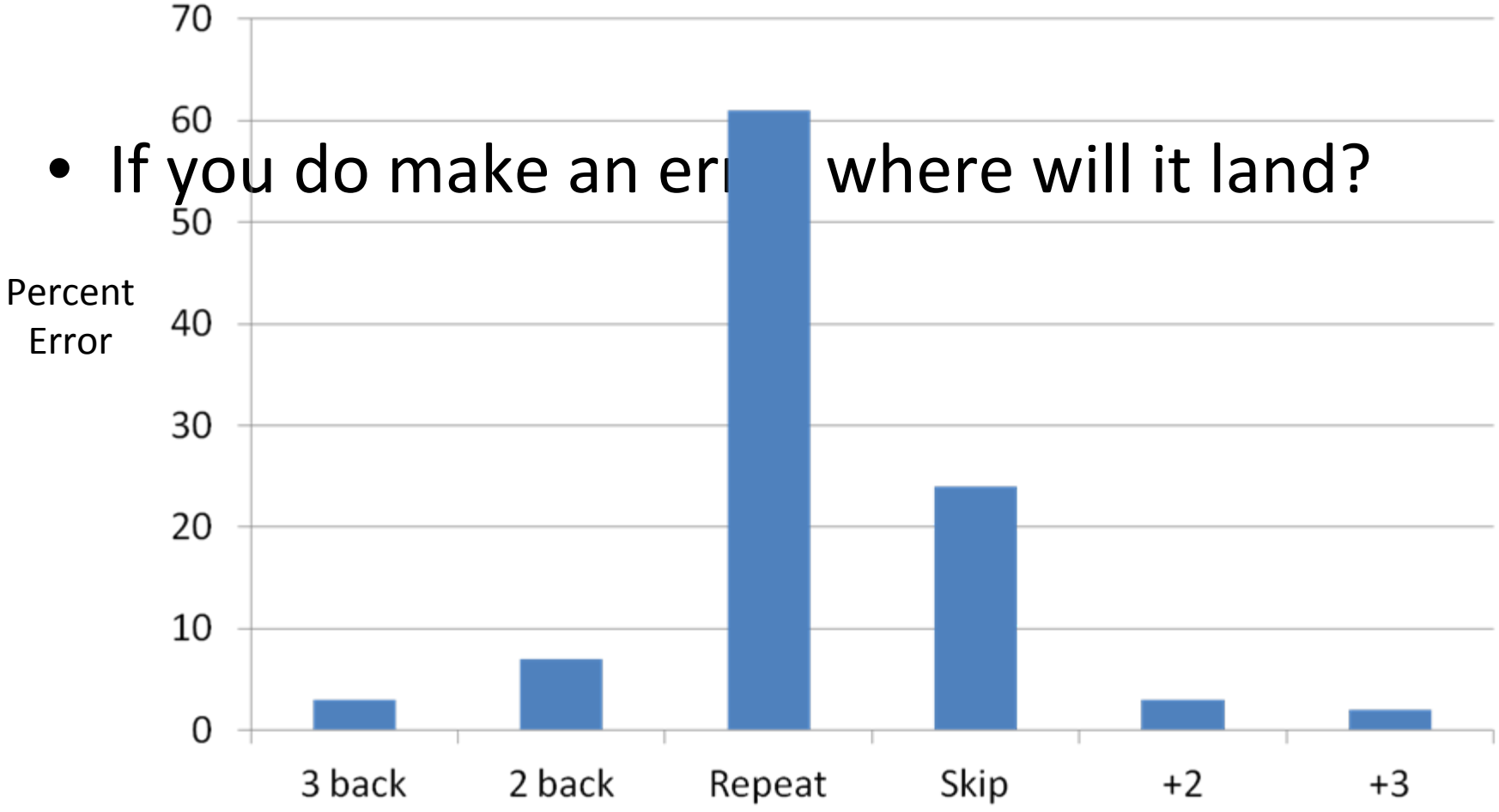
Task Analysis



Is this is a good design?

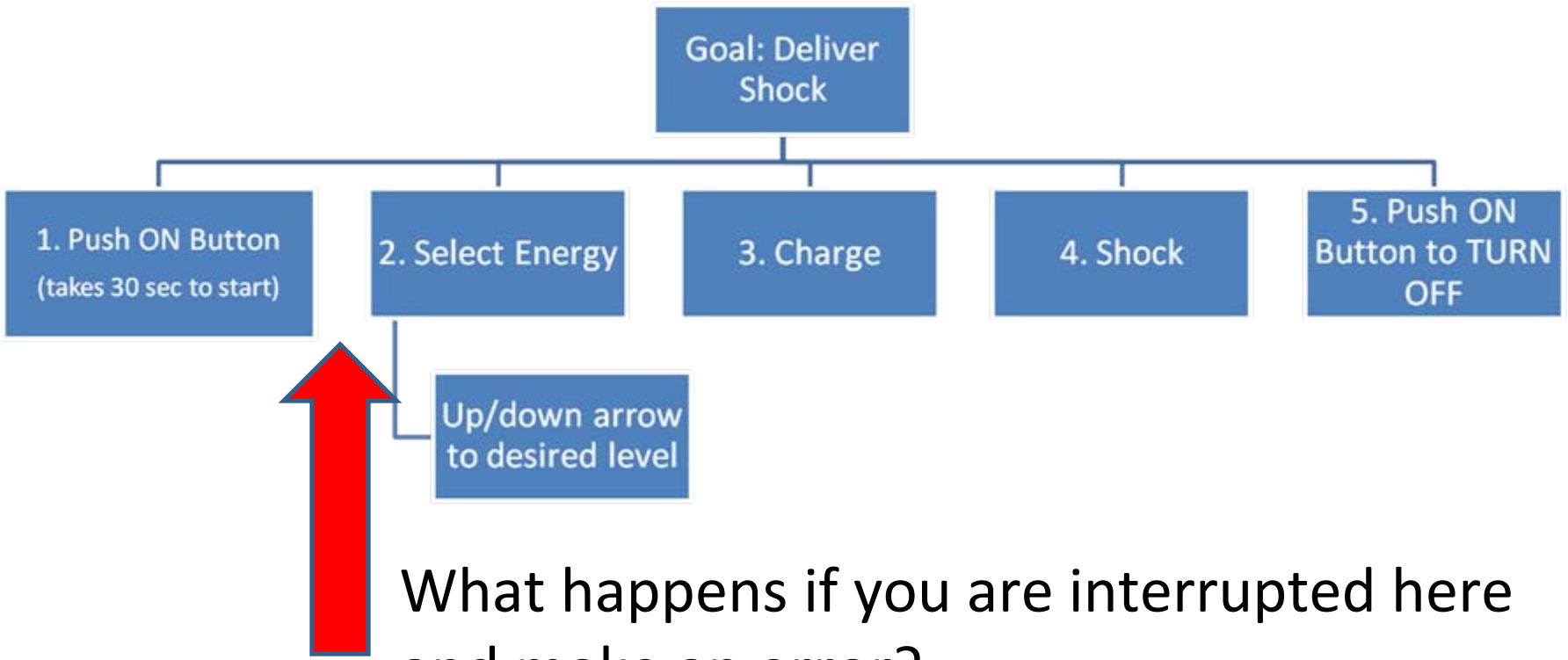
Understanding Skill-based Error Patterns

- If you do make an er[illegible] where will it land?



(Trafton, Altmann, & Ratwani 2009)

Understanding the Task in Relation to Error Patterns

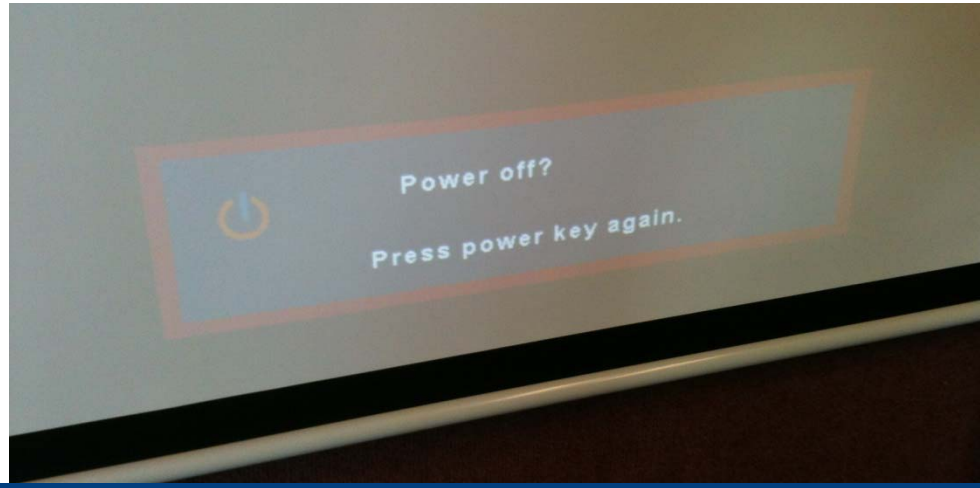


What happens if you are interrupted here and make an error?

There is a **high likelihood you will repeat the previous action**

Consequences

- Defibrillator will power down and it can take 2-3 minutes to restart
- Solution?
  - Anticipate that a “repeat” action is likely
  - Design for the error



(Hoyer, Christensen, et al., 2008)

(Fairbanks & Wears, 2008)

Where do we go from here?

- Skill-based errors are prevalent and have fundamental cognitive underpinnings
- We **cannot** reduce these errors by policy or training
- We **can** develop robust systems by applying cognitive theory to the design of systems

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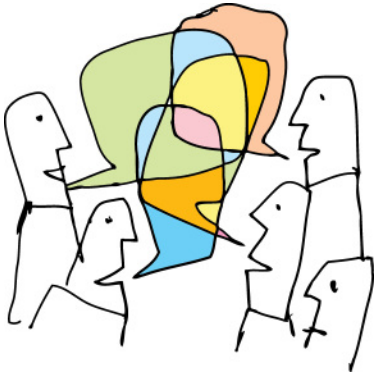
Discussion



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