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Cyber Informed Engineering (CIE) Principles Slide Presentation

June 2024

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Idaho National Laboratory

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Idaho Falls, Idaho 83415

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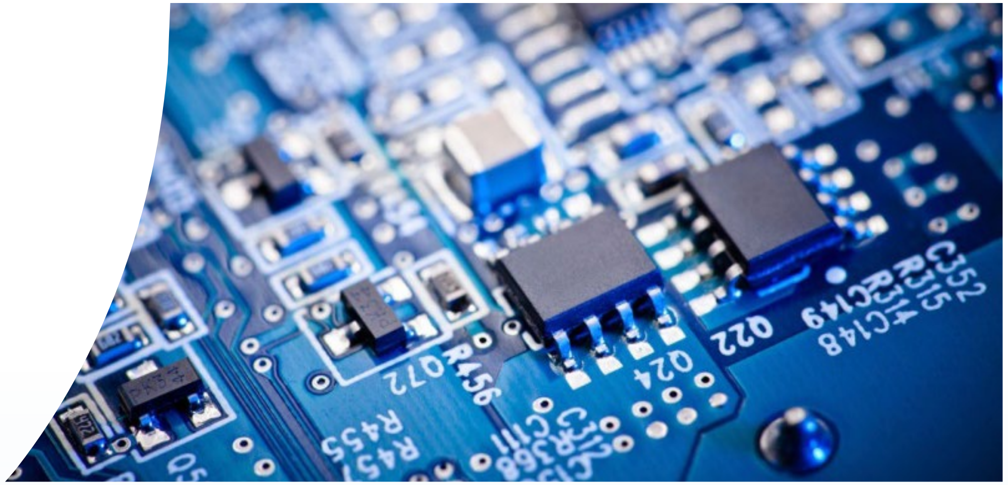
Cyber-Informed Engineering

What is CIE?

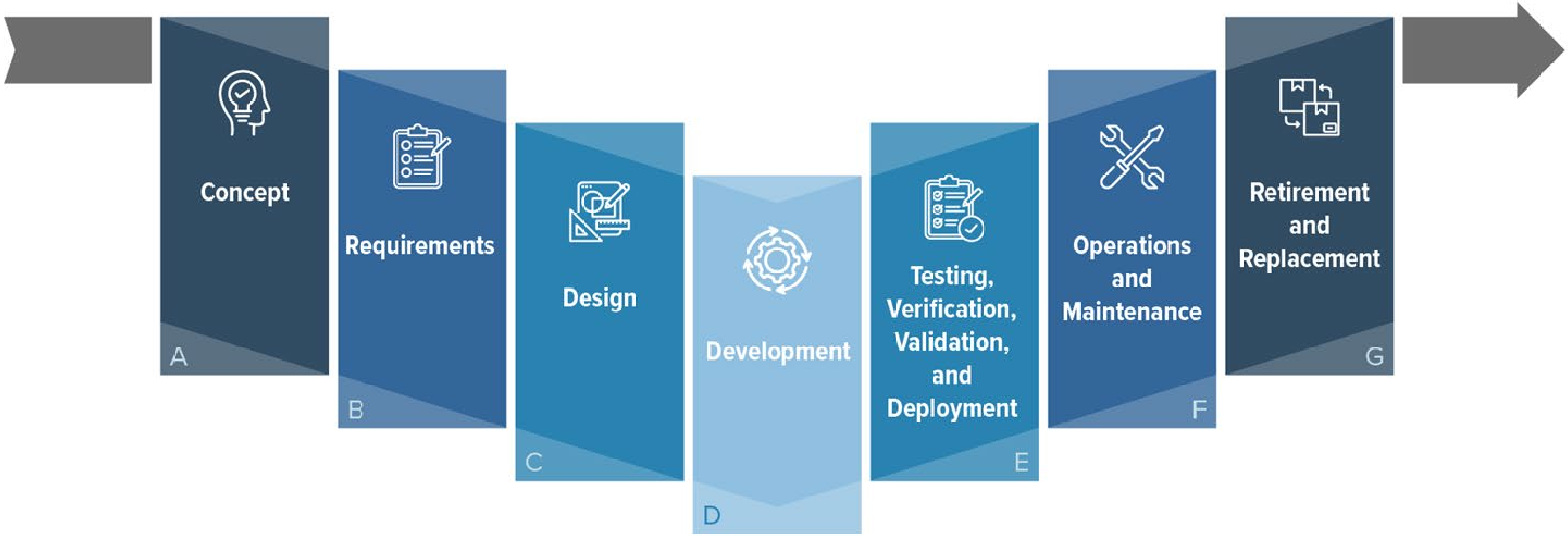
June 27, 2024

Cyber-Informed Engineering (CIE)

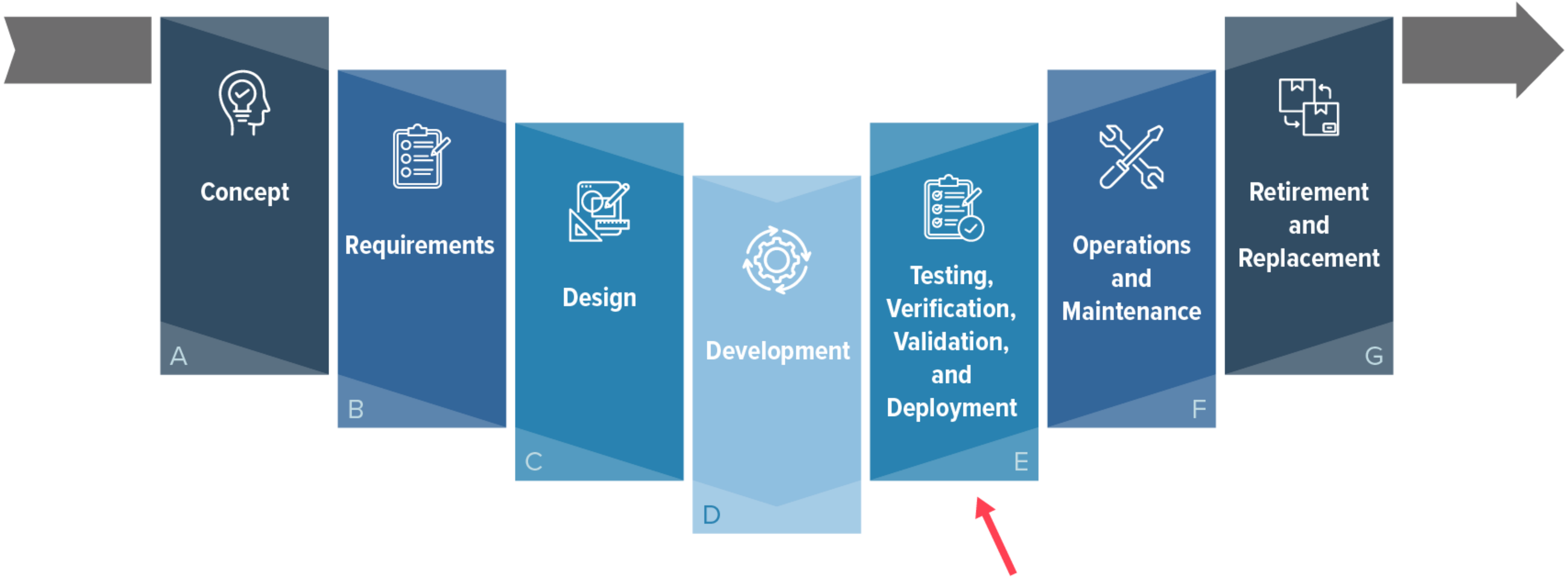
- CIE uses **design decisions and engineering controls** to eliminate or mitigate avenues for cyber-enabled attack.
- CIE offers the **opportunity to use engineering to eliminate specific harmful consequences** throughout the design and operation lifecycle in addition to traditional cybersecurity controls.
- Focused on **engineers and technicians**, CIE provides a framework for cyber education, awareness, and accountability.
- CIE aims to build **a culture of cybersecurity** aligned with the existing industry safety culture.



CIE and the Systems Engineering Lifecycle


Concept
A
Requirements
B
Design
C
Development
D
Testing, Verification, Validation, and Deployment
E
Operations and Maintenance
F
Retirement and Replacement
G

CIE and the Systems Engineering Lifecycle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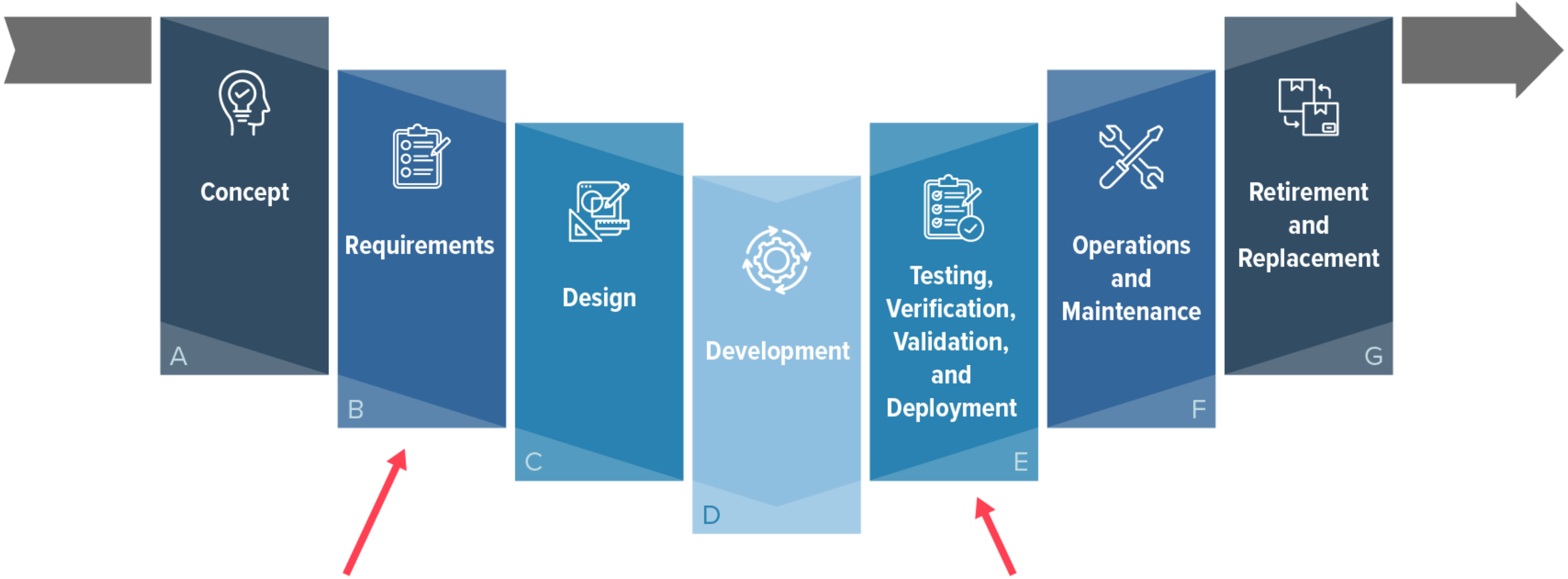
OT Cybersecurity risk mitigations are usually applied here…

CIE and the Systems Engineering Lifecycle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...but they are more effective and efficient when applied here.

OT Cybersecurity risk mitigations are usually applied here...

Cyber-Informed Engineering

CIE Principles

PRINCIPLE	KEY QUESTION
Consequence-Focused Design	How do I understand what critical functions my system must ensure and the undesired consequences it must prevent?
Engineered Controls	How do I select and implement controls to minimize avenues for attack or the damage that could result?
Secure Information Architecture	How do I prevent undesired manipulation of important data?
Design Simplification	How do I determine what features of my system are not absolutely necessary to achieve the critical functions?
Layered Defenses	How do I create the best compilation of system defenses?
Active Defense	How do I proactively prepare to defend my system from any threat?
Interdependency Evaluation	How do I understand where my system can impact others or be impacted by others?
Digital Asset Awareness	How do I understand where digital assets are used, what functions they are capable of, and what our assumptions are about how they work?
Cyber-Secure Supply Chain Controls	How do I ensure my providers deliver the security the system needs?
Planned Resilience	How do I turn “what ifs” into “even ifs”?
Engineering Information Control	How do I manage knowledge about my system? How do I keep it out of the wrong hands?
Organizational Culture	How do I ensure that everyone’s behaviors and decisions align with our security goals?

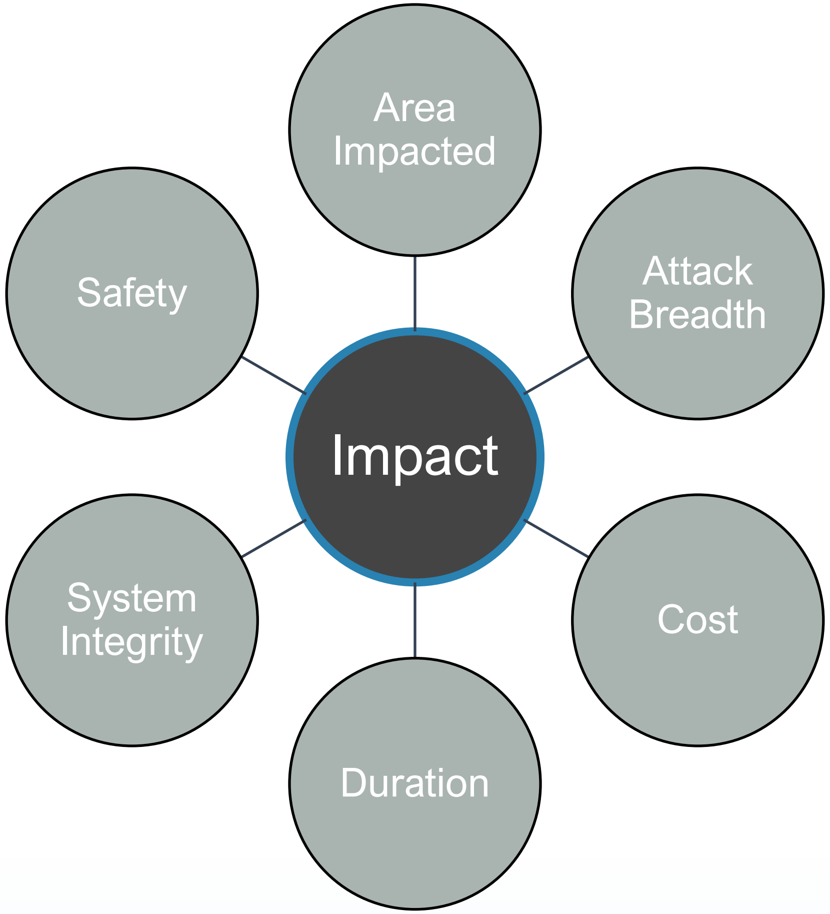
CIE Principles Deeper Dive

Consequence-Focused Design

KEY QUESTION

How do I understand what critical functions my system must ensure and the undesired consequences it must prevent?

- What is normal operation?
- What is the worst consequence of this operation?
- What are the system's critical functions?
- What is my risk appetite?

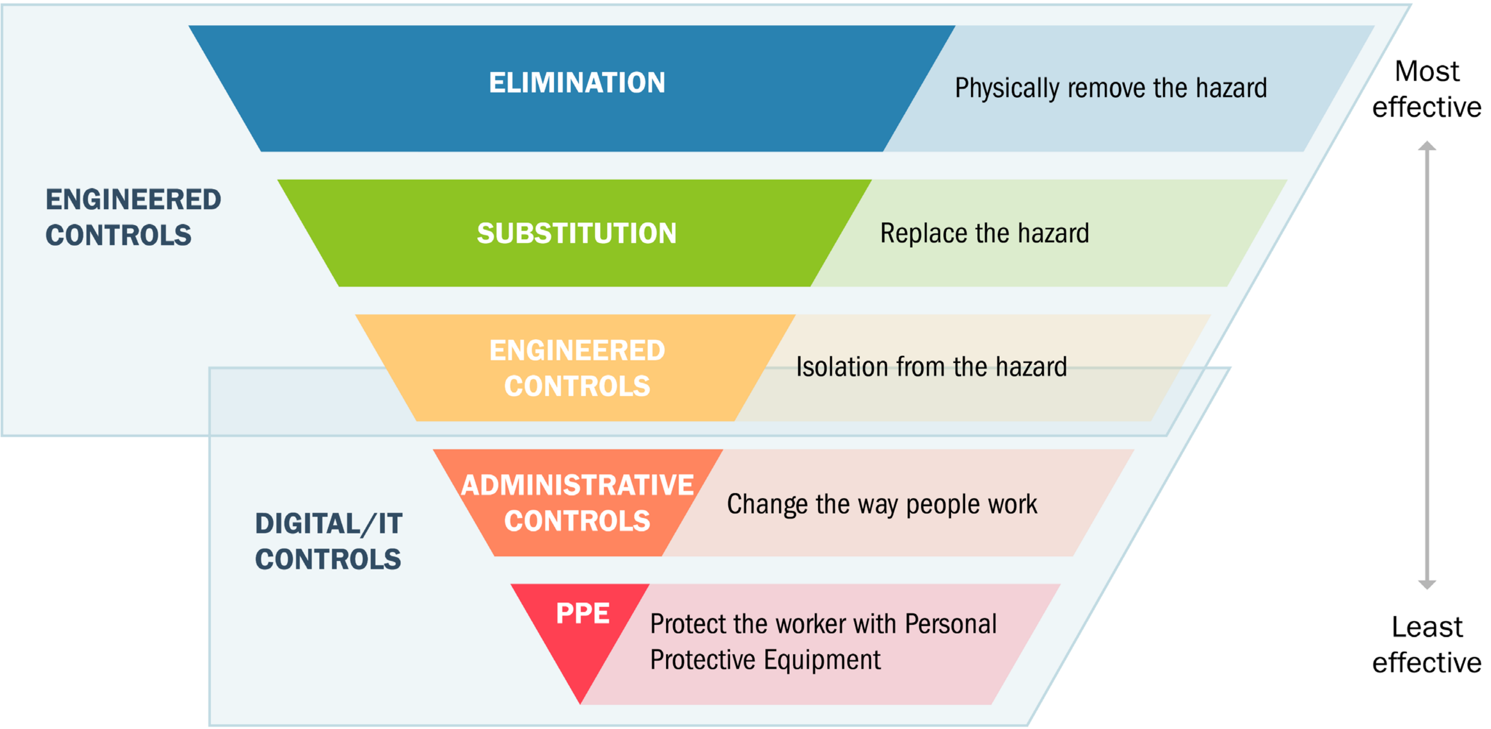


Engineered Controls

KEY QUESTION

How do I select and implement controls to reduce avenues for attack or the damage that could result?

Hierarchy of Controls



Graphic adapted from: CDC NIOSH - https://www.cdc.gov/niosh/topics/hierarchy/default.html

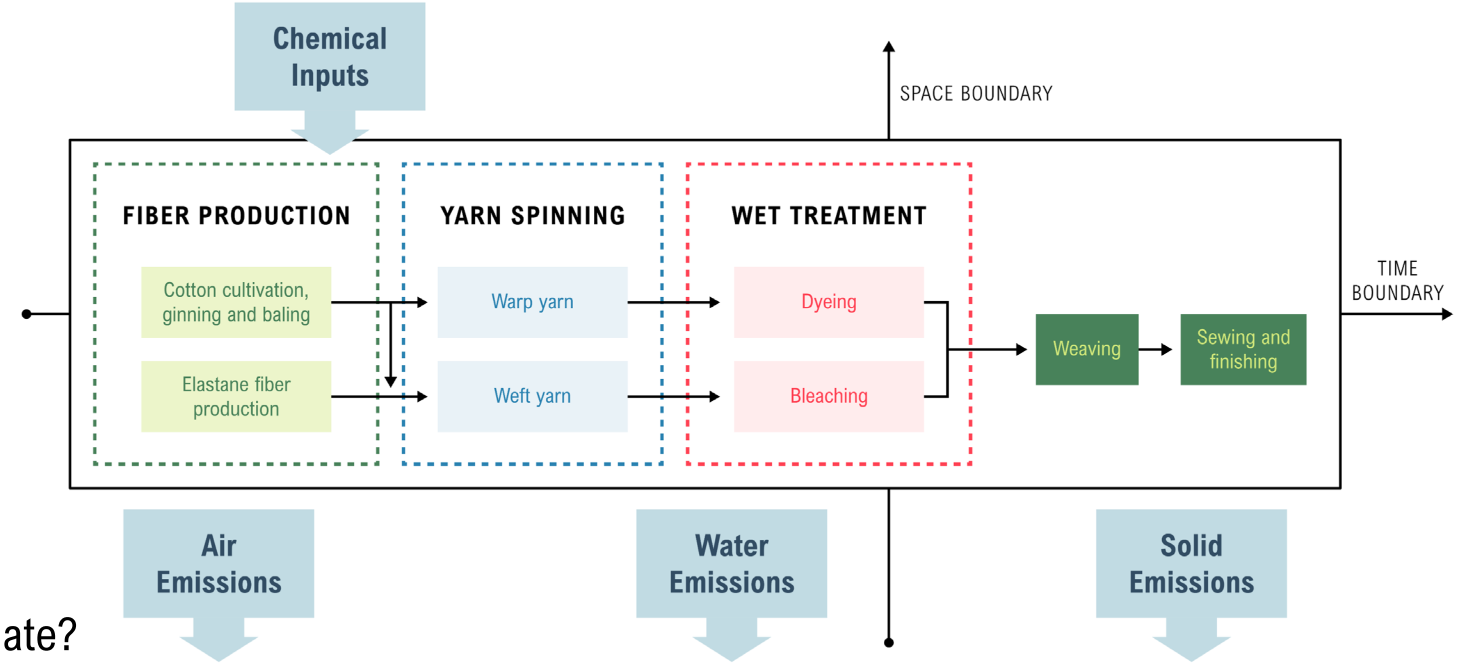
Secure Information Architecture

KEY QUESTION

How do I prevent undesired manipulation of important data?

For our critical functions:

- What is the critical data?
- What systems originate, change, and validate?
- How will data flow?
- How should we group the data flows and data?
- How can we create monitorable boundaries?
- Where are areas of implicit trust?

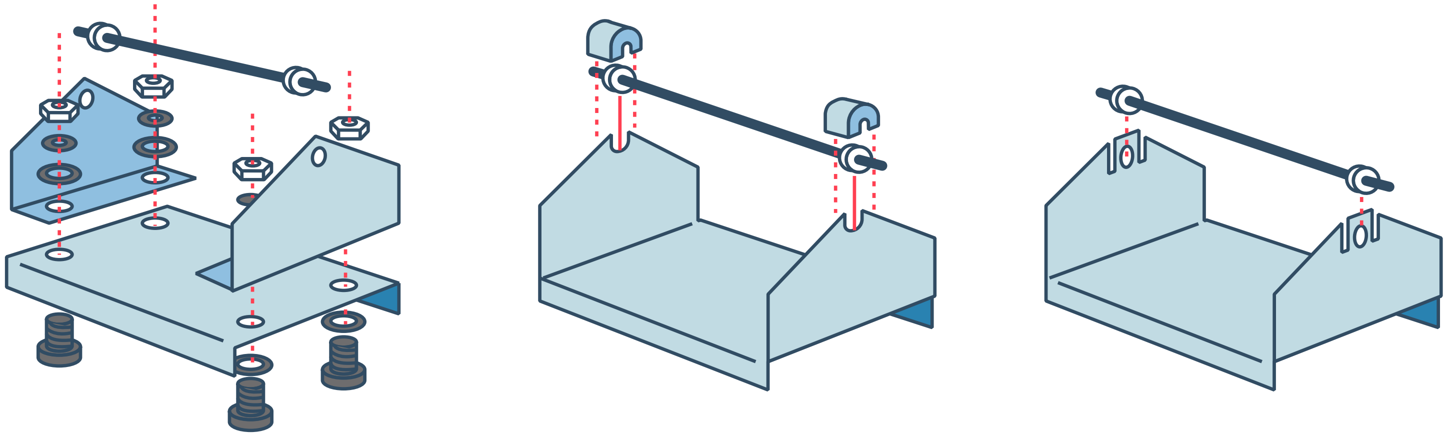


Design Simplification

KEY QUESTION

How do I determine what features of my system are not absolutely necessary to achieve the critical functions?

- Are all of the elements of my design actually required?
- How do I reduce complication?
- What do I lose by simplifying?

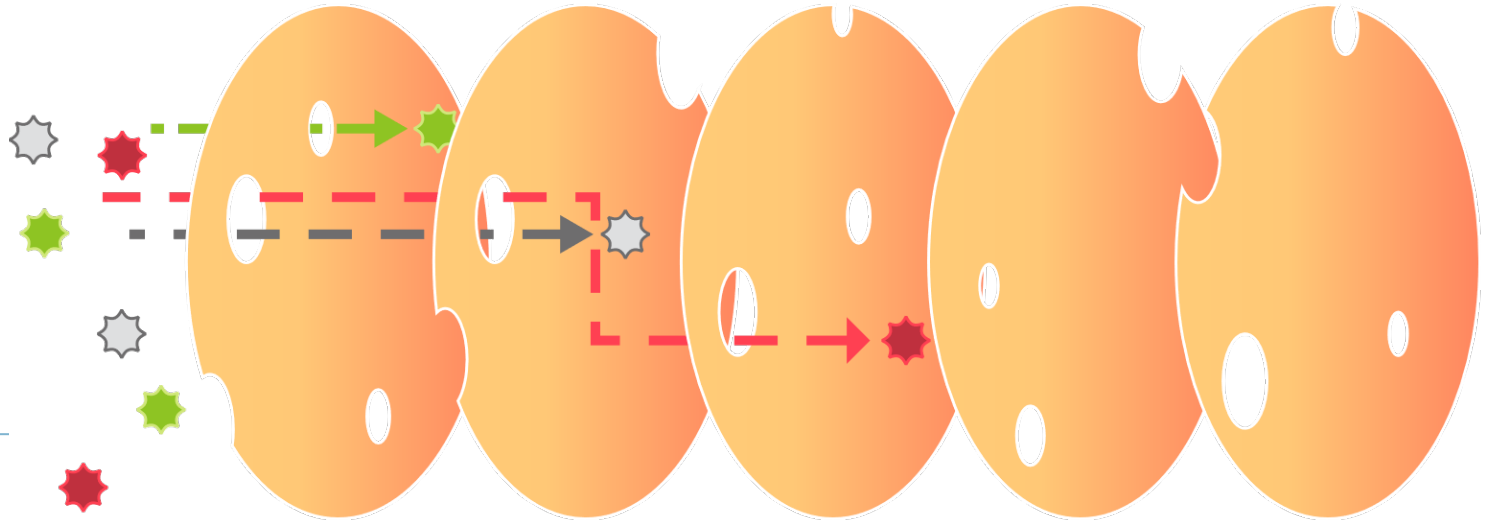


Graphic adapted from: http://www.slideshare.net/BabasabPatil/product-design-ppt-doms

Layered Defenses

KEY QUESTION

How do I create the best compilation of system defenses?



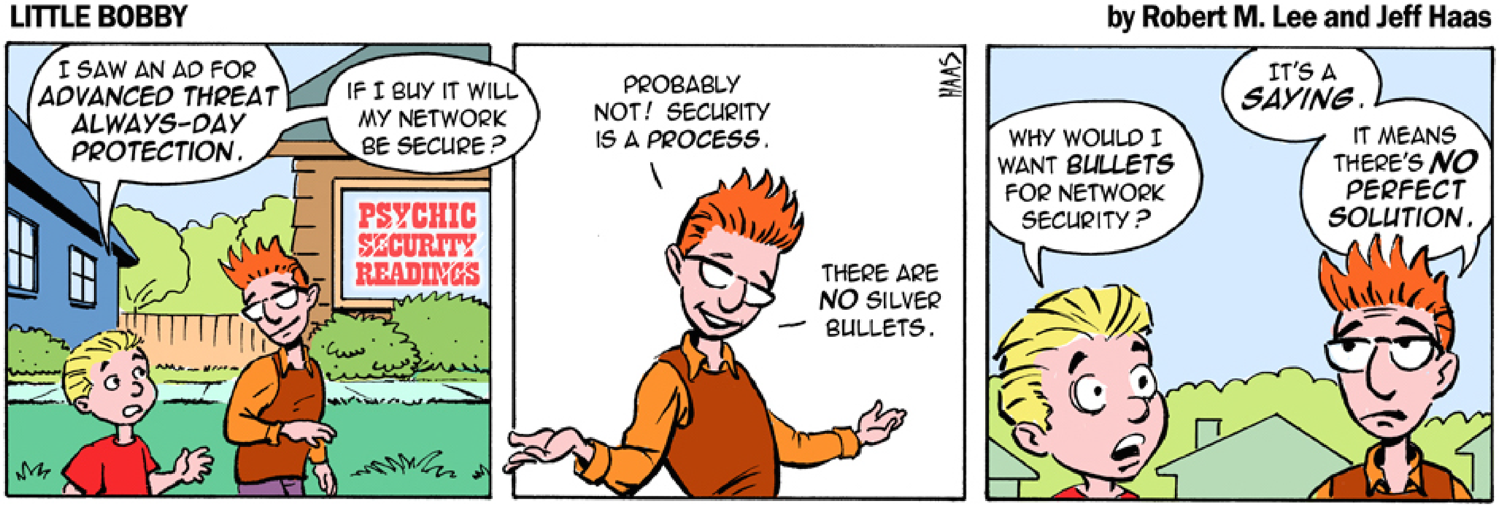
Reason's Swiss Cheese Model adapted from: https://skybrary.aero/articles/james-reason-hf-model

Active Defense

KEY QUESTION

How do I proactively prepare to defend my system from any threat?

- How do I protect what I designed?
- How can engineers and IT collaborate in defense?
- How do we exercise/practice defense?
- Have we developed policies and procedures?


LITTLE BOBBY
by Robert M. Lee and Jeff Haas
I SAW AN AD FOR ADVANCED THREAT ALWAYS-DAY PROTECTION.
IF I BUY IT WILL MY NETWORK BE SECURE?
PSYCHIC SECURITY READINGS
PROBABLY NOT! SECURITY IS A PROCESS.
THERE ARE NO SILVER BULLETS.
HAAS
WHY WOULD I WANT BULLETS FOR NETWORK SECURITY?
IT'S A SAYING.
IT MEANS THERE'S NO PERFECT SOLUTION.

Used with permission from: https://www.recordedfuture.com/active-cyber-defense-part-2/

Interdependency Evaluation

KEY QUESTION

How do I understand where my system can impact others or be impacted by others?

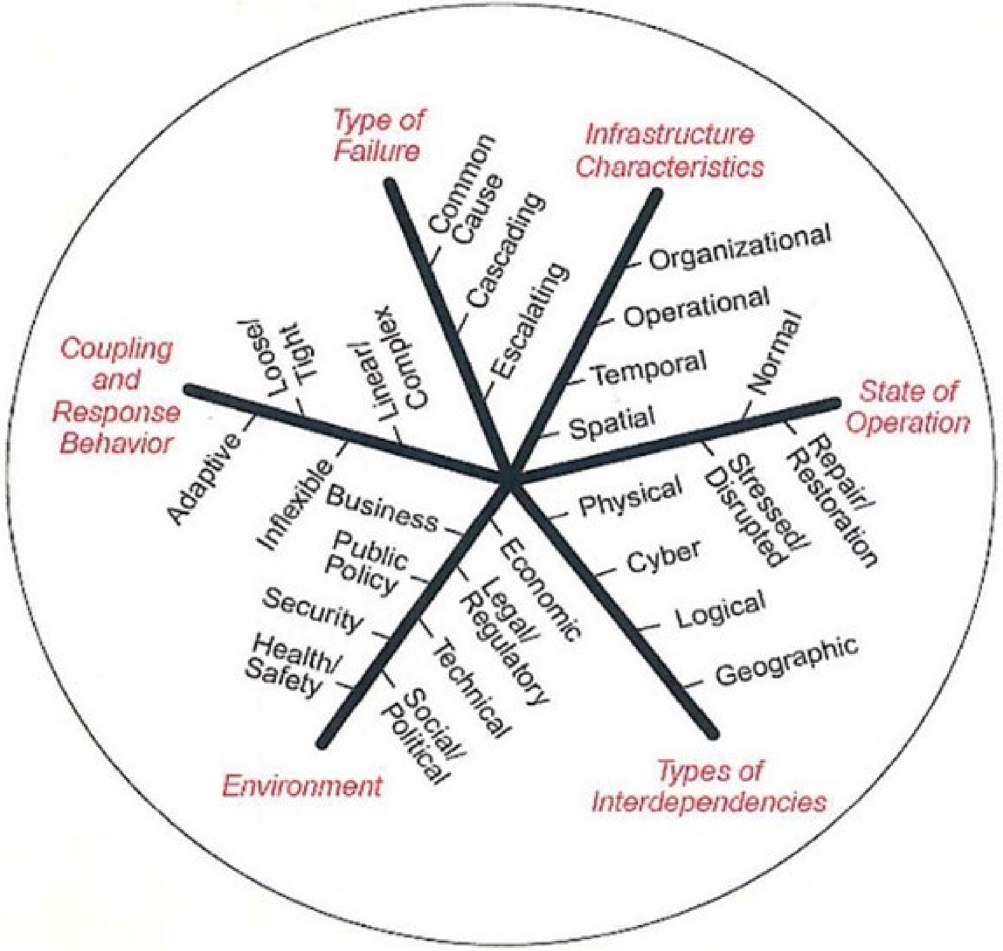


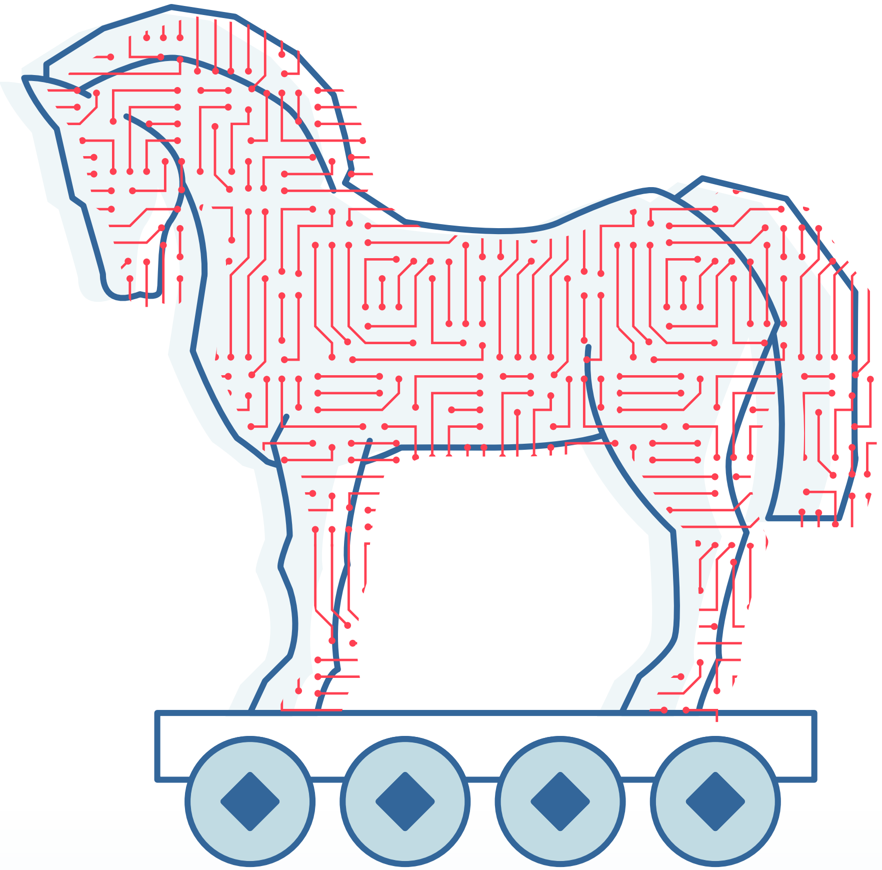
Image adapted from:
http://witandwisdomofanengineer.blogspot.com/2010/11/infrastructure-interdependencies.html

Digital Asset Awareness

KEY QUESTION

How do I understand where digital assets are used, what functions they are capable of, and our assumptions about how they work?

- Digital systems are different from their analog counterparts
  - Turning off features doesn't remove them
  - Digital features area a source of different risks
- One way of tracking risk is keeping an inventory of digital assets
  - Simple? Maintaining accuracy is not simple
- How do you protect this information?

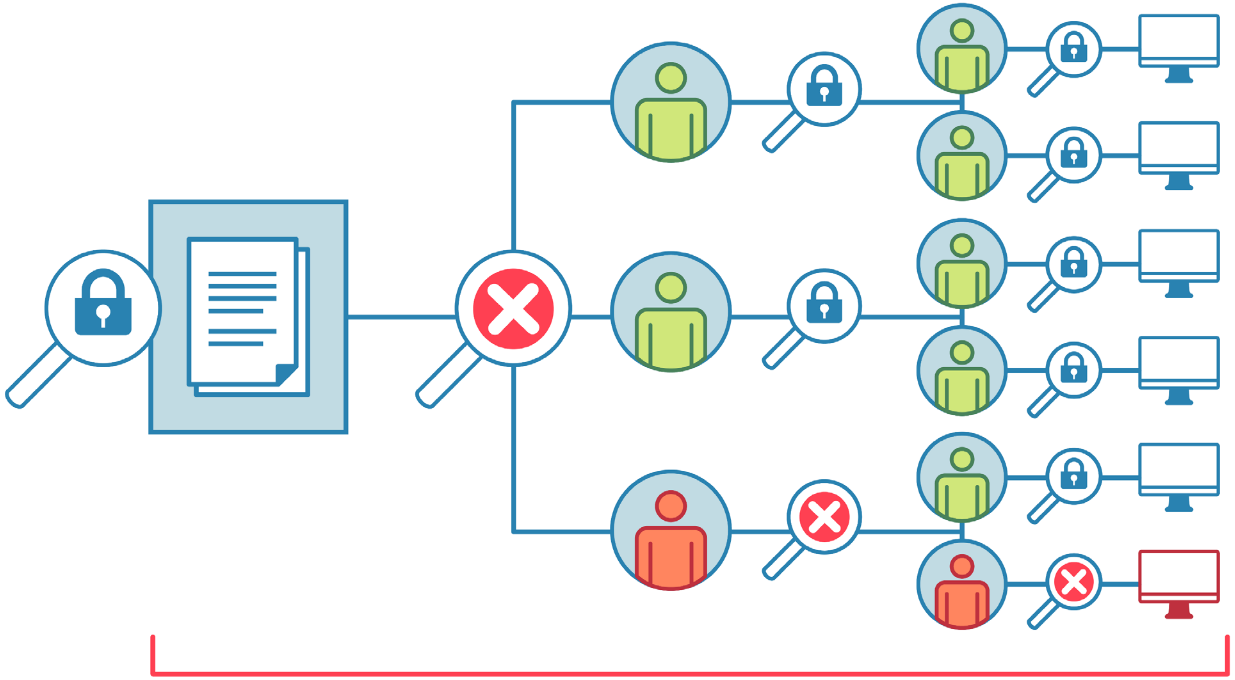


Cyber-Secure Supply Chain Controls

KEY QUESTION

How do I ensure my providers deliver the security the system needs?

- How do cyber security requirements flow to vendors, integrators, and third-party contractors?
    - What assumptions are we making?
- Does procurement language must specify the exact requirements a vendor must comply with as part of the system design, build, integration, or support?
- How do we verify compliance?



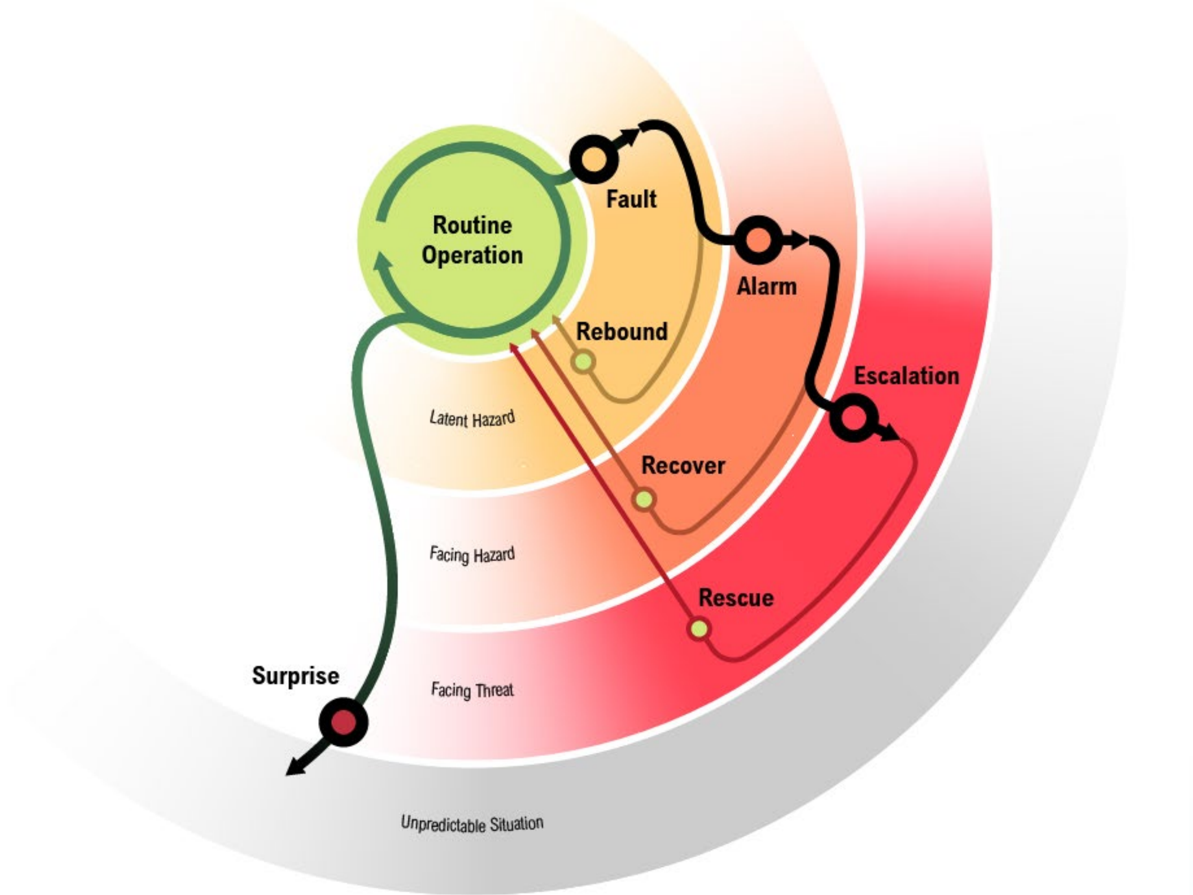
You are only as secure as your least secure vendor

Planned Resilience

KEY QUESTION

How do I turn “what ifs” into “even ifs”?

- What are the limits of acceptable degradation for critical system functions and what alternate operating modes would protect and maintain those critical system functions within acceptable limits?
- How does the organization maintain business continuity and critical function delivery through incident response and recovery?
- How will resilience measures be validated?



Cyber-Informed Engineering

Engineering Information Control

KEY QUESTION

How do I manage knowledge about my system? How do I keep it out of the wrong hands?

- **What** information should we protect?
- **Who** has and should have it?
- **How** do we protect it?

Image from: https://www.uscomputer.com/2016/02/16/employee-education-thwarts-social-engineering-threat/

Organizational Culture

KEY QUESTION

How do I ensure that everyone's behavior and decisions align with our security goals?

- Include cyber security into engineering and engineering into cyber security
- Ensure entire staff is enlisted and endorses cyber security
- Ensure staff understand and follow processes and procedures
  - All it takes is one user to lower security posture
- How do we encourage a questioning attitude?
- How can we provide the same rigor for cybersecurity as physical protection security and safety?

Conversations

Explicit Assumptions

Collaboration on Projects

Assessments

Scenarios

Exercises

Questions?