TEXAS A&M CYBERSECURITY CENTER

Society of American Military Engineers

A New Way of Thinking: Consequence-driven, Adversary-tolerant Lifecycle Engineering

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TEXAS A&M UNIVERSITY

Texas A&M Cybersecurity Center (TAMC^2) Mission:

Make outsized contributions to social good by:

- **Producing highly skilled cyber leader-scholars**
- **Facilitating the conduct of ground-breaking, basic and applied cybersecurity research**
- **Developing novel and innovative methods for cybersecurity education and work force development**
- **Building mutually beneficial partnerships with commercial, governmental, and academic partners**

Inquiring Minds...

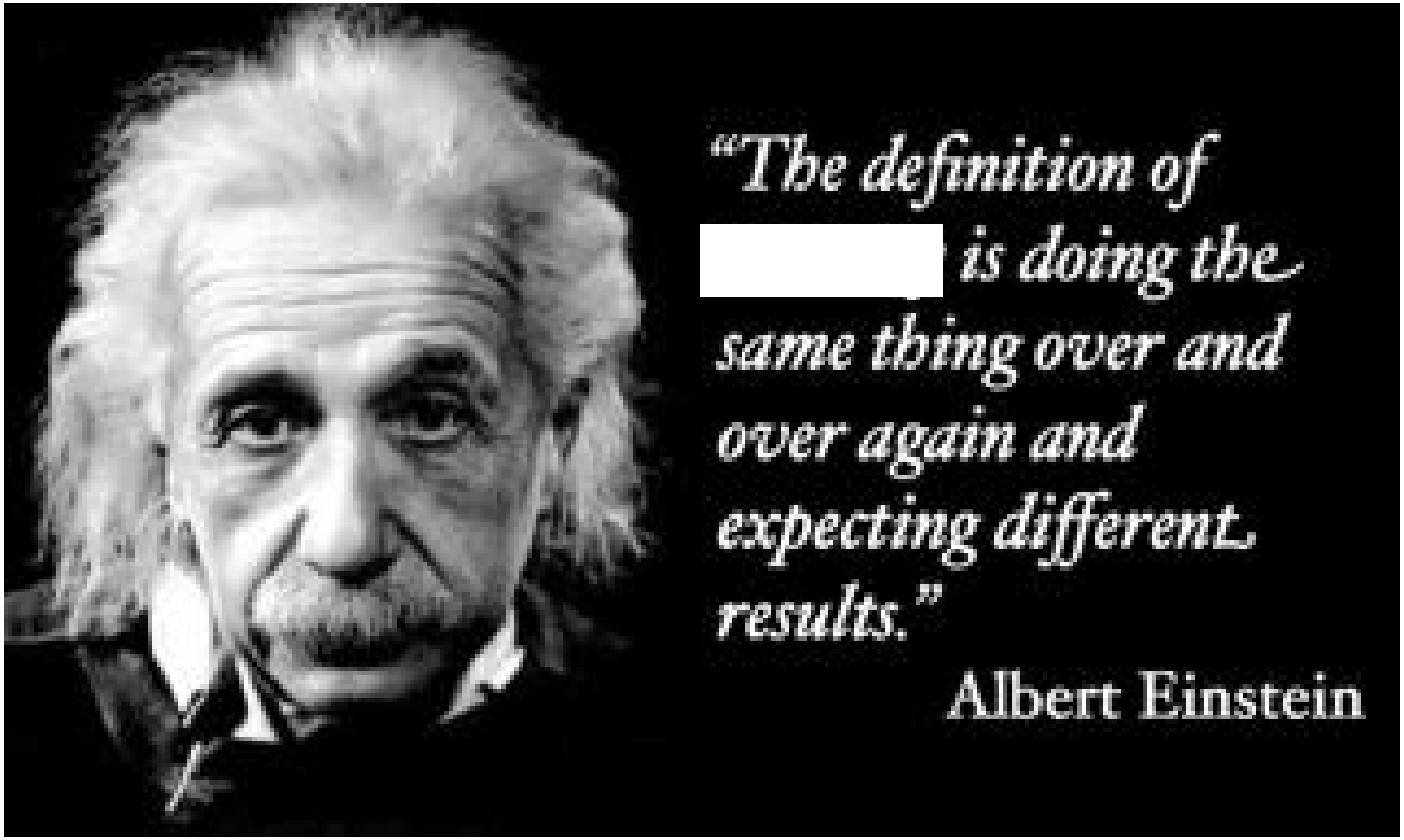
- Are we increasingly dependent on cyber systems?
- Are we disproportionately dependent on cyber systems
- Are we losing ground?
- Why?

Fill in the Blank...

- _____ Infrastructure
- _____ Cites
- _____ Roads
- _____ Bridges
- _____ Power Plants
- _____ Cars
- _____ Homes
- _____ Thermostats
- _____ Crock Pots
- _____ Engineers

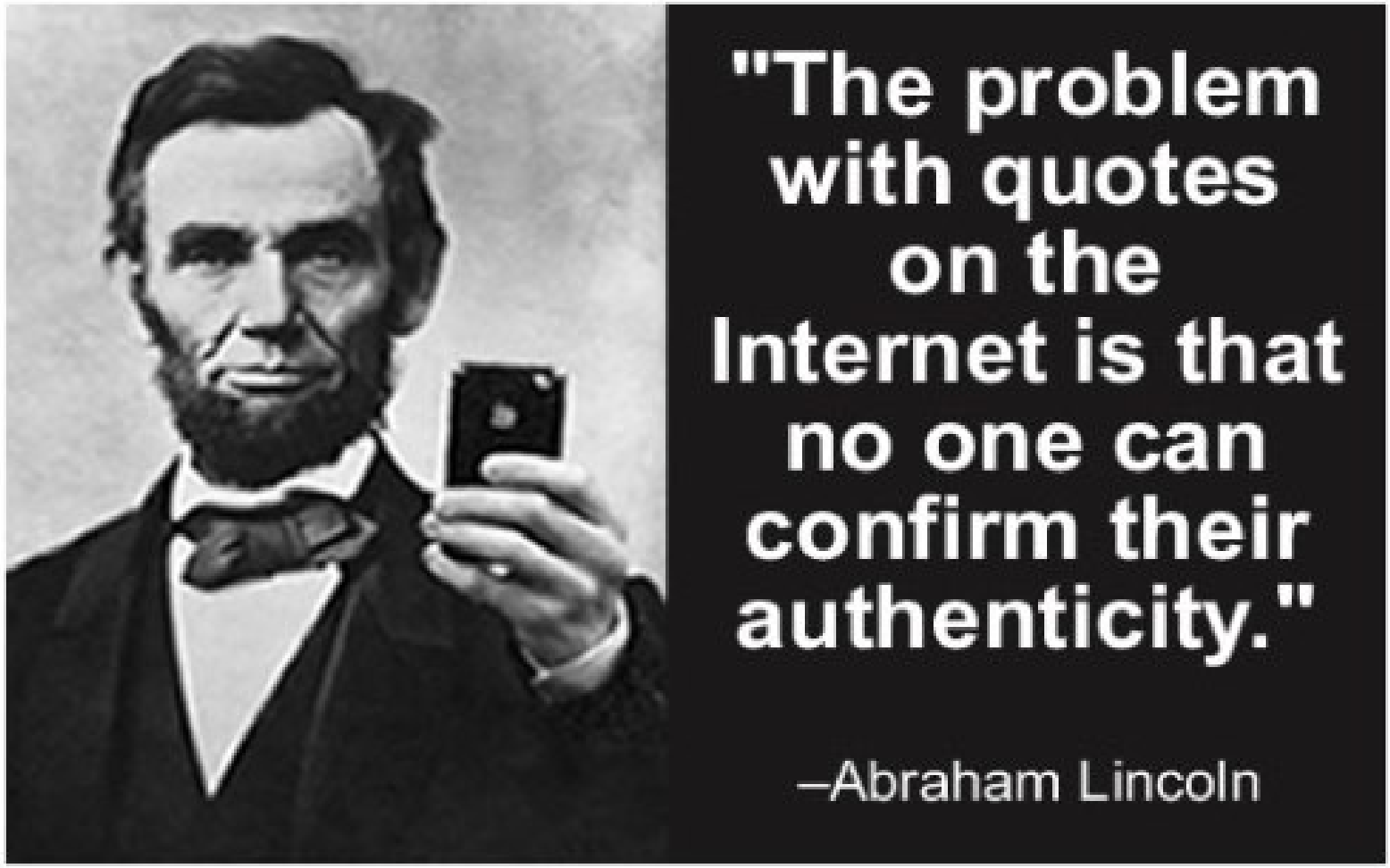
https://gcn.com/~/media/GIG/GCN/Redesign/Articles/2017/January/smartinfrastructure.png

Obligatory Einstein Quote



http://www.stridentconservative.com/wp-content/uploads/2016/11/Albert-Einstein-Insanity.jpg

Obligatory Lincoln Quote



https://dragonscanbebeaten.files.wordpress.com/2015/11/the-problem-with-quotes-on-the-internet.jpg

What we've been reading…

"Hacking Nuclear Systems Is The Ultimate Cyber Threat. Are We Prepared"

~The Verge, 23 Jan 2018

- "Unless we start to think more creatively, more inclusively, and have cross-functional thinking ...we're going to stay with a very old-fashioned [security] model ..."
- "[We don't] have the luxury of banking on probabilities...even a minor attack ... could further erode public confidence."

What we've been reading…

"Hacker takes control of hundreds of rooms in hi-tech 5-star Shenzhen hotel"

~South China Morning Post, 29 July 2014

- "A San Francisco-based cybersecurity expert claims he has hacked and taken control of hundreds of highly automated rooms at a five-star Shenzhen hotel"
- "I'm an ethical hacker... explaining why he didn't immediately plunge the entire hotel into darkness or switch every television to the same channel."

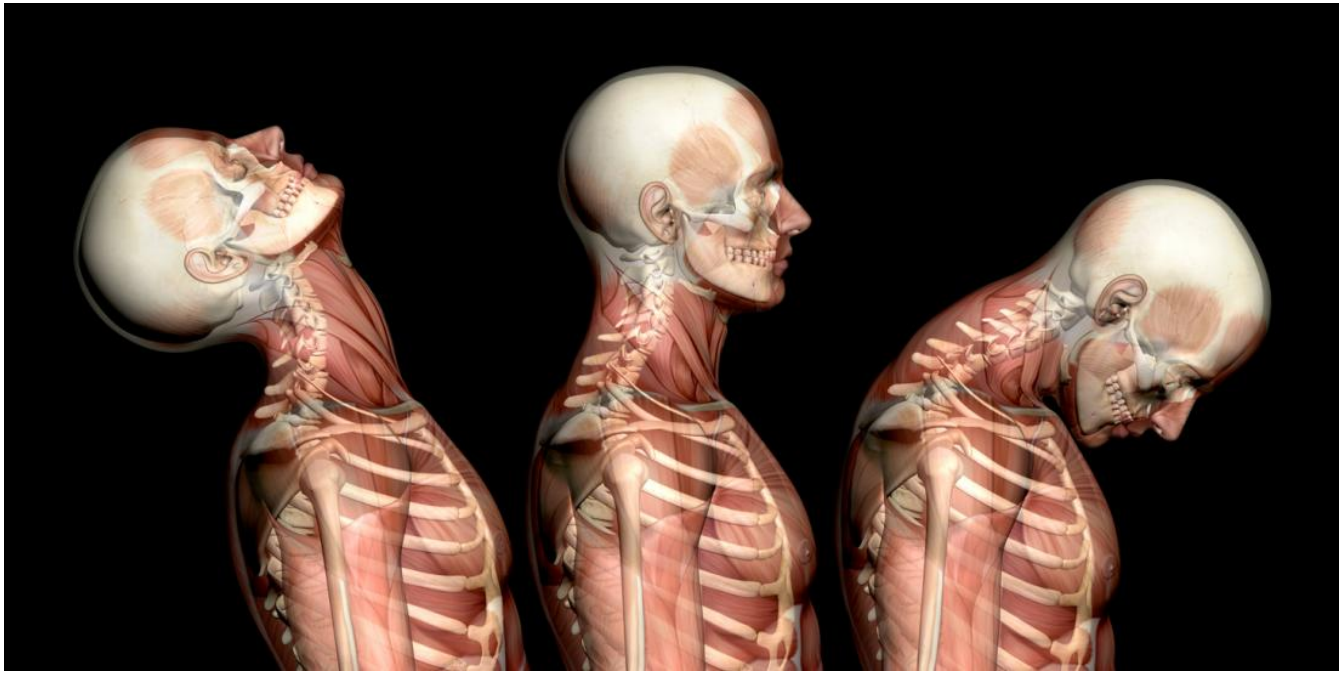
Definition System Lifecycle

Includes all phases of system to include:

- System conception
- Design
- Development
- Production
- Operation
- Maintenance and support
- Retirement
- Phase-out and disposal [1]

[1] Blanchard and Fabric *Systems Engineering and Analysis, Fourth Edition*. Prentice Hall. 2006, p. 19.

Warning: Whiplash Alert!



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Commander/Staff Actions During an "Operation's Lifecycle"

- Planning and Execution
- Risk Management
  - During Planning:
    - MDMP - "Operation Design"
      - COA Development / Analysis Selection
      - War gaming
  - During Execution:
    - Continuously monitoring and ongoing assessment of red and blue activities
- They manage risk, in part, by continuously listening to...

  ...the voice of the adversary!

Definition: Risk

- **"The anticipated [and quantifiable] loss or damage to an asset associated an event"**

Risk Components?

- P(Event)
- Impact(Event)

Risk Strategies

- **Accept**
- **Avoid**
- **Transfer**
- **Mitigate**
  - Reduce
    - probability (likelihood)
      and/or
    - consequence (impact)

https://www.google.com/search?biw=1707&bih=844&tbs=isz

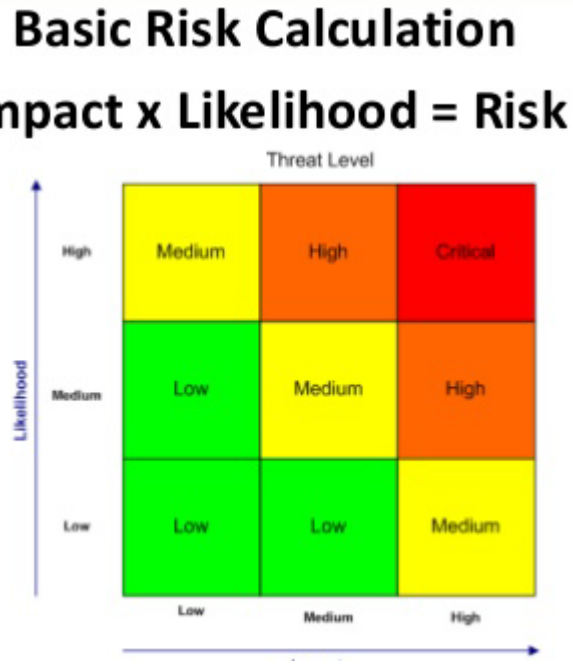
Cyber Risk

"The anticipated quantitative loss or damage to an asset associated with a specific cyber threat event(s)"

https://www.cybersecurity-insiders.com/wp-content/uploads/2017/12/CYBER-RISK-custom-general-1.jpg

Risk Associated with a Cyber Threat Event (CTE)

- **A Function of:**
  - P(CTE)
  - Consequence(CTE)
- **Mitigate a cyber risk?**
  - Reduce the probability (likelihood) AND/OR
  - Reduce the impact (consequence)



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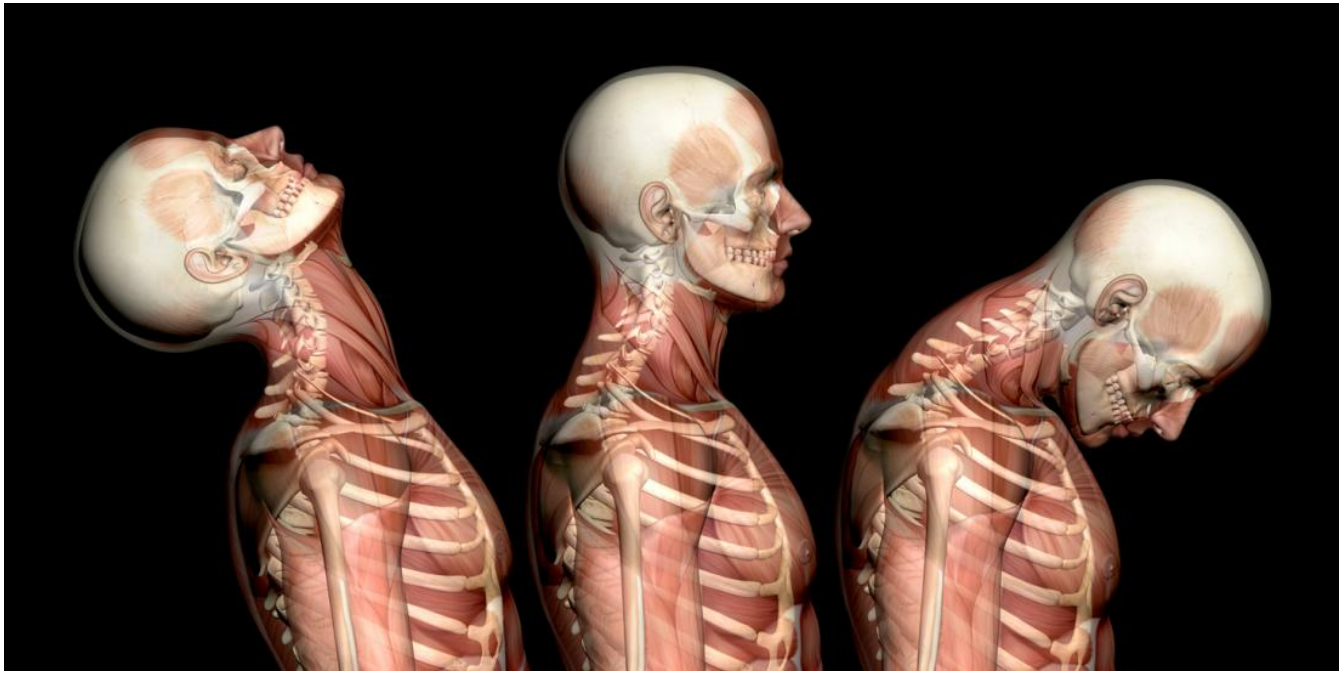


https://cdn1.medicalnewstoday.com/content/images/articles/174/174605/whiplash-anatomy-diagram.jpg

Risk Associated with a Cyber Threat Event (CTE)

Risk(CTE) = P(CTE) * Consequence(CTE)

- P(CTE) is a function of
  - P(The vulnerabilities associated with a CTE are present)
  - P(Threat has the capability and intentionality to cause a CTE)
  - P (Threat has access to the vulnerabilities that are associated with a CTE)
- Consequence(CTE) is influence by:
  - Plan/Design
  - Operational Decisions
- I.e., an "operation's lifecycle"

Risk Perspectives

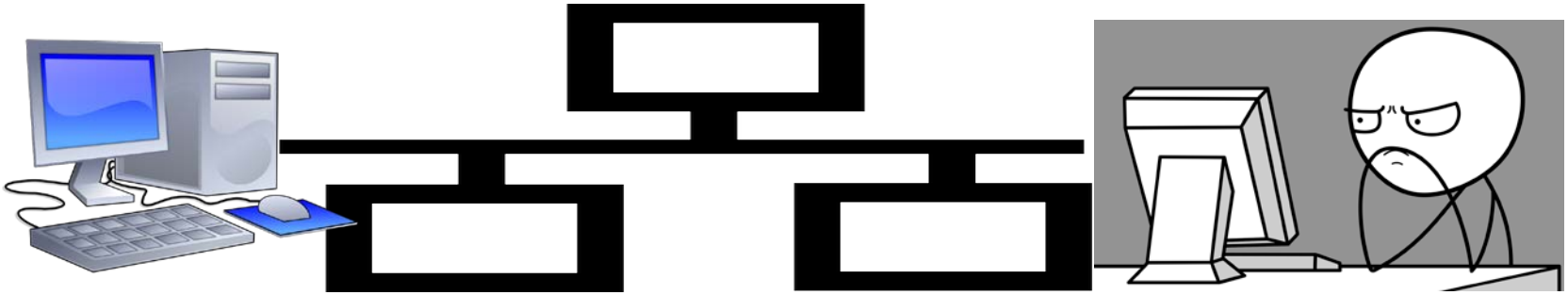
Assets

Threats

Consequences
Vulnerabilities

Accessibility

Capability and Intentionality



Inward Looking

Inward and Outward Looking

Outward Looking

How does these cyber risk considerations relate to design?

Why Do Systems Fail?

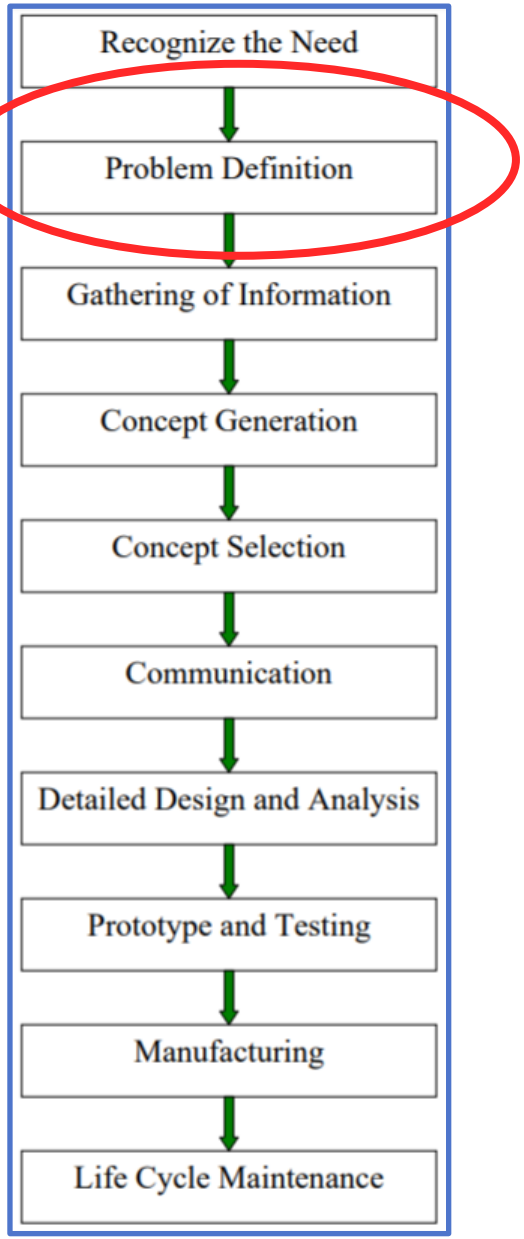
- **Bad design!**
- **What contributes to bad design?**
  - **Invalid assumptions**
  - **Lack of knowledge**
  - **Sole focus on functionality**
    - **In cyberspace, failure to understand and adequately consider vulnerabilities, threats, and consequences**

https://static.seattletimes.com/wp-content/uploads/2015/11/eedc84cc-84e0-11e5-b53b-a576789c5b7f-780x605.jpg

Elements of Design

Fundamental elements of the design process:

- Establishment of objectives and criteria
  - Assumptions
  - Constraints
- Synthesis
- Analysis
- Construction
- Testing and evaluation [ABET]



The Root Cause of the Cybersecurity Problem...

- **The most serious of all invalid design assumptions and famous last words:**
  - **"No one would ever..."**
  - **"That can't happen..."**

So how can we do better?

Tolerance for Failures

- **Fault Tolerance:**
  - **The ability to continue to function correctly in the presence of component failures caused by random events**
- **Adversary Tolerance:**
  - **The ability to continue to function correctly in the presence of component failures caused by [purposeful and ongoing] adversary activities**

Continuous Cyber Consequence Analysis

- Identify set of negative consequences
- Determine the adversary actions that could produce the consequence
  - Requires knowledge of adversary cyber tactics, techniques, and procedures (TTPs)
    - Aka Kill chain, plays, etc.

Consequence-driven Adversary Tolerant Life Cycle Design

- Focus on consequences
- Always include an adversarial perspective
  - "Voice of the Threat"
- Conduct continuous formal and Informal "War gaming"
- Analyze EVERY lifecycle decision, in all phases, to determine the degree to which the decision influences risk
- More broadly, perform continuous risk assessment throughout a system lifecycle taking into account:
  - Consequences
  - Threats
  - Accessibility
  - Vulnerabilities

Questions?