IARIA Work Group Meeting: Advances on Systems

Topic : Robustness in Real-time Complex Systems

Moderator: Gary Weckman
Ohio University
USA

Robustness in Real-time Complex Systems

- What is complexity?
  - Interactions?
  - Defy understanding?
- What is robustness?
  - Predictable performance?
  - Ability to absorb change?
- Robustness in:
  - Behavior?
  - Modeling?

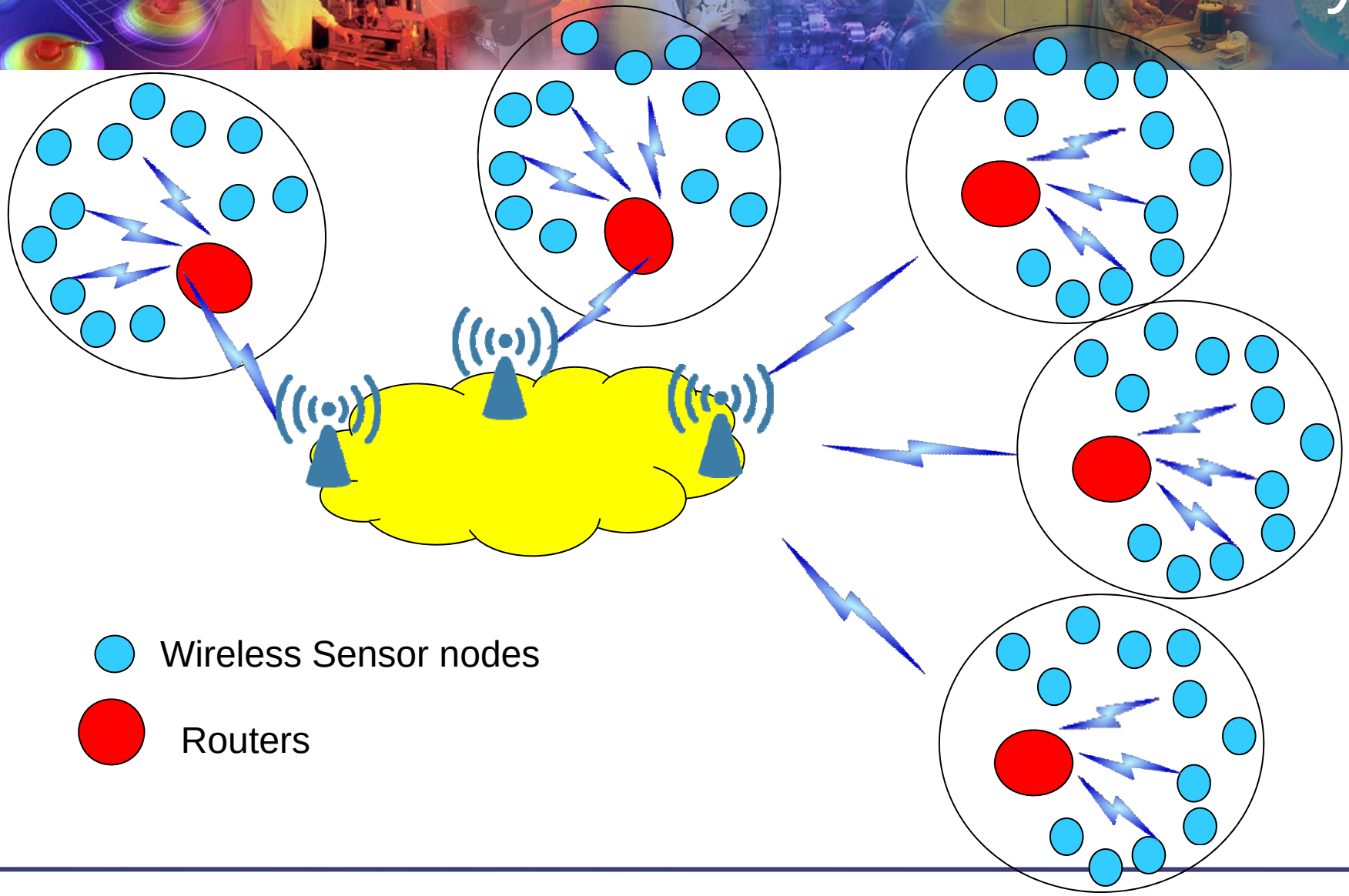
Expert Panelists

- Gary Weckman , Ohio University, USA
- Marko Jäntti, University of Kuopio, Finland
- Daniela Dragomirescu, LAAS-CNRS, University of Toulouse, France
- Andy Snow, Ohio University, USA
- Discussion and Q&A Session

Robustness in Real-time Complex Systems: WSN case study

Daniela Dragomirescu
LAAS-CNRS, University of Toulouse
France

Wireless Sensors Network case study



WSN - Complex systems

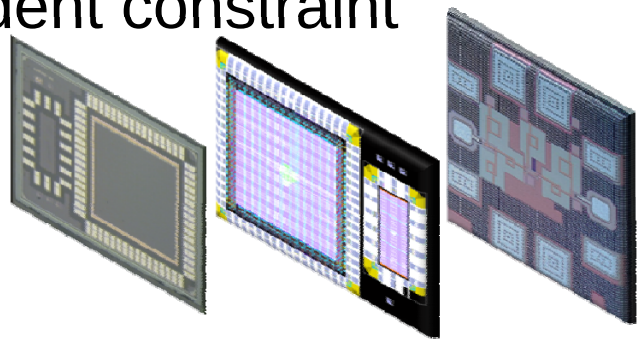
- WSN – very high number of nodes → complex systems, network
- Supposed to work for very different applications
  - One system, communicating sensor node, can answer to very different applications ?
  - Which will be the complexity of such a node?
  - The energy consumption ?
- Constraints are applications dependent
  - Real-time – very important constraint application for WSN for metrology ar
  - Localization
  - Synchronization
  - Safety of the communications
  - Security of the communications

Robustness

very important for WSN in aeronautics

WSN –complex systems

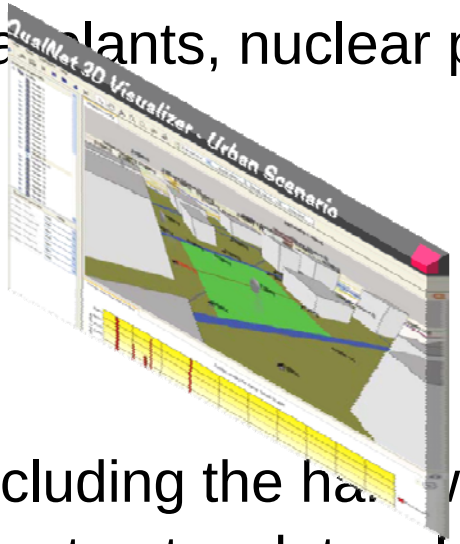
- To answer to the application dependent constraint →reconfigurable hardware



- Hardware robustness ?
  - Simulations using models, testing using models
  - Digital and analog hardware on the same chip →SoC modeling (VHDL-AMS) has to be developed
  - User experiences → back-annotation to hardware models
- WSN implies hardware and software elements
- Co-design hardware software – needs of very accurate models

WSN – complex systems

- Testing in labs (arround 10 nodes) - demonstrate the principle of the hardware developed systems and software protocol.
- How to predict the functioning of more than 1000 nodes in different environments (aircrafts, satellites, industrial plants, nuclear plants, etc)
- What robustness for such a system ?



- Network simulator has to be developed, including the hardware layers and the channel propagation. Determine best network topology.
- How accurate will be the first models we will include in the simulator ?

WSN – complex systems

- Models and their accuracy is a key point !
- Taking into account from the beginning hardware and software developments and their connections.
- Real testing can’t be replaced !

Thank you !

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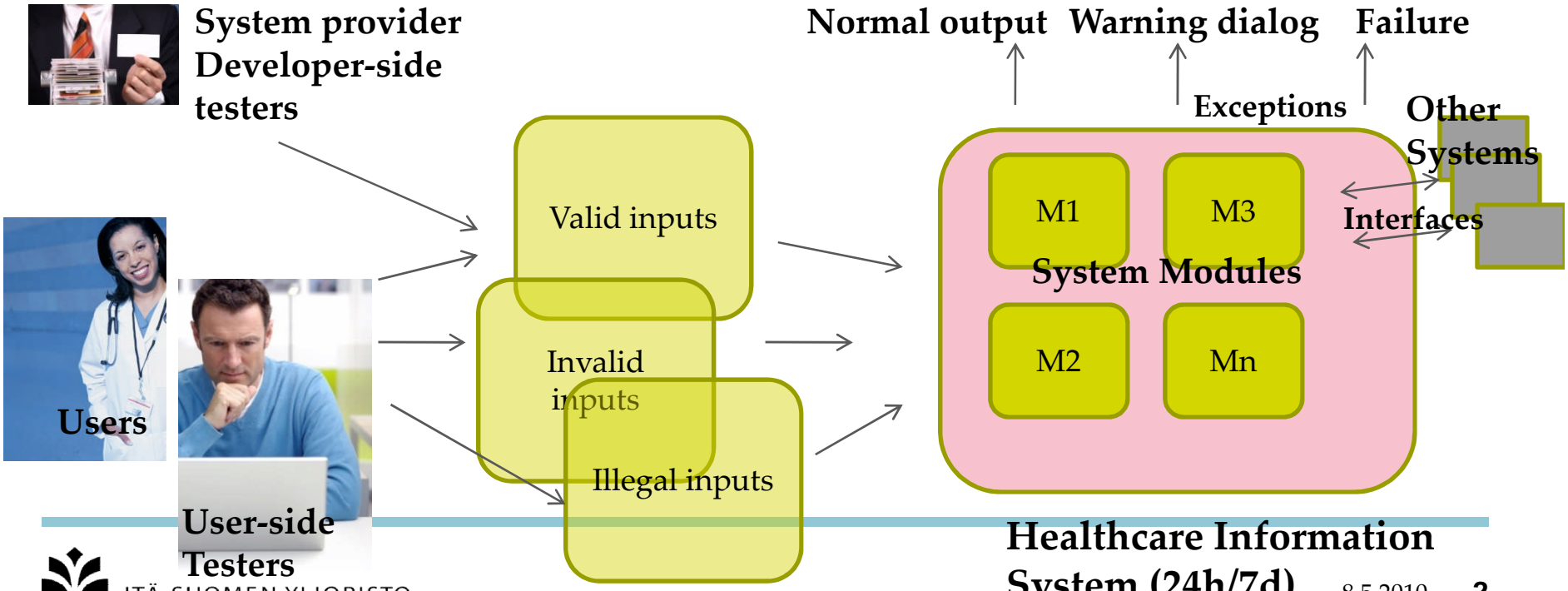
Marko Jäntti, ICONS 2010 panel

Robustness in Real-time Complex Systems: Testing-based approach

ITÄ-SUOMEN YLIOPISTO
UNIVERSITY OF EASTERN FINLAND

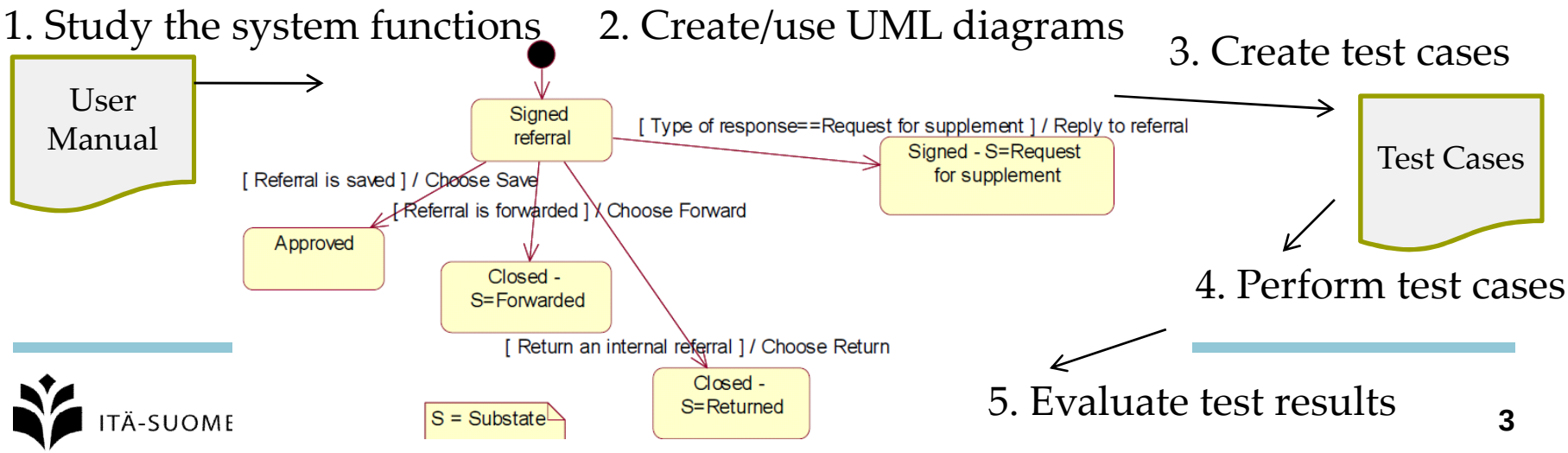
Robustness in Software Engineering

- Definition of Robustness [FDA]:
  - "the degree to which a software system or component can function correctly in the presence of invalid inputs or stressful environmental conditions."



UML-based Test Model: A Case Study

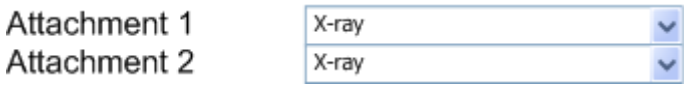
- Case organization: A large university hospital in Finland
- The system under test: a healthcare information system
  - Medical referral module
  - Resource management module
  - Time booking module
- The research goal: to identify system defects through the UML-based test model



Case study results

A test case with ”Invalid” input

- Testing revealed
  - one serious defect (Run-time error 6160) in the Resource Management module
  - two serious defects (Run-time error 438) in the Referral module
  - numerous usability problems



  - poor robustness (the modules did not recover after run-time errors)
- **How to improve robustness of systems?**
  - Better exception handling
  - More focus on the use of test models

Thank you!!

- Contact:
  - Marko Jäntti, PhD.
  - marko.jantti@uef.fi

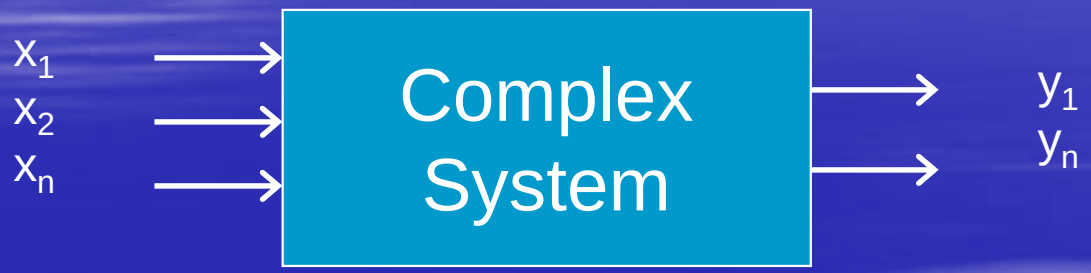
Avoiding, Accepting and Influencing Complex System Behavior

Andy Snow
School of Information & Telecommunication Systems
Ohio University

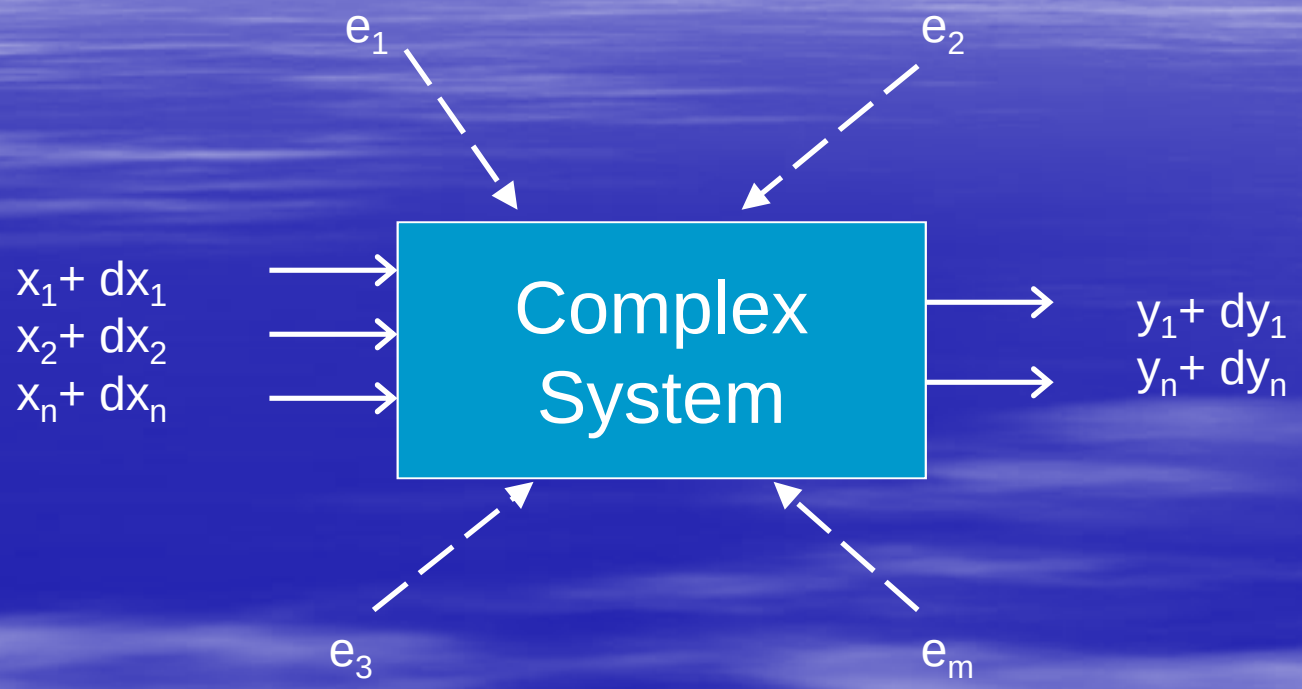
Complex Systems

- Examples
  - Internet, PSTN
  - Electric Power (generation, grid)
- Unforeseen stimuli
  - Internal
    - Latent defects and vulnerabilities
    - Hidden instabilities
    - Scalability limitations
  - External
    - Traffic intensity and mix
    - Other system interactions
    - Socio-political-economic interactions
    - Natural disasters
- Users demand robustness

Black Box



Black Box Robustness



- dx or Dx …… e or E
- Random deviations…..erratic outputs?
- Random or rare externalities…..erratic outputs?

Lifecycle Robustness

- User requirements
- System requirements
- Architecture
- Component Specification
- Detailed Design
- Deployment
- Operations

Robust Models

- Can we really model complex system behavior?
  - Can we enumerate all internal and external operating conditions?
  - Exhaustive testing and modeling prior to deployment possible?
  - Performance Perturbations vs. Loss of function or availability?
- “All models are wrong. Some are useful”

Complexity and Robustness

- "There is ….struggle between complexity and robustness in both evolution and human design. "
- "A….*survival imperative*, whether in biology or engineering, requires…..fragile systems become more robust."
- "…mechanisms to increase robustness will…make the system considerably more complex."
- "…..additional complexity brings with it its own unanticipated failure modes….."
- "This balancing act between complexity and robustness is never done."

Irving Wladawsky-Berger Posted on August 25, 2008 at Complex Systems, Innovation, Technology and Strategy

What's a Systems Engineer To Do??

Complexity ↑

Robustness ↓

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1. Avoid complexity
   (KISS)

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1. Avoid complexity
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2. Accept complex system behavior
   (Live with it) "Normal Accidents"

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1. Avoid complexity
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2. Accept complex system behavior
   (Live with it) "Normal Accidents
3. Influence complex system behavior
   (Try to predict and avoid outlier behavior)

What's a Systems Engineer To Do??

Complexity ↑

Robustness ↓

1. Avoid complexity
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Yes…….all three!!!!!