System Engineering

Self-Sustaining Systems

- A system that maintains its own health and protects itself from attack, perhaps by monitoring its own status and acting on anomalies

- robustness in the face of faults- human and otherwise

Self-Sustaining Systems

- biologically inspired mechanisms

- engineering

- models and/or reasoning

Biology

- diversity

- redundancy

- anti-redundancy

- biological modularity

- spatial compartmentalization

Biology

- gradients

- decay/excitation

- abundance

- randomness (swarms)

Biology

- stigmergy

- apoptosis (programmed cell death)

- evolution/fitness landscapes

- symbiogenesis (Elysia viridis, lichens)

Biology

- growing systems (both with and without programming)

- horticulture

- homeostasis/repair

Engineering

- writing correct programs is hard

- writing to correct requirements is impossible

Engineering

- modularity (in the face of changing context)

- encapsulation

- abstraction

- eg, static typing (anti-redundancy)

- eg, aspects (biological modularity)

Engineering

- dynamic adaptation (eg, learning what people mean by preferences- what does red mean to you?)

- test-driven design-planning how to recognize correct behavior & problems through instrumentation

Engineering

- feedback

- building systems from modules
  (using self-awareness)

Models & Reasoning

- formal models to check validity- range of acceptable systems behavior

- reasoning about the past and results-and about the future and checking predictions

Models & Reasoning

- construct models down to some level, then generate (grow) the levels below

- parts need to understand their roles & negotiate with other parts

- in some systems, there is no possibility of global control-parts need some autonomy

Attacks

- fault => error => failure

- fault => error => alternative

- hard to detect and diagnose (faulty data)

- attacks might be indistinguishable from bugs

Attacks

- defense without diagnosis possible

- quick, reactive defense => deliberation and retraction/repair

- diversity (diverse instruction sets; obfuscation)

Levels

- biological

- engineered

- reflective

Levels

- biological
  - totally reactive
  - quick
  - sublogical
  - fight/flight
  - error prone

Levels

- engineered

  - deliberation

  - compositional semantics

  - stimulus generalization

  - hypotheses about past/future

  - long-term perceptions & behaviors

Levels

- reflective

  - ability to represent systems of information management

  - meta-management

where I'm from...