

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. . .

