Systems Integration

3 - Heuristics as Tools

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Source: A significant part is from Mark W. Maier and Eberhardt Rechtin's *The Art of Systems Engineering 3rd Ed*

Introduction

An exaggeration

- Engineers compute
- Architects use heuristics

Reality is a mix

- How do you debug hardware or software?

Heuristics: a collection of tools

- There are many tools
- Select the right tool for the right problem

Abstractions of experience

Human race

- Ability to learn ...
- ... and to pass on knowledge to future generations

Formulation

- $E = mc^2$
- Heuristics are expressed in natural language
- They are an extension of anecdotes, stories, fables and myths: they become a self-evident truth
- It fits one's model of the world
- First, you nod. Then, you recall a personal experience that strengthens it.

First Four Heuristics

Basic set of heuristics

- Do not assume that the original statement of the problem is necessarily the best, or even the right one
- In partitioning, choose the elements so that they are as independent as possible; that is, choose elements with low external complexity (and high internal cohesion)
- The eye is a fine architect. Believe it. Simplify. Simplify. Simplify
- Build and maintain options as log as possible in the design and implementation of complex systems. You will need them

Extending the set

Eliminate personal opinions, corporate dogma, anecdotal speculation, mutually contradictory statements...

- Must make sense. Correlation between heuristic and successes or failures
- The general sense should apply beyond the original context
  - *Do not assume*
  - *Before the flight it is opinion; after the flight it is obvious*
- Should be easily rationalized in a few minutes/lines of text
  - *If you can't explain it in five minutes, either you don't understand it or it doesn't work*
  - *A model is not reality*
- The opposite should be foolish: *If it can fail, it will*
- The lesson should stand the test of time
  - *The beginning is the most important part of the work (Plato)*
  - *All the serious mistakes are made the first day*

Using Heuristics

- Virtually everybody uses heuristics (knowingly or not)
- Can they be communicated for others to use?

Usage

- Evocative guides. They evoke new thoughts. Read the set of heuristics when faced with a new problem. Pick one that seems suggestive
- Codifications of experience. Heuristic is a heading of a story
- Integration into development process. Design is a series of steps –heuristics are attached to each step