George Mason University

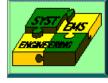# SYST 101: Intro to Systems

Lecture 17

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Agenda

- Trouble shooting projects

Review of Key Points

- Three Step Process (or any other process of your choice)
  - Trial
    - Create, Build, Use
  - Evaluate
    - Observe, compare, decide
- Iterate with models
  - Build the real thing when the performance is good enough

Review (cont)

- Trouble occurs when
  - Reality doesn't match the model
    - It doesn't do what the model says it should
  - The model doesn't match reality

- The first inclination is to say the unit has faulty performance
  - But, the unit's performance (reality) always conforms to the way it is built and used

Why Doesn't It Work?

- The model is wrong
- The model is not sufficiently accurate
- The entity doesn't match the model
- The entity is broken

- So what's wrong, the model or the entity? Or both?
- What to you do about it?

Good vs. Bad Practitioners

- What makes a good auto mechanic?
- What makes a good doctor?
- What makes a good flight controller?
- What makes a good TV repairman?
- What makes good "street smarts"?

- What makes a good system engineer?
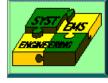 - And why is this job harder?

The Secret Ingredient

- There is a critical element in the evaluate block essential to explaining reality vs the model
  - ***OBSERVE*** the operation of the entity
    - Note the differences between reality and the model
    - Identify the (possible) cause of the differences
  - Formulate (guess) a "solution" that addresses the causes for the differences
  - Analyze the solution
  - Interpret the analysis to see if the solution is adequate

Why?

- In order to make a better guess you need to understand the difference between the model's performance and the entity's

- To do this you need to understand what the model says it should do and what the entity does

- You have to observe the entity to understand what it is doing!

Quality of the Observation

- Sufficient detail to hypothesize what is causing the observed anomalous behavior
  - Why is it doing what it is doing
  - As usual, the needed quality of observation depends on the situation

Decide What is Wrong

- Are the anomalies caused by a wrong or an inaccurate model
  - You did document the model and the supporting assumptions didn't you?

- Did you build what you thought you were building?
  - You do have the plans and programs don't you?
  - You did follow the plans and programs didn't you?

- Is the entity broken?

Problems With New Stuff

- If it ever worked before, then something is broken now

  - What single "failure" could cause all (or most of) the anomalies

- If it never worked the question is whether it is broken, or could ever have worked at all, or is even what you think it is

  - This is why engineering new things is harder

Observe – Think - Do

- Think before you make changes
  - Do you have a rationale for what caused the difficulties? Really?
  - Does the "fix" address the cause?
  - Should the "fix" solve all the problems?
- Only then apply the fix
  - Document the fix
- Observe and document the results

Retest

- Note the last bullet on the previous slide
    - Observe and document the results
- After you change the model/entity you should retest the model/entity
    - Did the change work? Should you keep it?
    - Was the anomaly's cause mitigated
    - Were there other unanticipated changes
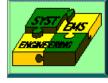   - Pollyanna or Cassandra

And the Answer --

- Depends on the situation
- You have to cultivate the ability to observe accurately and adapt
  - Critical element of intelligence
  - Difference between academic exercise and real world engineering
    - observation → possible cause → improved solution
  - 30 years of experience or 1 year experience 30 times

Assignments

- Reading
  - Petroski IBD, Chapter 8, 9
    - Water and Society
    - Bridges and Politics

- Homework
  - None. Focus on projects. Try to make a lot of progress this week.