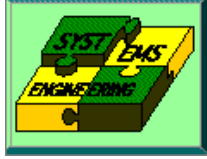
George Mason University



SYST 101: Intro to Systems

Lecture 5

Feb. 3, 2004

C. Wells, SEOR Dept.

Announcements

- You will be required to attend the final project presentations of SYST 490/495 time and location TBD

Agenda

- Topics for Today
  - Homework discussion
  - Assumptions and analysis

Homework Discussion

- Task consisted of 3 elements
  - Bend a paperclip (to redesign the GEM) and draw the resulting design
  - State the good and bad points of the design
  - State how you might test your claims

Homework Grading

- Indication that you bent a paperclip (if only in a thought experiment) as evidenced by a drawing 70 pts.
  - Would the design really work? 10 pts.
- Any honest discussion of the merits or weaknesses of the design 10 pts.
- Any plausible discussion of a possible test program 10 pts.

Not Looking For:

- Not looking for:
  - Marketing brochure
  - Unsubstantiated claims
  - New clasping methods
  - Impossible (implausible) solutions
  - extra features beyond utility to hold papers
- K.I.S.S.
  - Know what the job is
  - Minimum acceptable job, shortest time, least cost

Use The SE Process!

- Evaluate
  - Understand the requirements
    - Read The Question
- Conceive
  - Assume a solution
- Build
  - Bend a paperclip (even if only mentally)
- Use
  - See if it works
  - Write up the project and turn it in
    - Good and bad points and a possible test procedure

Establishing Your Team

- You will need more communications and face time than you expected
- Grading criteria next time:
  - Robot performance
  - Oral presentation
  - Lab Notebooks
  - Peer evaluations

Review

- Systems Engineers are a mile wide and a foot deep
  - Breadth encompasses the way system engineering works across the whole system
  - Depth encompasses some understanding of the elements of a system
- Your courses provide “experience” to use
  - SEOR courses describe the things and how system engineers do them across a system (breadth)
  - Other courses provide understanding of the elements (depth)

Technical & Non-technical Areas

- Physics
- Chemistry
- Aerodynamics
- Materials
- Electrical / Electronics
- Information
- Dynamics
- etc.

- Customer needs and utility
- Customer perceptions
- Aesthetics
- Personnel issues
- Ergonomics
- Socio-economic issues
- etc.

Conceiving a Solution

- Assume a solution
  - Based on the requirements
  - Based on knowledge / previous experience
    - Study widely
- Analyze the assumed solution
  - Fix what does not work well enough
- Repeat as necessary

Assumptions in Analysis

- Always starts with simplifying assumptions.
  - Solve the easy problem first, then add complicating factors and issues
- Always keep in mind your assumptions
  - You not really solving the real problem, you're solving something similar (you hope)

Analysis Difficulties

- You can never be sure when you are done
  - Understanding what is important
  - Unanticipated failure mechanisms
  - Unrealistic assumptions
- Mind set when performing analysis
  - Keep an open mind
  - Second set of eyes on the problem

How to Analyze

- Actually build the system and test it
  - Costs a lot and can't test for all situations
  - Risks to life
  - One time events
- Build a model of the system and test the model.
  - Cheap(er), safer, repeatable under various situations, and usually simpler that the system
  - But are they adequate?
    - it depends

Modeling

- What do we mean when we say “model”?
- Models:
  - Plastic airplanes
  - Mental models
  - Simulations
  - Scale models
  - Test models

Model - Definition

- A model is a representation of some entity.
- The entity does not have to actually exist.
- The model itself does not have to have physical existence.

Modeling - Purpose

- We build models to
  - Describe the entities they represent
  - Learn about the entities they represent,
  - Learn how the entities interact
  - Have fun!
  - Others (too numerous to mention)

Forms of Models

- Mental models
  - how you conceive of something
  - how you perceive something
- Physical models
  - to describe
  - to predict or validate behavior
- Mathematical models
  - to understand behavior
- Others (too numerous to mention)

Examples

- Model airplane
- Sculpture
- Drawings (pictures, sketches, blueprints, etc.)
- Equations
- Ideas
- Plans?
- Functional Flow Block Diagrams?

Why Use Models

- Because the entity –
  - does not have to exist
  - is too complicated to understand
  - is too costly to build unless it works
  - is too dangerous to use until we understand it

Models Are Scalable

- How detailed must a model be?
  - It depends on the use
- What kind of model should be used?
  - It depends on the use
- You can do a cost/benefit analysis of the information gained (benefit) versus the type/detail of the model (cost)

Model Verification

- Models may need to be validated if their accuracy is questionable
  - Too simplified
  - Design far from the existing practice
  - Design close to failure
- The design may require Qualification if the accuracy of the model is questionable

Assignments

- Reading
  - Petroski, To Engineer is Human
  - Chapter 4
  - Chapter 5
- Homework
  - Lego Mindstorm Tutorial
    - Install and run the software. Proceed through the tutorial. (completed by all team members by Thursday)

Homework (cont.)

- Consider the roads and parking lots of the GMU Fairfax campus as “the GMU Fairfax Traffic System”.
  - One external element within the environment of the Traffic System (i.e., can affect and can be affected by) is listed below. List 4 more.
    - -- Local road & street network
  - One external element within the Context of the Traffic System (i.e., can affect the parking system but CANNOT be affected by it) is listed below. List 4 more.
    - -- the weather