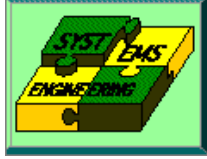
George Mason University



SYST 101: Intro to Systems

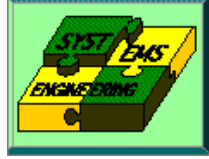
Lecture 3:

Jan. 28, 2002

C. Wells, SEOR Dept.

Announcements

- Teaching Assistant
  - Amir Motamedi
  - fmotamed@gmu.edu
- If you have not submitted your demographic information please do so



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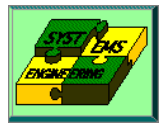


e-mail format

to: charles.wells@cox.net

subject: SYST 101 demographics

body:

name:

major:

year:

interpersonal skills: (scale 1=low to 5=high)

artistic expertise: (scale 1=low to 5=high)

literary expertise: (scale 1=low to 5=high)

mechanical expertise: (scale 1=low to 5=high)

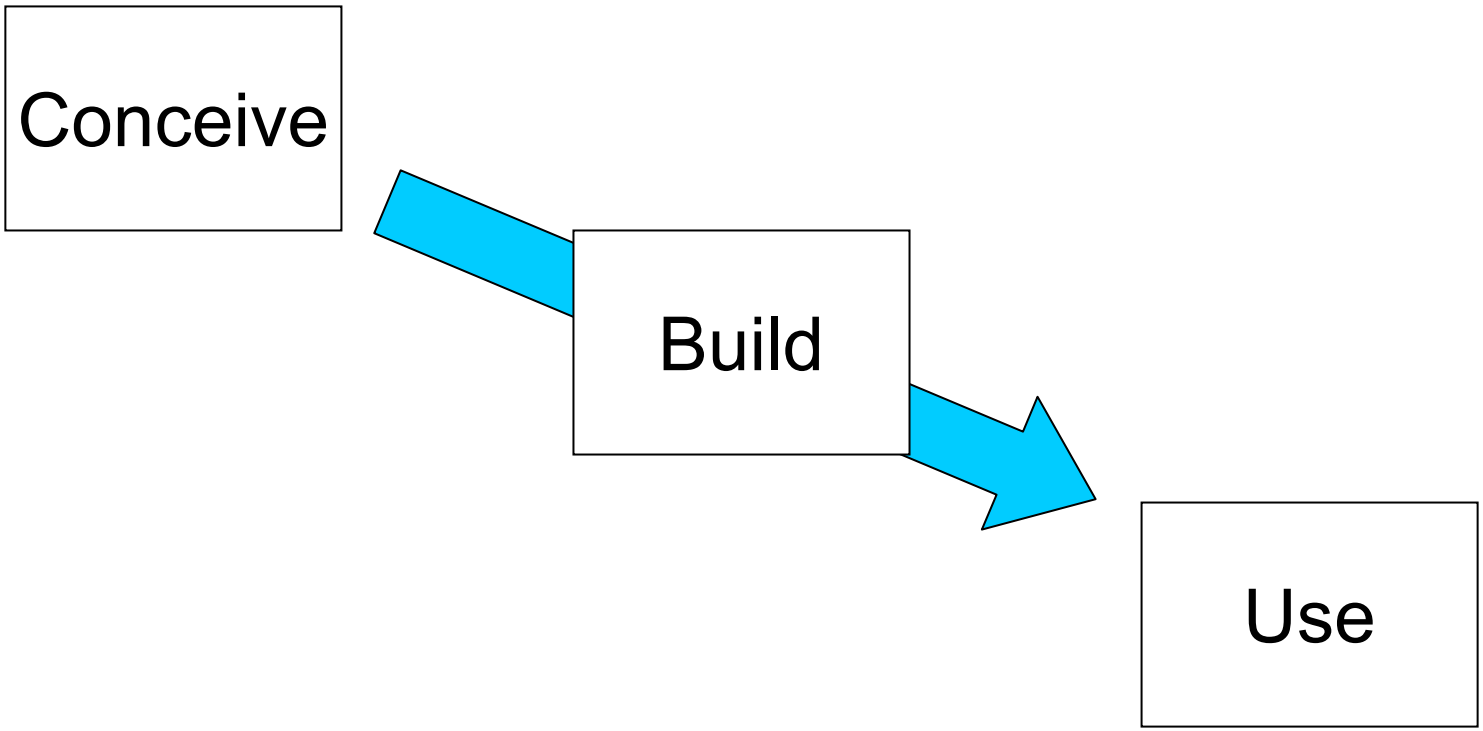
computer expertise: (scale 1=low to 5=high)

math courses:

Agenda

- Objective for Today:
  - Review select topics
  - Discussion of Petroski, Ch. 1, 2
    - Need drives invention (and therefore design)
    - Therefore, invention & design MUST satisfy need

The Most Basic Creative Process



- Suitable for anything from stone chisels to ...

Invention Versus Need

- Invention Driven by need
- Needs not always conscious and perceived
  - needs may exist that you don't realize
  - but, revolutionary inventions create their own need
    - did we "need" the internet, webpages and browsers before they were invented?

Need is critical to success

- 1) Dont build things that aren't needed.
  - Clear recipe for going out of business.
  - You can convince some folks to buy things they don't need for a while, but not for long.

Utility

- 2) Even with a clear need that exists, things not built with the right priorities in mind won't really satisfy the need.

Needs Vs. Subgoals

- Need (i.e., mission or goal or purpose) can be decomposed into a set of subgoals
  - similar process to functional decomposition
- paper clip = paper fastener
  - hold up to x sheets reliably
  - don't tear the paper
  - put on, take off easily (one hand)
  - be cheap

    mass manufacturing, sell in bulk

Satisfying a Need

- When a system satisfies a need, we say that it has “utility”.
- “Utility” - The system (or device) serves some purpose and does it better (in some measure) than other things. It may do it cheaper, faster, more efficiently, easier for the user, more reliably....

Utility

- "Cost-Benefit"
  - A standard term used often
  - All systems have an associated "cost"
    - Cost to buy, time to learn and use, maintenance costs
  - All (good) systems have a benefit when used.
  - Is what you get out of them worth what you put in?

Utility Is A Function of Many Things

- The system itself
  - Cost, difficulty to use
- The environment
  - How bad is the need?
- The competition
  - How is the function done now?

Changes in the Environment

- External Issues, above and beyond the paper clip
- When there wasn't much paper, there was little need for the paper clip
- Therefore, changes due to the industrial revolution (i.e., offices, typewriters) led to lots of paper being created and distributed, which creates a need for an improved paper fastener.

Specific Factors

- More papers produced and circulated
- More papers needing to be grouped together (larger packages)
- Speed becoming more important in business
- Manufacturing machines becoming more tailor-able
  - Custom order a machine to make what you want

Pin vs. Paper Clip

- Pros and Cons

	Pro	**Con**
Pin	Exists Folks Used to it	Limited number of sheets
Paper Clip	Easy to use Larger capacity	New, more expensive

External Factors

- What factors drive the design (or evolution) of systems?
- Key question that must be answered in order to have real understanding
- Also referred to as “Issue Analysis”
- Related strongly to business cases and/or marketing analyses.

How to Determine What's Important?

- Now the hard part...
- This is a continual challenge, and there is no guaranteed process, formula or authority.

Why Were Bald Eagles Dying Off?

- Before folks were environmentally aware...
- Bald eagle populations in North America were dropping drastically and dangerously
- Extinction was a real possibility
- Why?

Chains of Cause and Effect

- Bald eagle population was decreasing because
- Baby chicks were dying before hatching because
- Their egg shells were too thin and cracked prematurely because
- Their parents had calcium deficiencies because

Chains of Cause and Effect

- The parents ate fish that were polluted with DDT because
- The fish ate bugs killed with DDT and DDT was running off into their streams because
- People didn't like bugs and DDT was great at killing bugs.

Reverse Engineering

- To understand, to figure backwards how a system works.
- Often used in environmental and biological systems
- Sometimes used in digital systems when you're trying to figure out how a competitor's (or enemy's) product works.

Examples for Discussion

- Mississippi River Levee System
  - Cost-Benefits?
- Cell Phones

So, How *Do* You Determine What's Important?

- Experience
- Experiments
- Open Mind
  - Willingness to Admit Your First Guess Was Off Base

For The Lego Cars...

- What issues are important?
- Some are set:
  - Time to complete the course
  - Must stay on track, no hopping the walls
  - Car must stay in one piece

Design Project (Last Year)

1. % of distance on short course
   - Best: 100; Worst: 0%
   - Score: percent traveled [0 100]
   - 3 minute time period.

     If your robot gets stuck
     - distance will be measured
     - restart the obstacle course
     - repeated until end of 3 minutes
     - use the longest distance
2. % of distance on long course
   - Best: 100%; Worst: 0%
   - Score: percent traveled [0 100]
   - Note: same as for part 1.
3. Unit Cost of parts
   - Best: $0
   - Worst: $12,500
   - Score: 100 ($11,109 – Unit Cost) / $11,109

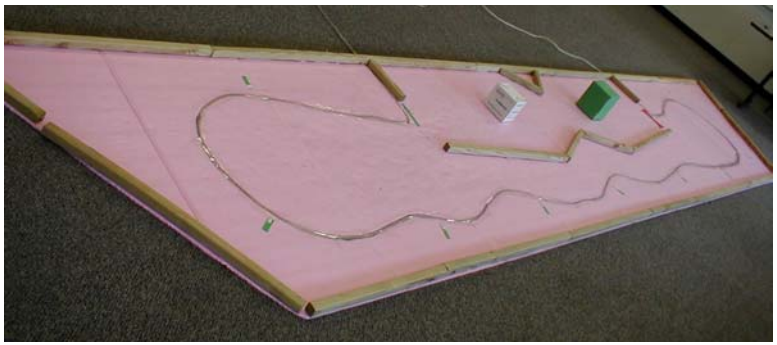
- Relative weights of objectives:
  - % distance on long course: 0.4
  - % distance on short course: 0.4
  - Unit cost of parts: 0.2
- No modifications allowed to design for 2 courses except change of software program

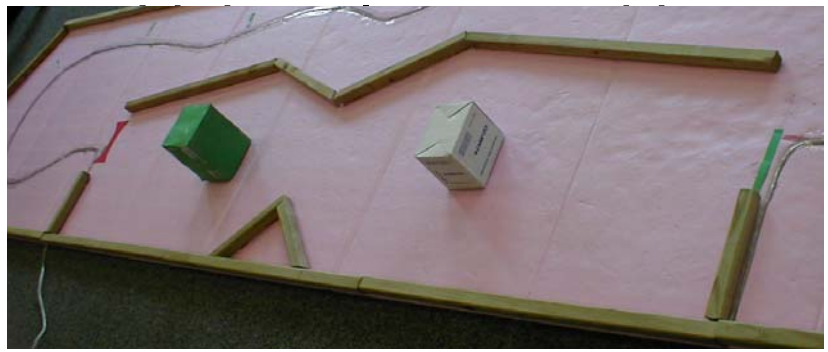
Lego Car Issues

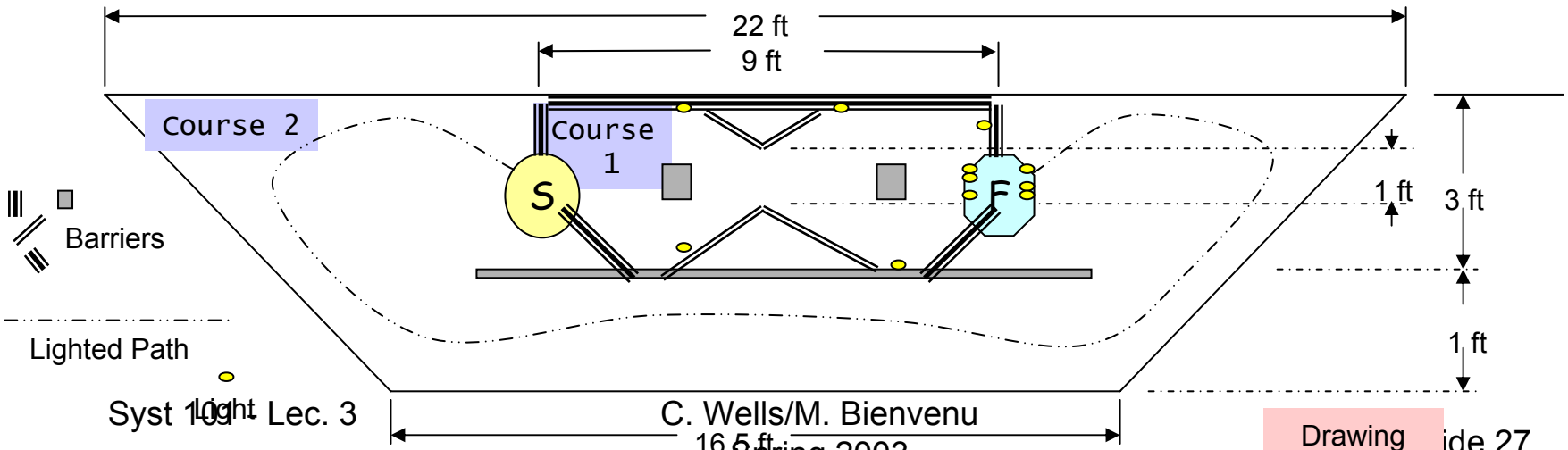
- Some can be derived based on the physical dimensions of the track

Obstacle Course

- Long Course
  - Two large turns
  - Light rope along center offered
- Short Course
  - 2 Obstacles





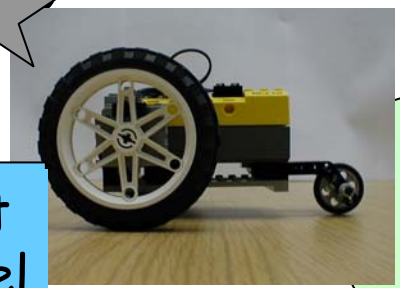


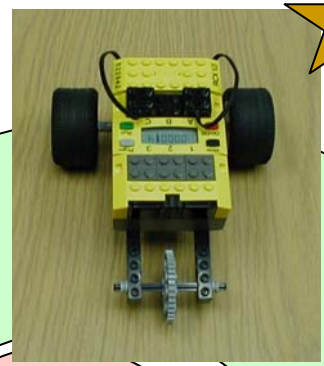
Drawing not to scale

What Questions Should You Ask?

- What do you need to know to build a successful car?
- What characteristics of the track will affect how you build your car?
- What performance characteristics of your car will you measure?

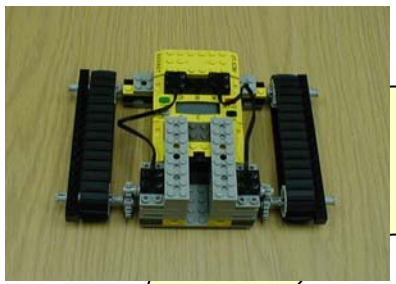
Alternate Designs

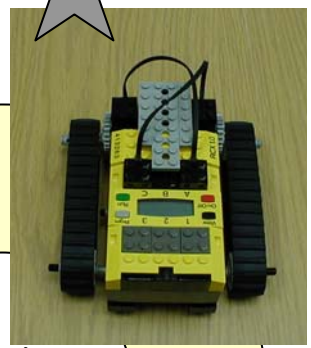




Front Wheel Drive

3 Wheels

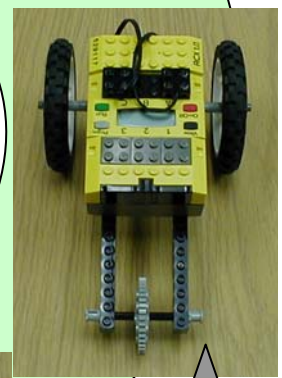


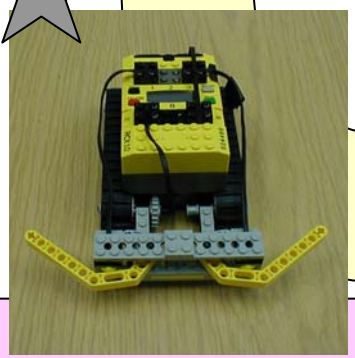


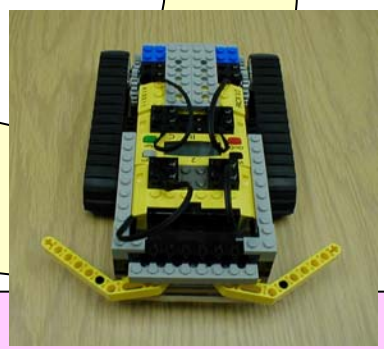
Tracks

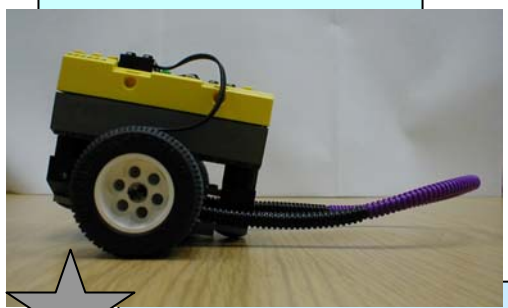
Wheels

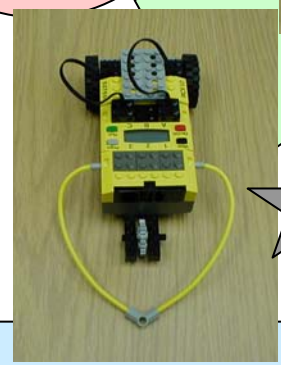
2 Wheels









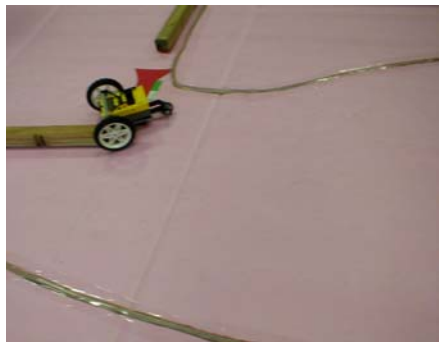


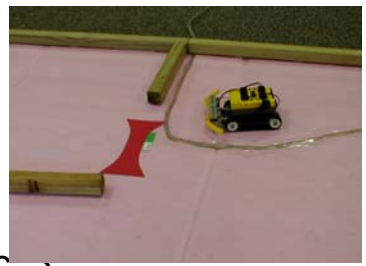
Bumpers

Stabilizers

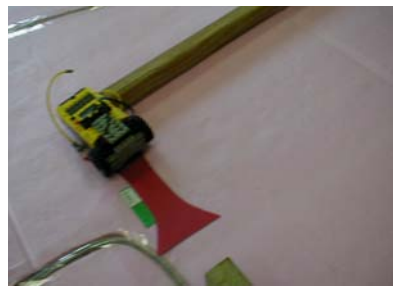
Pictorials of Results

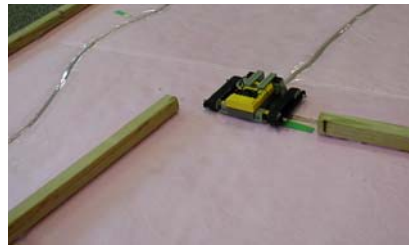
Long Course

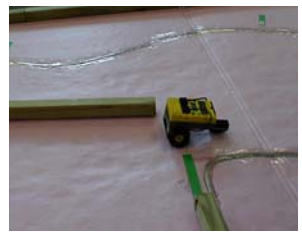




Short Course







Project Overview

- Hand out Mindstorms Kits next class
- Three week initial trial period with testing
  - Objectives:
    - Learn Lego robot construction & Mindstorms programming
    - Build a car that will go in either 3 foot diameter circles or 5 foot diameter circles (Instructor's choice at test time).
  - Trials 25-27 Feb
- Return Mindstorms Kits
- Additional lectures on issues analysis
- Mindstorm kits returned for advanced design, development and testing

Assignments

- Reading
  - –
- Homework
  - –