Schedule and Content Information for Automating the Future Saturday at NASA Langley Research Center

14 February 2008

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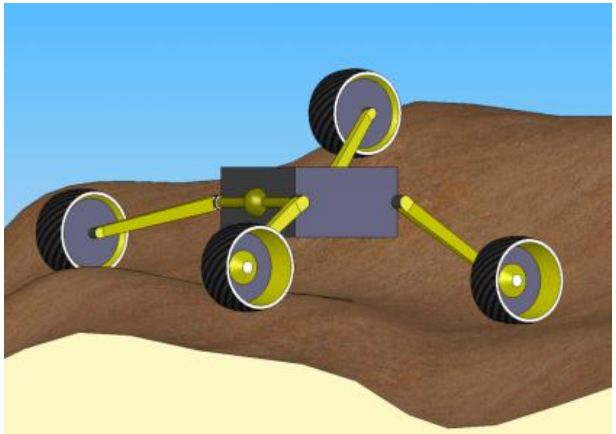
Robots

The first segment of the day consists of a presentation on robotics. Robots are the heart of mechanical automation, and their construction and operation requires intimate knowledge of most branches of engineering. As robotic automation becomes more prevalent, possessing detailed engineering and technical skills will be every more essential. This segment will lay a foundation for understanding the basic building blocks of robotics, in the context of NASA Langley's "robot ecology" efforts. A particular focus will be on specific examples of robot-building endeavors. The presenters will conclude by giving an overview of their educational trajectory, highlighting the early decisions and efforts that shaped their current work as robot designers and builders.



“Robots” presentation here…

Penny Hauling Competition

This segment will consist of a competition based engineering exercise. The exercise is designed to simulate the pressures and dynamics experienced in a real world engineering setting. Contestants will be randomly assigned to teams. Each team will be given a schedule, a monetary budget and a closed set of materials available for purchase. The teams will be assigned an engineering objective requiring them to design and construct a self-powered vehicle that will transport pennies along a string track. As in the engineering world, the winning team of the competition will be declared based solely on the performance of their vehicle.

Penny Hauling Competition

Objective:
Communicate the importance of team work
Demonstrate importance of fabrication skills

Given: - Randomly selected team of up to 5 students
- $1000 of Robot Money
- A closed set of materials
- A schedule of 30 minutes
- An 8 foot track

Goal: Carry the greatest number of pennies the longest distance for the lowest project cost.

$$\text{Score} = \frac{\text{Pennie Hauled} \cdot \text{Distance Traveled}}{\text{Total Project Cost}}$$

Format:
- Instructions will be given to the entire group of nominally 75 students
- The group will be randomly split into <u>3 divisions</u> of <u>5 teams</u> with <u>5 students per team</u>
- All groups will be given the same <u>30 minutes</u> to design, build, and test a penny hauler
- Each team will be allowed exactly <u>2 minutes</u> for up to two competitive trials
- The ultimate winner from each division will go on to a championship round
- Parents are welcome to participate as a contesting team

Penny Hauler Challenge

The Frank Batten College of Engineering and Technology
Old Dominion University
March 2008

OBJECTIVE

To design and construct a small self-powered vehicle that will transport pennies along a string track.

RULES

1. The hauler must be built and powered using only parts purchased at the "Penny Hauler Store"--- More details are given below. You are not allowed to use any other parts, such as items which may be lying around the lab.
2. At the beginning of the contest, the "hauler" must be hung from the string track, in the two-foot long launching area. The hauler must be self-propelled—no pushing is allowed.
3. No more than two minutes of set-up time is allowed per team.
4. Only students are allowed to set-up and start the car. Each team will be allowed up to two attempts to run the car, provided the total time does not exceed two minutes. At the judges' discretion, attempts considered as "false starts" will not be counted toward the two attempts.
5. The hauler may not be touched after it begins motion.

SCORING

The score will be based on the number of pennies hauled, the distance hauled, and the amount of money spent to build and test the hauler. Only pennies remaining in the hauler vehicle, after it comes to a complete rest, will be counted. Distance will be measured between the end of the launching area and the backmost part of the vehicle. The contest will be scored as follows:

Score = (Pennies hauled x Distance moved)/ Dollars spent

For example, if your team builds a hauler that hauls 30 pennies, moves them a distance of 100 centimeters, and costs 500 dollars to build, your score would be:

(30 X 100)/500 = 6.0

In the event of ties, teams that have the most unspent dollars to turn in will be considered the winner. Judges decisions are final.

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LAYOUT

The "track" is an 8-foot long piece of string attached to a frame made out of 2 x 4 pieces of wood. The string cannot be removed from the track to attach your vehicle. The first two-foot section of string is the "launching" area. At the two-foot mark, there is another piece of wood 6 inches below the string. This piece of wood has three nails protruding from its top that can be used as hooks to help launch your vehicle.

Track Diagram

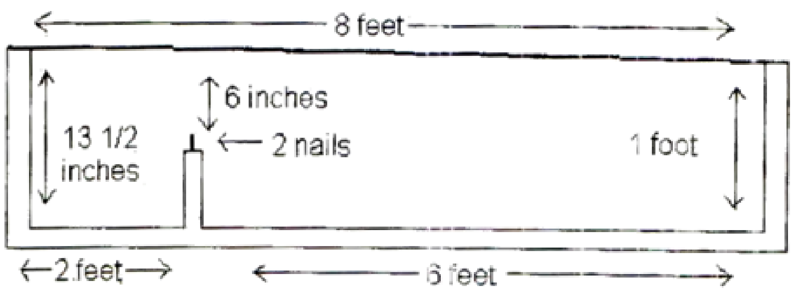

Figure NOT drawn to scale. All dimensions are approximate.

PRIZES

Each student on the winning team for the day will be given a small prize from the Frank Batten College of Engineering and Technology (BCET) at Old Dominion University.

PENNY HAULER STORE

The following items will be available from the store:

Paper clips
Rubber bands
Balloons
Popsicle sticks
Paper
Masking tape (12 inch pieces)
Straws

Each item costs $50 of BCET money. Your team will be given $1,000 of BCET money to use for purchases.

Each team will have about 30 minutes to design and build a hauler.

In addition, practice runs can be made on the track for $50 each.

Each hauler must be designed and built by students only.

Good Luck!

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Demonstration Session

This segment will consist of a series of interactive breakout sessions designed to present a range of robotics related topics in a user friendly and interactive format. Six groups, of 12 to 13 students each, will rotate through six different demonstration exhibits. The exhibits are designed to give students a flavor of the type of engineering involved in robotics research and to present the students and their parents with a possible ‘next step’ in a career towards engineering and engineering technology. The exhibits will be as follows.

- A demonstration of robotic systems from NASA Langley’s Robotics and Intelligent Machines Lab.
-A mechanical design overview of a research robot covering design, development, and fabrication of robotic systems.
-A demonstration of visual programming as it applies to vision systems and robotic algorithms
-A FIRST Lego League (FLL) team and their robot: FLL is a robotics competition for elementary and middle school students based on the Lego Mindstorm™ kit.
-A FIRST Tech Challenge (FTC) team and their robot: FTC is a robotics competition for middle and high school students based on an amateur robotics kit, which uses the Lego Mindstorm™ processor.
-A FIRST Robotics Competition (FRC) team and their robot: FRC is a robotics competition for high school students that allows for open ended design of a robot within a set of game constraints.

Robot Building Activity

This segment will consist of an engineering exercise to *construct* a working robot, quantitatively *predict* then *test* the robot's performance, and finally *critique* the analysis methods in the light of the empirical test data. This exercise will underscore the importance of technical fabrication skills when constructing electro-mechanical systems. More importantly however, the exercise will demonstrate the application of applied math to quantitatively designing and characterizing a real-world system.

Robot Building Activity

Objective:
Show application of applied mathematics
Demonstrate importance of fabrication skills

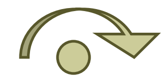
Game:
- Build vehicles (parent-child team)
- Project performance of vehicle analytically
- Test vehicle performance competitively

Format:
- 80 minutes: Build robot
- 10 minutes: Perform analysis
- 20 minutes: Compete individual robots: (Winner has smallest error between analysis and experiment)
- Parents will mentor the students in this exercise

Predict Robot Performance

Variable	Variable	Measured Value
Battery voltage	V_b	<students measure>
Diameter of motor pulley	D_m	<we supply>
Diameter of wheel pulley	D_w	<we supply>
Wheel radius	r_w	<we supply>

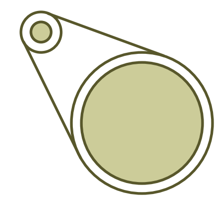
Rotational velocity of motor



$$\omega_m = \{\text{use } V_b \text{ in lookup table}\} \qquad \left[\frac{\text{rotation}}{\text{s}}\right]$$

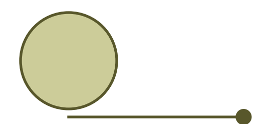
Gear ratio

$$G_r = \frac{D_m}{D_w} \qquad \left[\frac{\text{in}}{\text{in}} = 1 = \text{no units}\right]$$



Distance covered by wheel per rotation (e.g. wheel circumference)

$$C_w = \pi \cdot r_w \qquad \left[\frac{\text{in}}{\text{rotation}}\right]$$

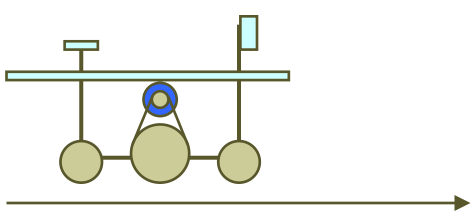


Predicted velocity of robot

$$V_r = \omega_m \cdot G_r \cdot C_w$$

$$= \omega_m \cdot \frac{D_m}{D_w} \cdot \pi \cdot r_w$$

$$\left[\frac{\text{rotation}}{\text{s}}\right] \cdot 1 \cdot \left[\frac{\text{in}}{\text{rotation}}\right] = \left[\frac{\text{in}}{\text{s}}\right]$$

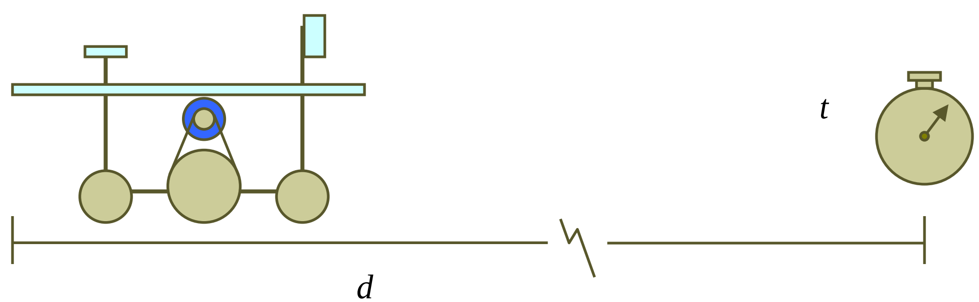


Measure Robot Performance

Velocity of robot

Variable	Variable	Measured Value
Distance	d	<students pick>
Diameter of motor pulley	t	<students measure>

$$V_r = \frac{d}{t} \qquad \left[\frac{\text{in}}{\text{s}}\right]$$



Note: When picking *"d,"* what factors should you consider?

Evaluate Prediction Against Reality

- What factors do *you* think contributed to error between experimental and predicted robot velocity?
- What was your error percentage?

$$\text{error} = \frac{\text{measured} - \text{predicted}}{\text{measured} + \text{predicted}} \cdot 100$$

- <insert our velocity prediction, our measured result, our chosen distance, our rational for that distance (e.g. long time at steady-state vs. energy dissipation is criteria)>

Identified Error Sources

- <fill in dynamically at event>

Our Error Sources

- <pop up this block after filling in above>
- <fill these in, in order of importance, with a rationale for the error and the order>
- <include how to increase fidelity of prediction at each bullet>
- <we should do a sensitivity analysis of our errors>

Wrap Up