George Mason University

SYST 101: Intro to Systems

Lecture 20

Apr 3, 2003

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Announcements

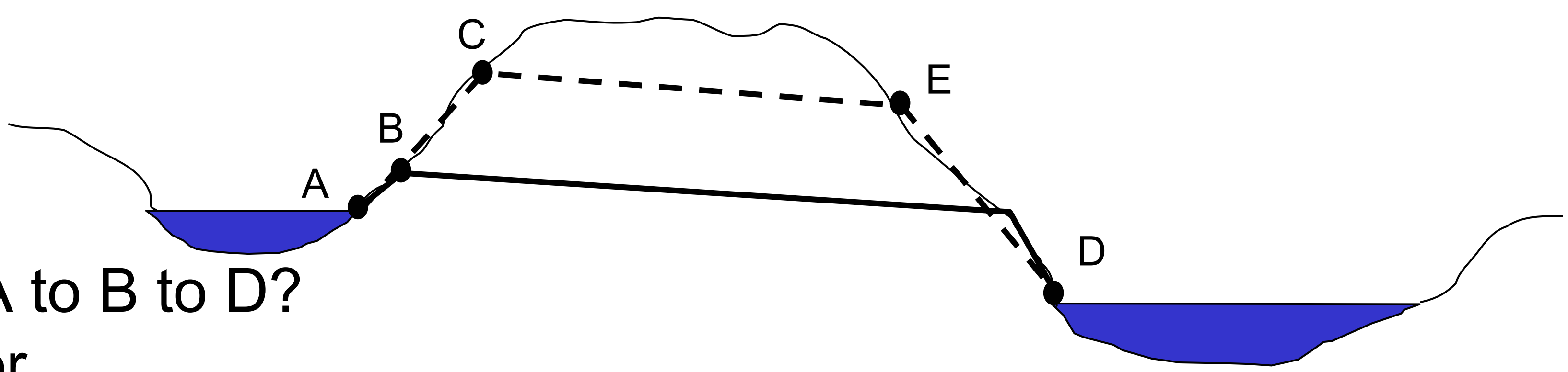
- Remaining Semester Schedule
  - Apr 8, 10 — Project 2 laboratory testing
  - Apr 15, 17 — lecture 23, 24
  - Apr 22, 24 — Project 2 demos and oral presentations
  - Apr 29, May 1 — Review for final
  - May 2 — SYST 490/495 presentations
  - May 13 — Final Exam 10:30 – 1:15

Agenda

- System Trades

Tradeoff Analyses

- Question in the text:
  - Given a mountain between here and there, what's the best combination of uphill pumping and downhill tunnel?



A to B to D?
or
A to C to E to D?

Components of Tradeoff Analyses

- At least two components, and a +/- relationship between them
- In the previous example:
  - The higher we decide to pump, the shorter the tunnel needs to be
- Calculate (or look up) the cost functions of each

Mountain Tunnel Cost Components

- Cost of Pumping
  - as a function of pumping height

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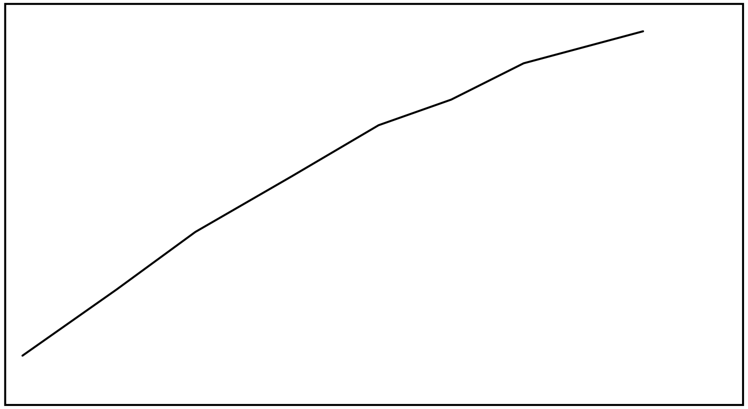

Pumping Height

- Cost of Tunnel
  - as a function of pumping height

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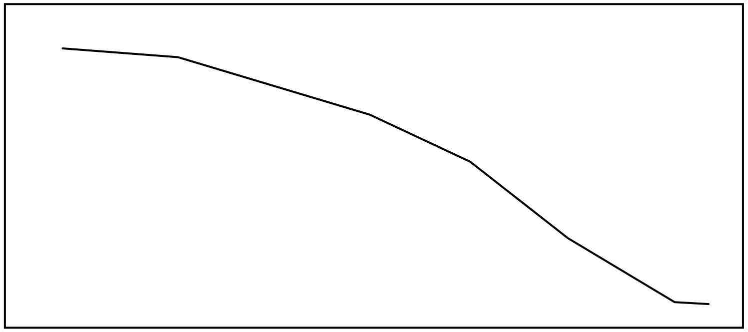


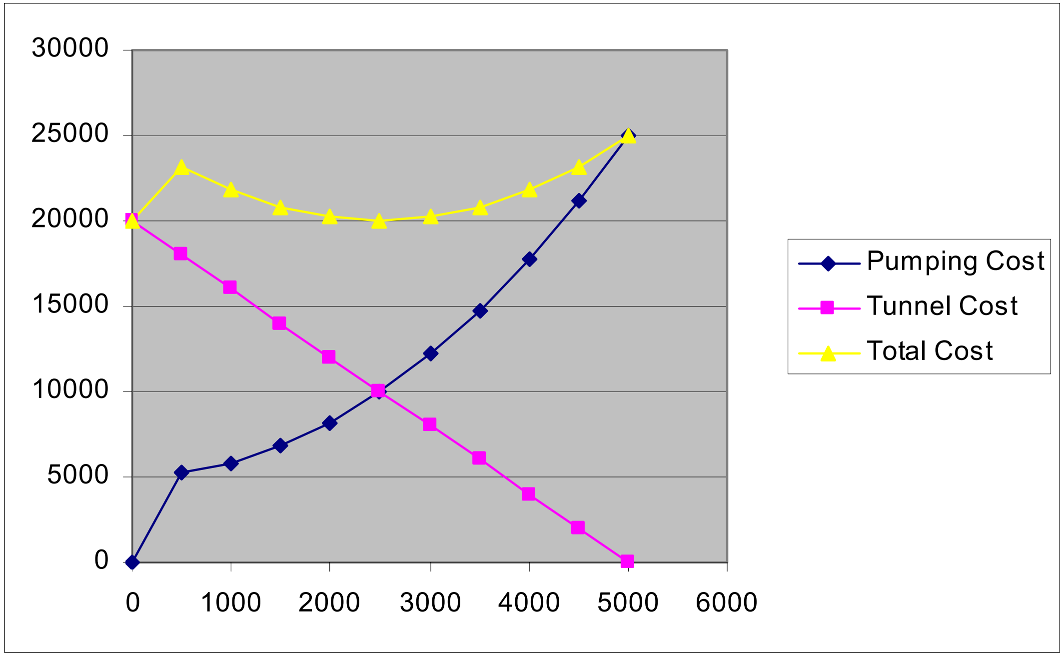
Pumping Height

Optimization Procedure

- Sum the costs (as a function of the single independent variable, pumping height)
- Look for minima in the curve
  - inflection points
    - Slope = 0 ($\frac{d}{dx}f(x) = 0$)
  - endpoints

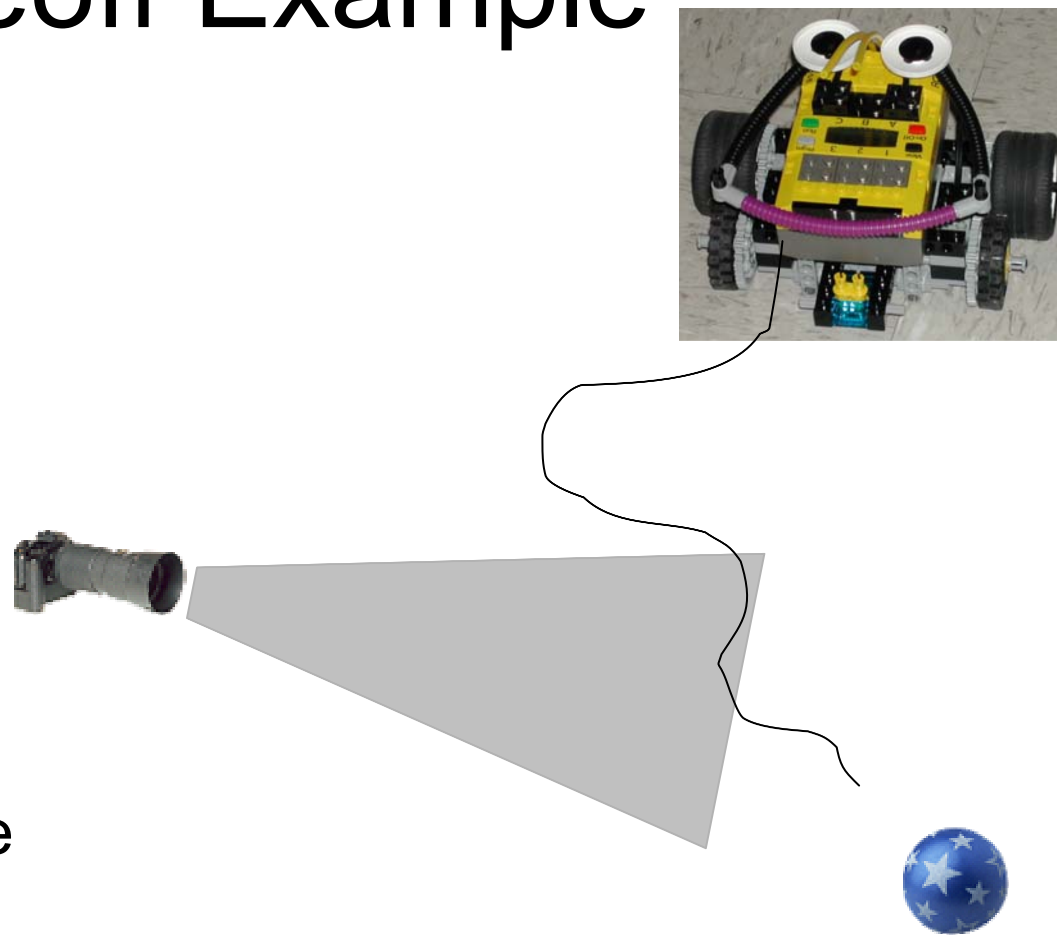
Tradeoff Optimization

Pumping Cost	Tunnel Cost	Total Cost
0	20000	20000
5200	18000	23200
5800	16000	21800
6800	14000	20800
8200	12000	20200
10000	10000	20000
12200	8000	20200
14800	6000	20800
17800	4000	21800
21200	2000	23200
25000	0	25000



Tradeoff Example

- Robot guided by fixed, remote sensor.
- The sensor guides the robot towards the ball; when the robot gets close enough, it uses its own sensors to detect and grab the ball.



Two Primary Variables

- Sensor Accuracy, A_s: How accurately can the sensor see and guide the vehicle? (measured in inches, smaller means more accurate)
- Robot Acquisition Basket Size, B_a: How much area can the robot search on its own and successfully find and capture the ball? (measured in inches, larger means more capable robot)

System Effectiveness

- Let us assume that:
  - If the sensor accuracy is better (i.e., smaller) than the robot acquisition basket, then that means that the sensor can accurately guide the robot so that the ball is within the robot's acquisition basket.
  - Therefore the robot will capture the ball
  - System will succeed if $A_s \leq B_a$
  - In other words, if the sensor accuracy gets bad (large), then the robot must be more capable to make up.

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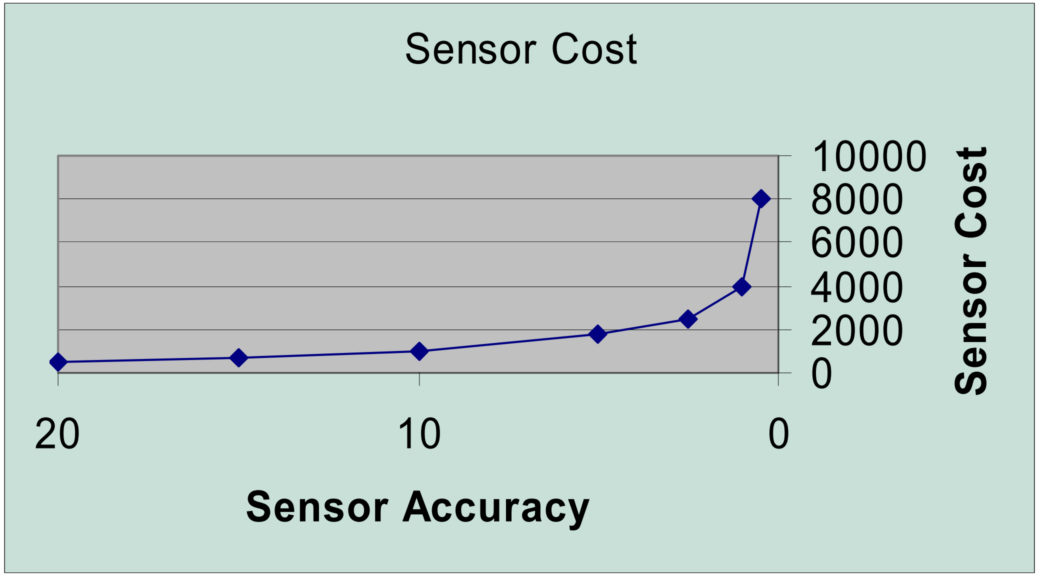
Sensor Costs

- Sensors get real expensive if they have to be real accurate...

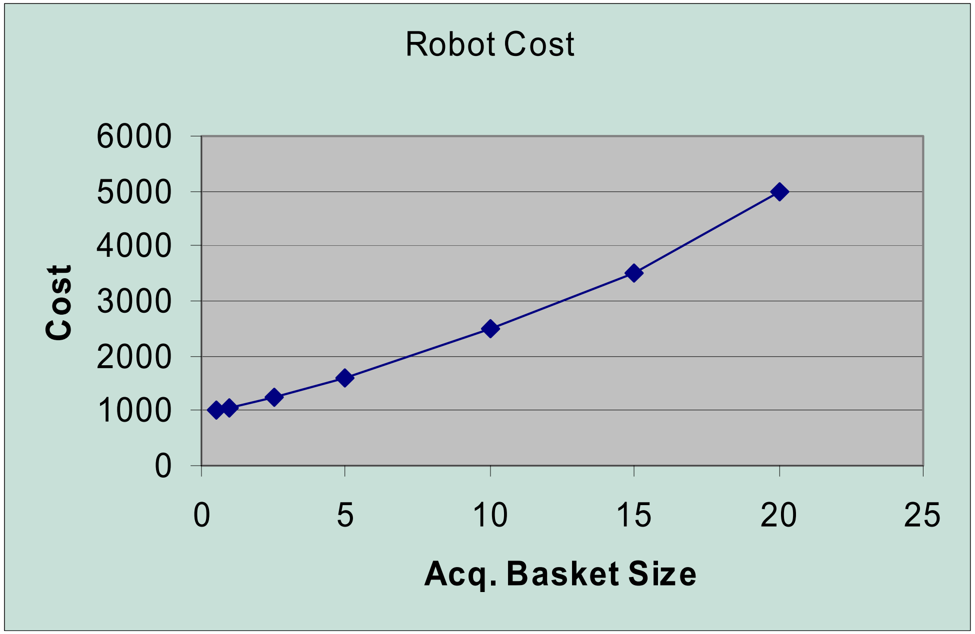
Sensor Accuracy	Sensor Cost
20	500
15	650
10	1000
5	1750
2.5	2500
1	4000
0.5	8000



Robot Costs

- Robots get to be real expensive if they have to search large acquisition baskets

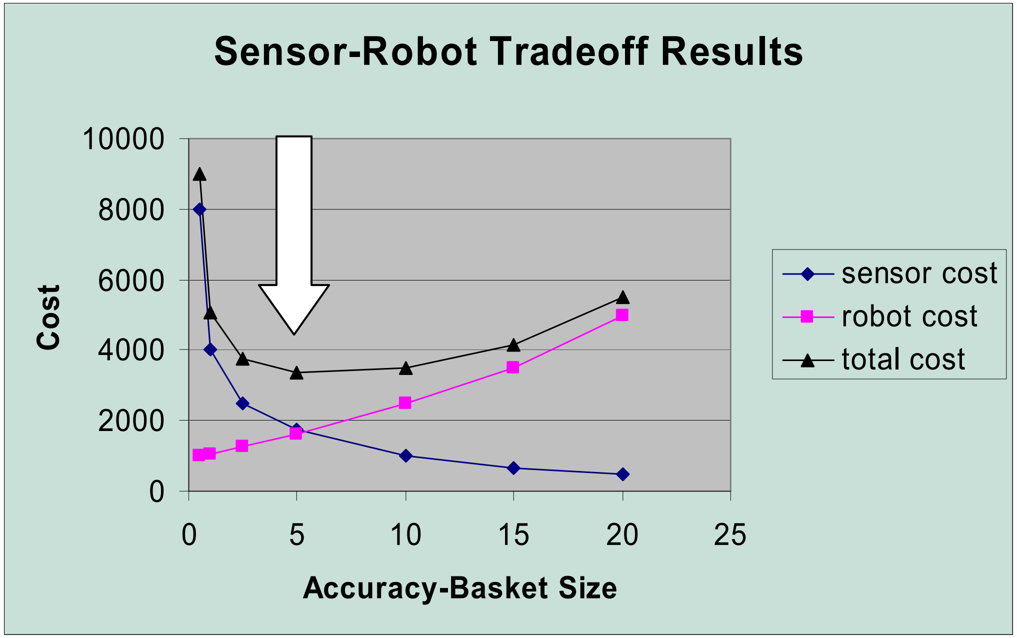
Robot Acq. Basket Size	Robot Cost
0.5	1000
1	1050
2.5	1250
5	1600
10	2500
15	3500
20	5000



Total System Costs

- one independent variable - sensor accuracy
  - for each sensor accuracy value, use the cheapest robot possible

sensor acc	sensor cost	robot cost	total cost
20	500	5000	5500
15	650	3500	4150
10	1000	2500	3500
5	1750	1600	3350
2.5	2500	1250	3750
1	4000	1050	5050
0.5	8000	1000	9000



Homework

- Additional tradeoff problems in
  - tradeoffHomework.doc
  - You may do the homework
    - By pencil and paper
    - By spreadsheet
  - Either way, please hand in hardcopy. Don’t email hw.

Assignments

- Reading
  - Petroski, Ch. 10, “Buildings and Systems”
- Homework
  - Individual basis, due next Thursday
  - Solve the tradeoff problems in TradeoffHomework.doc posted on the Web