Assignment 1 (Due Monday Sept. 20 at start of class - 10% penalty per day late)

Part 1: Do the following problems from your text: 3-1 (5 points), and 3-2 (5 points). Show all of your work, including assumptions used.

Part 2 (15 pts): Below is a summary of data pertaining to the electricity costs and use of buildings on campus for 2001. There are columns for the annual amount of electricity consumed (in kilowatt-hours) as well as the cost per year of that consumption. There is also a column for building size in square feet. This data is also on the course website.

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Gross Sq Ft</th>
<th>Electric kWh</th>
<th>Electric Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker Hall/Porter Hall</td>
<td>250,840</td>
<td>7,016,279</td>
<td>$333,261</td>
</tr>
<tr>
<td>College of Fine Arts/Studio Theatre</td>
<td>127,073</td>
<td>1,135,046</td>
<td>$61,202</td>
</tr>
<tr>
<td>Doherty Hall</td>
<td>217,072</td>
<td>2,426,904</td>
<td>$130,334</td>
</tr>
<tr>
<td>GSIA/Posner</td>
<td>106,881</td>
<td>2,752,799</td>
<td>$141,223</td>
</tr>
<tr>
<td>HbH, Smith, Print, PRB, 4902</td>
<td>183,141</td>
<td>4,903,210</td>
<td>$246,111</td>
</tr>
<tr>
<td>Hamerschlag Hall</td>
<td>114,275</td>
<td>2,660,096</td>
<td>$139,641</td>
</tr>
<tr>
<td>Margaret Morrison Carnegie Hall</td>
<td>108,954</td>
<td>1,063,964</td>
<td>$55,421</td>
</tr>
<tr>
<td>Newell-Simon</td>
<td>172,919</td>
<td>3,507,858</td>
<td>$171,613</td>
</tr>
<tr>
<td>Purnell Center</td>
<td>98,250</td>
<td>2,131,241</td>
<td>$113,800</td>
</tr>
<tr>
<td>Wean Hall</td>
<td>295,845</td>
<td>7,625,643</td>
<td>$384,587</td>
</tr>
<tr>
<td>407-409 S. Craig St</td>
<td>10,118</td>
<td>254,640</td>
<td>$20,752</td>
</tr>
<tr>
<td>6555 Penn Ave</td>
<td>99,369</td>
<td>576,440</td>
<td>$47,078</td>
</tr>
<tr>
<td>Alumni Hall</td>
<td>8,223</td>
<td>127,420</td>
<td>$12,436</td>
</tr>
<tr>
<td>Bramer House</td>
<td>3,000</td>
<td>36,840</td>
<td>$3,856</td>
</tr>
<tr>
<td>Cyert Hall</td>
<td>62,709</td>
<td>5,274,418</td>
<td>$260,422</td>
</tr>
<tr>
<td>Hunt Library</td>
<td>102,073</td>
<td>1,770,855</td>
<td>$93,323</td>
</tr>
<tr>
<td>Physical Plant Bldg</td>
<td>44,057</td>
<td>2,720,914</td>
<td>$129,891</td>
</tr>
<tr>
<td>Scaife</td>
<td>36,084</td>
<td>689,409</td>
<td>$36,483</td>
</tr>
</tbody>
</table>

a) Given this data, estimate one linear and one non-linear demand function for campus electricity. (Note: the form of the function is your decision, as well as the estimation method. Please describe your assumptions and methods, and submit evidence of the work and model. **Make sure your demand function is like those we have done in class, i.e. price on y-axis**).

b) Using these new demand functions, assume they are relevant for colleges in Pittsburgh. Assuming a price of 6 cents per kilowatt-hour, forecast the quantity of electricity demanded with both of your demand functions.

c) If the price increases to 6.5 cents per kilowatt-hour, forecast the change in revenue and user benefit from your linear model only.

d) Discuss the weaknesses in your answers above and how you could improve it.

a) Create a list of factors in this school that are benefits and costs of building it green. Make sure you have at least 3 descriptions of benefit factors and 3 cost factors. DO NOT give numerical values.

b) For each of your benefit or cost items in part (a), discuss how each item could be quantified and monetized. Be specific – if you need other data to do so, discuss how/where you might find that information. Note that you only need to discuss how to quantify – you do not need to actually quantify them.

c) Given the dollar values from this article, and your benefits and costs above, do you think that making this school ‘green’ has positive net benefits?
Part 4 (15 pts): All CMU-affiliated people (faculty, staff, and students) are able to get stickers on their ID cards allowing them to ride the local Port Authority Transit (PAT) buses and light rail vehicles in Pittsburgh. In this problem, you will estimate the number of trips per year taken by all CMU-affiliated people on these vehicles.

Note: Please do each part honestly, without looking ahead. This is how you become proficient at such problems, and 'cheating' by finding the answer ahead of time will only hurt your ability to improve. Remember that I care much more about your 'process' than I do about your answer.

a) Please follow a process similar to what we have done in class to make your estimate. Use only 'single estimates' rather than 'ranges' - i.e. you can use midpoint guesses along the way. Feel free to use a calculator for this, but NOT a computer. I want you to do this on paper.

b) WHEN YOU HAVE AN ESTIMATE from part (a), compare your answer with the data on campus (http://www.cmu.edu/planning/factbook/facts2001/) and the entire PAT system (not just CMU riders) found at http://www.portauthority.org/grow/pgstats.asp. Given this total system usage data, How close were you to the answer and comment on the 'difference' between your estimate and the real data, specifically on how your choices of assumptions might have led to the difference. Is your estimate realistic given the total data? Be sure to compare your CMU data on a per-capita basis with the implied per-capita rides taken by people in the Pittsburgh area on PAT.

c) Given your findings in part (b), use a more complex analysis (either on paper or via Excel) to make your 'original estimate' better and give a range where the actual answer fits. Use ranges of assumptions, more robust assumptions, etc.
A 'green' school saves on costs of energy

Monday, August 30, 2004

By Bill Toland, Pittsburgh Post-Gazette

HANOVER -- From the outside, Clearview Elementary School in Hanover looks brand-new, but otherwise unremarkable. The remarkable part is on the inside -- they've come up with a school that reimburses its owners over the long haul.

It's a school that saves about $18,000 a year through energy efficiency, compared to what a same-sized school built with traditional construction materials would normally consume in utility expenses. That's why Clearview, less than two years old, already serves as a landmark example of what an accommodating school administration and an environmentally sensitive architect can accomplish.

The eco-friendly concept school puts Hanover Public School District in York County on the leading edge of a construction trend that figures to grow in popularity over the next decade, as architects and builders learn more about so-called "green" design.

"It's a very responsible thing to do," said Jo Bookwalter, the school's principal. "If you can build it this way, and it only costs a little bit more to do it, why wouldn't you?"

During a building tour, which she's committed to memory in the 18 months since the school has opened, Bookwalter ticks off a list of features: recyclable modular carpeting, recycled steel siding, recycled cement block construction. Cabinets and countertops are made of wheat board, a renewable material that comes from the chaff left over after harvest. The gym floor is made of recycled tires. Bulletin boards are built from recycled plastic soda bottles.

Those features are merely environmentally sensible. But the savings come from other sources: The urinals in the boys' room are flush-less, which saves water. The walls are lined with two layers of a new, Styrofoam-like insulation padding. Classrooms are equipped with light sensors that dim the lamp bulbs if sunlight is sufficient for reading. The rooms also are equipped with motion sensors, which turn off the lights if nobody is in the classroom.
It adds up to one of the country's most environmentally friendly public schools, one of just three elementary schools nationwide to receive a gold "LEED" certification from U.S. Green Building Council. The LEED rating system stands for Leadership in Energy and Environmental Design, and the council is a group of builders promoting environmentally responsible construction.

While just 126 public and commercial buildings have so far received certification from the Green Building Council, more than 1,500 such projects are either under way or on the drawing board, according the council's in-house statistics.

There are 13 LEED-certified buildings in Pennsylvania, including Hanover's.

For such a forward-thinking project, Clearview's design and discussion phase was surprisingly rancor-free. Taxpayers in Hanover Public School District generally warmed to the design, the school board backed it, and by 2001 it was under construction. For a while, construction was behind schedule because of cement-pouring delays, and after the school opened there were initial problems with the heating system when the temperature dipped below freezing.

But that's about it, glitch-wise.

John Boecker, an architect from L. Robert Kimball & Associates, designed the 43,000-square-foot school with an ambitious plan in mind: Create a building that not only uses green materials during the construction phase, but also takes advantage of passive solar power to heat and cool the building and save on utility costs.

"It's sort of gained a national reputation," Boecker, one of the nation's top green designers, said of the school building.

The school's dominant bank of windows faces south. Spaced about 10 feet in front of the windows is a two-story concrete wall with window-shaped holes cut into it. In the winter, the holes allow the sunlight to beam directly through the windows, warming the south-side hallway.

And in the summer, late spring and early autumn, when people are using air conditioners, the sun is at a different angle in the sky. Instead of pouring through the windows, the direct rays of sun bounce harmlessly off the "sunscreen" wall, providing shade and preventing the school from getting too hot.

"You're looking for ways to eliminate systems, or eliminate redundancies," Boecker said. "So you're trying to come up with design ideas that perform many functions."

There's more:

- Below the floors in each classroom, there's a space called the plenum, a hollowed-out chamber that serves as the building's air conditioning system. Pressurized air is forced from the plenum through vents in the floor, instead of ceiling or wall vents. That leads to a more even distribution of air.
- The building's windows are triple-paned, to prevent heat and cool air from escaping.
- The classrooms have a warehouse feel, with exposed pipes and beams gracing the
ceilings, because Boecker decided to forgo traditional drop-down ceilings.

About 70 percent of the school's building materials came from Pennsylvania. In a roundabout way, that's also an environmentally friendly choice, because local products don't have to be transported long distances, which helps conserve gasoline and airplane fuel.

The school's heating and cooling system is tied to a series of 30 geothermal wells. The wells, 350 feet beneath the surface, keep water at a constant 55 degrees. In the summer, the warm classroom air is sent below ground, where it's cooled to 55 degrees before being returned to the classrooms. In the winter, cold surface air is likewise sent below ground, where it's warmed, then returned to ground level.

It's not just the flush-less urinals that save water. It's also the automated sink faucets, low-flow shower heads, and the landscaping schema -- landscapers selected hardy plants that don't require much irrigation.

The school cost about $7.1 million. A same-sized school -- Clearview can accommodate up to 300 pupils, grades kindergarten through fourth grade -- built with traditional materials would have cost about $6.5 million, Bookwalter said.

But the extra expense will be recouped through utility savings in about nine years.

So why don't more schools, and more architects, build this way, especially if extra construction costs can be offset by utility savings inside of a decade? In all, Boecker estimates, the school spends about 40 percent less on utilities than it would if it had been built "traditionally."

"It's really a function of education," Boecker said. "We're trying to disseminate this information to design professionals across the country ... It is becoming far more common in more and more school districts. Within the next 10 years, this will probably be commonplace."

The old Clearview Elementary, which sits behind the new one, will be demolished next month.

Tomorrow: First-generation college students can face a lot of hurdles on their path to campus.

(Bill Toland can be reached at btoland@post-gazette.com or 1-717-787-2141.)

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