MIDTERM REPORT

IPRO 320

Sustainability Planning of IIT Buildings

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OBJECTIVES

The objective of IPRO 320, Sustainability Planning of IIT Buildings, is to contribute to the problem solving necessary to implement energy efficiency improvements in existing buildings and to the central steam and electric systems. Alternate possibilities for energy use in context with their building type and surroundings will be discovered through research of other university buildings at the University of Chicago, Loyola University, and IIT. This research will then be used in finding alternate forms of energy generation to secure the sustainability of the IIT campus. Also, thermal images of buildings on all three campuses will be analyzed to see where the buildings are losing heat.

RESULTS TO DATE

The data collection team has been working with facility members from University of Chicago, Loyola University, and the Illinois Institute of Technology to understand the heating and cooling requirements of all three campuses.

A tour was conducted by IIT's power personal to give students an idea of the layout of the facility. They also showed the improvements being made to enhance the efficiency of the plant. Currently, there are two new 20,000 pound boilers running at 85% efficiency. The steam can be powered using either fresh air, which comes in at 48000 pounds of pressure per hour per unit, or, for elevated steam needs, the turbines can be turned on to force 69000 pounds of pressure per hour per unit through. These gas combustion turbines run at 5000 horsepower. Further along the steam generation line, the condensate return tank gathers up the now-cooled steam from the steam lines. Another machine polishes this water and resoftens it, since it has gathered up hard mineral deposits from the trip through the pipes. Also on our tour were the old coal-burning boilers, which have obviously been updated as there are newer, much more efficient ways of generating heat.

During the University of Chicago tour, the director answered many questions about their steam and chilled water production. During the summertime, U of C cools its buildings through chilled water flowing through the building with fans blowing over to create and air conditioned atmosphere. The problem that faces this campus is the fact that they cannot turn off steam to conserve energy since the hospital that is located on campus has specific heating and cooling requirements. The 1929 steam plant located on the southeastern portion of the campus formerly ran off of coal, similar to the IIT campus plant. Today, four natural gas powered boilers are used to heat the steam. Usually, only two to three of the boilers are ever running at one time, as the fourth is considered a "backup." Generally, about 180,000 pounds of steam per hour run through the plant, increasing to around 350,000 pounds per hour in the wintertime. Summer production is around 100,000 pounds per hour. The exhaust from the electric fans and turbines is used to heat the surrounding buildings. Water purification for the steam is also important, and they are building a new facility for this within the next six months. Currently, they are getting 85% of the condensate back that they send out as steam. Facilities continues maintenance on the steam traps to improve this percentage. In the near future, U of C will be breaking ground on new chiller and steam facilities.

A representative from Loyola University met with our group to discuss their systems and how they are making their new building more energy efficient. The key to Loyola's energy saving method is to run the system at different levels depending on the requirements of the buildings. There are sensors in each of the buildings connected to the main system that determine water volume going into and out of the building. These sensors enable the plant to slow the pumps down and divert that pressure to other buildings. Once all the requirements are satisfied, the pumps are slowed down. Fans are also sensored using frequency drivers to save on horsepower. The campus has been automatic for two years now. Information is send through Ethernet to the main control station. Thus far, the campus has saved $200,000 a year on the automation of the steam production and $80-100,000 on chillers. The new refrigerants used lead to more efficient motors. Problems arise for the heating and cooling requirements of laboratory buildings, which, according to code, must be 100 percent outside air at a constant pressure. The new library that is being built will use the breeze from the lake to cool. The windows open on the east side, allow air to flow through the building and come out a chimney-like window setup. Automatic shades control natural light from the sun as well as the heat energy associated with it. The entire Loyola system is only ten to eleven buildings, since the campus is split up by major Chicago roadways. The distance of the campus also makes steam connection difficult.

Illinois Institute of Technology

We are currently analyzing preliminary research from the IIT campus, which includes research the students have done themselves, and information given by the university. The information that we have collected include, but not limited to, are campus size, number of buildings on campus, landscaping plans, site plans and energy facilities layout plans. Part of our research includes using a thermal imaging camera to test the efficiency of doors and windows on campus. Results from this camera are expected within the next two weeks. From these images, we will be able to compare the efficiency of the buildings not only on the IIT campus, but at Loyola and the University of Chicago as well. By the comparison of the three campuses, we hope that we can take sustainability design ideas from Loyola and the University of Chicago and address them on the IIT campus. While the aim of our IPRO is not to create a working prototype, we do expect to have various ideas, from research of Loyola and U of C, on how to improve the efficiency of the IIT campus. We feel that the results we obtain will address the problem of efficiency at IIT.

University of Chicago

The University of Chicago is located in Hyde Park, eight miles south of downtown. There are 136 buildings on the campus's 211 acres.

At the University of Chicago, there are currently 4,391 undergraduates, and 9,110 graduates. There are also 2,160 faculty members as well as 12,460 total employees.

According to the University of Chicago website, there are 33% students of color, 76% from the Midwest, 45% under twenty-five years old, 30% between 25-29 years old, 15% between 30-40 years old, and 9% over forty years old.

The original buildings at the University of Chicago are English Gothic style, which are grouped around quadrangles with a handful of Contemporary buildings as well. These include Laird Bell Law Quadrangle, the School of Social Service Administration, Joseph Rezenstein Library, and Max Palevsky Residential Commons.

Loyola University

Reduced energy usage = $avings.

The above statement can be accomplished by several methods;

- Design – whether Architectural , Mechanical or Electrical
- Building Automation
- Building Materials
- Usage Strategies

Design

1. Architectural
    - orientation of the building to the Sun - reducing the Solar load
    - Automated Shading – closes shades as Sun rotates around the building.

Opens as the Sun moves around the building, also known as “Daylight Harvesting”. Maintains proper interior lighting levels with minimal use of artificial lighting and electricity. Sensors tract the lighting levels within the building and automatically turn on/off lights as necessary.

- Passive Solar walls – chimney effect, moving air naturally to or away from desired areas.
- Rooftop Gardens – reduce roof’s solar load.

2. Mechanical
   - Air Conditioning using “Chilled Water” – went from constant pumping to variable flow/volume. Reduces the required pumping horsepower by moving a lesser volume of water. Resulting in less electrical energy used by the pumps, the fans that distribute the cooler air in the space and the air conditioning equipment that produces the chilled water.
   - VFD – variable frequency drives are used to control motor speed/electrical usage and reduce the flow of air or water through its respective system.
   - “In Floor” radiant heating or cooling. Take advantage of the concrete’s mass. Once heated or cooled the concrete provides a “fly wheel” effect to continue to heat or cool, even if the boiler or air conditioning unit has been turned off.

3. Electrical
   - Better lighting techniques. More lumens using less wattage/electricity.

Building Automation

- Programming fans, pumps associated equipment to only operate when necessary. “off” is the best energy strategy for saving money.
  Operational Modes – Duty Cycling, Optimum Start all operate the fans only as necessary. Unoccupied vs. Occupied temperature settings for classrooms and offices. The “Unoccupied” setting saves at least 2% of electrical usage per degree setback from the occupied temperature set point.
- The constant surveillance by the automation system keeps space temperatures at or very close to the desired set point.

Usage Strategies

- Utilize as many hours in the “Unoccupied Mode”. Everything operates at a lesser capacity, which saves energy.
- Don’t forget “Holiday” schedule. This is a great opportunity for an extended “Unoccupied Mode”.

Building Materials

- Thermal Pane/Double Glass Windows – reduce heat transmission.
- Low E Glass – reduces solar transmission through glass.
- Color of roofing and building material.

REVISED TASK / EVENT SCHEDULE

The schedule of tasks for the semester has been divided into two phases; Phase One includes all of the research and data gathering necessary to conduct our analysis of energy usage at the three campuses. The schedule for phase one includes the following critical events:

- Speakers from IIT, University of Chicago, and Loyola meet with all team members to brief them on the energy systems and facilities of each campus
- All team members participate in site visits to each campus where necessary data can be gathered and further meetings with facilities staff can be conducted. The information to be

gathered from site visits pertains to landscape records, utilities equipment and facilities organization, energy usage, and campus building history.

- Thermal imaging will be utilized as much as possible on each campus, and the utilities team will analyze the photographs to discuss the significance of that they show.
- The teams decide on buildings from each campus which have energy usage designs that attain sustainability and have significance for possible implementation elsewhere, including the IIT campus.
- R-values for significant buildings are calculated and a design analysis for these buildings discussed by both the architectural and utilities team.
- The website for IPRO 320 will continually be updated throughout this phase and Phase Two as significant data are gathered.
- Phase one ends at which point the midterm report is due.

Phase Two will consist of presentation of the data and analysis from Phase One, along with further research of possibility for sustainability that have not yet been implemented at either of the three campuses. The tasks for Phase Two follow in chronological order:

- Designated data person from each Architectural team lead their team members while the poster and other presentation visuals are prepared.
- Utilities team research emerging energy technologies that have significance for implementation, and possibly create a design plan for how one or two of these technologies could be implemented.
- Analysis of available sustainability and recycling grants along with application for grants that have applicability at the IIT campus. At the present time, one possible recycling grant is already being discussed.
- All deliverables required by the IPRO office are completed, including the final poster, abstract, final report, website and CD-ROM.

A more detailed breakdown of tasks, showing all sub-tasks involved and also including estimates of hours needed to complete each task can be found in the chart from Microsoft Project below.

		Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**WEEKLY MEETINGS**	**6 days**	**Thu 8/24/06**	**Tue 12/12/06**		
2		WEEKLY MEETINGS 1	1 day	Thu 8/24/06	Tue 9/12/06		
3		WEEKLY MEETINGS 2	1 day	Tue 9/12/06	Thu 9/28/06	2	
4		WEEKLY MEETINGS 3	1 day	Thu 9/28/06	Tue 10/17/06	3	
5		WEEKLY MEETINGS 4	1 day	Thu 10/19/06	Tue 11/7/06	4	
6		WEEKLY MEETINGS 5	1 day	Tue 11/7/06	Thu 11/23/06	5	
7		WEEKLY MEETINGS 6	1 day	Thu 11/23/06	Tue 12/12/06	6	
8		**WEEKLY WEBSITE INPUT**	**6 days**	**Thu 8/24/06**	**Tue 12/12/06**		
9		WEEKLY WEBSITE INPUT 1	1 day	Thu 8/24/06	Tue 9/12/06		
10		WEEKLY WEBSITE INPUT 2	1 day	Tue 9/12/06	Thu 9/28/06	9	
11		WEEKLY WEBSITE INPUT 3	1 day	Thu 9/28/06	Tue 10/17/06	10	
12		WEEKLY WEBSITE INPUT 4	1 day	Thu 10/19/06	Tue 11/7/06	11	
13		WEEKLY WEBSITE INPUT 5	1 day	Tue 11/7/06	Thu 11/23/06	12	
14		WEEKLY WEBSITE INPUT 6	1 day	Thu 11/23/06	Tue 12/12/06	13	
15		**WEEKLY WEBSITE UPLOAD**	**7 days**	**Tue 8/29/06**	**Thu 1/4/07**		**ANNA**
16		WEEKLY WEBSITE UPLOAD 1	1 day	Tue 8/29/06	Thu 9/14/06		
17		WEEKLY WEBSITE UPLOAD 2	1 day	Thu 9/14/06	Tue 10/3/06	16	
18		WEEKLY WEBSITE UPLOAD 3	1 day	Tue 10/3/06	Thu 10/19/06	17	
19		WEEKLY WEBSITE UPLOAD 4	1 day	Tue 10/24/06	Thu 11/9/06	18	
20		WEEKLY WEBSITE UPLOAD 5	1 day	Thu 11/9/06	Tue 11/28/06	19	
21		WEEKLY WEBSITE UPLOAD 6	1 day	Tue 11/28/06	Thu 12/14/06	20	
22		WEEKLY WEBSITE UPLOAD 7	1 day	Tue 12/19/06	Thu 1/4/07	21	
23		**RESEARCHING PHASE 1**	**7 days**	**Thu 8/24/06**	**Tue 1/2/07**		
24		NANCY SPEAKS TO U OF C	1 day	Thu 8/24/06	Tue 9/12/06		NANCY
25		QUESTION LIST FOR U OF C	1 day	Tue 9/12/06	Thu 9/28/06	24	ANNA,CHRISTINE,CRAIG,DESPINA,EF
26		LIST COLLEGE COMPARISON DATA	1 day	Thu 9/28/06	Tue 10/17/06	25	ANNA,CHRISTINE,CRAIG,DESPINA,EF
27		PROJECT PLAN	1 day	Thu 8/24/06	Tue 9/12/06		JOANNA
28		**GUEST SPEAKERS**	**0.56 days**	**Tue 10/3/06**	**Tue 10/10/06**		
29		IIT	0.19 days	Tue 10/3/06	Tue 10/3/06		
30		LOYOLA	0.08 days	Thu 10/5/06	Thu 10/5/06	29	ANNA,CHRISTINE,CRAIG,DESPINA,EL
31		U OF C	0.19 days	Tue 10/10/06	Tue 10/10/06	30	
32		**SITE VISITS**	**3.83 days**	**Thu 8/24/06**	**Thu 11/2/06**		
33		OBTAIN EQUIPMENT LIST OF EACH S	1 day	Thu 8/24/06	Tue 9/12/06		
34		VISIT U OF C ENERGY CONTACT	1 day	Thu 8/24/06	Tue 9/12/06		
35		VISIT U OF C LANDSCAPE RECORD	1 day	Tue 9/12/06	Thu 9/28/06	34	
36		VISIT LOYOLA ENERGY CONTACT	1 day	Thu 9/28/06	Tue 10/17/06	35	ANNA,CHRISTINE,CRAIG,DESPINA,EF
37		VISIT LOYOLA LANDSCAPE RECORI	0.33 days	Thu 10/19/06	Tue 10/24/06	36	JOANNA,CRAIG,GUILLERMO
38		UTILITIES GROUP	0.5 days	Tue 10/24/06	Thu 11/2/06	37	LIZ,ERICA
39		CAMPUS HISTORY	7 days	Thu 8/24/06	Tue 1/2/07		ANNA,CHRISTINE,CRAIG,DESPINA,EF
40		**THERMAL IMAGING**	**2.83 days**	**Thu 8/24/06**	**Tue 10/17/06**		
41		TRAINING TO LEARN CAMERA USAC	1 day	Thu 8/24/06	Tue 9/12/06		ANNA,CHRISTINE,CRAIG,DESPINA,EF
42		PHOTOGRAPH IIT	0.5 days	Tue 9/12/06	Tue 9/19/06	41	ANNA,CHRISTINE
43		PHOTOGRAPH LOYOLA	0.5 days	Thu 9/21/06	Thu 9/28/06	42	JOANNA,CRAIG
44		PHOTOGRAPH U OF C	0.5 days	Thu 9/28/06	Tue 10/10/06	43	DESPINA,MELISSA
45		COMPARE PHOTOGRAPHS	0.33 days	Tue 10/10/06	Tue 10/17/06	44	ANNA,JOANNA,MELISSA
46		**DESIGN BUILDING ANALYSIS**	**3 days**	**Thu 8/24/06**	**Tue 10/17/06**		
47		CHOSE ONE BUILDING ON EACH CAI	1 day	Thu 8/24/06	Tue 9/12/06		
48		FIGURE OUT R-VALUE OF WALL	1 day	Thu 8/24/06	Tue 9/12/06		
49		COMPARE CAMPUS BUILDINGS DAT.	3 days	Thu 8/24/06	Tue 10/17/06		
50		**MID TERM REPORT**	**1 day**	**Thu 8/24/06**	**Tue 9/12/06**		**ANNA**
51		DIVIDE WHAT IS DUE	1 day	Thu 8/24/06	Tue 9/12/06		ANNA,CHRISTINE,CRAIG,DESPINA,EF
52		**RESEARCHING PHASE 2**	**7 days**	**Thu 8/24/06**	**Tue 1/2/07**		
53		POSSIBLITIES OF NEW TECHNOLOGIES /	7 days	Thu 8/24/06	Tue 1/2/07		
54		INNOVATIVE METHODS FOR IIT	7 days	Thu 8/24/06	Tue 1/2/07		
55		APPLICATION FOR ILLINOIS RECYCLING	1 day	Tue 11/28/06	Thu 12/14/06		
56		**FINAL PRESENTATION**	**5 days**	**Thu 8/24/06**	**Thu 11/23/06**		**ANNA,CHRISTINE,CRAIG,DESPINA,I**
57		CHARTS FINALIZED	1 day	Thu 8/24/06	Tue 9/12/06		
58		DATA ORGANIZED	1 day	Tue 9/12/06	Thu 9/28/06	57	
59		WEBSITE COMPLETED	1 day	Thu 9/28/06	Tue 10/17/06	58	
60		ABSTRACT DUE	1 day	Thu 10/19/06	Tue 11/7/06	59	
61		POWER POINT PRESENTATION	1 day	Tue 11/7/06	Thu 11/23/06	60	
62		FINAL REPORT COMPLETED	1 day	Thu 8/24/06	Tue 9/12/06		
63		POSTER DESIGN	1 day	Thu 8/24/06	Tue 9/12/06		
64		POSTER DUE	1 day	Thu 8/24/06	Tue 9/12/06		
65		IPRO CD DUE	1 day	Thu 8/24/06	Tue 9/12/06		

UPDATED TASK ASSIGNMENTS AND DESIGNATION OF ROLES

Loyola University Research Team	* Joanna Ruiz Craig Lanum Guillermo Gomez
University of Chicago Research Team	* Melissa Friel Despina Zouridis
Illinois Institute of Technology Research Team	* Chrissy Atterberry Sean Thompson

* Data person that will coordinate research with other research teams and provide the data to the IPRO class in a manner that is easy to compare, analyze, and make conclusions.

Utilities and Data Engineering Analyzing Team	Elizabeth Bilitz Eugene Gargas
Policies and Grants Research / Floater	Erica Kahr
Minute Taker/ Agenda Maker	Erica Kahr
Master Schedule Maker	Joanna Ruiz
Web Site Designer	Anna Dannhausen

BARRIERS AND OBSTACLES

The biggest challenge for the data team at the moment is general understanding of heating and cooling systems. As our team is composed of members who are not familiar with these systems, background research has been a must.

Another obstacle our team has is finding a time to meet outside of the scheduled class time. A lot of the research we have done has required our team to accommodate the schedule of a lecturer or tour, or to find a time that is longer than the time allotted for class. Our team has not overcome this barrier, but has had to allow some students to not attend all tours. This has taught the team to teach the information to other group members, allowing them the same knowledge that they received first hand.

Our next obstacle that must be resolved before completing the work is compiling the knowledge and data we have received into a report that can be easily read by the common person. The technical information we are researching must be presented in a way that is understandable and useable by anyone. We intend to work as a team in preparing the charts and graphs necessary to explain what we have researched and the conclusions we have made.