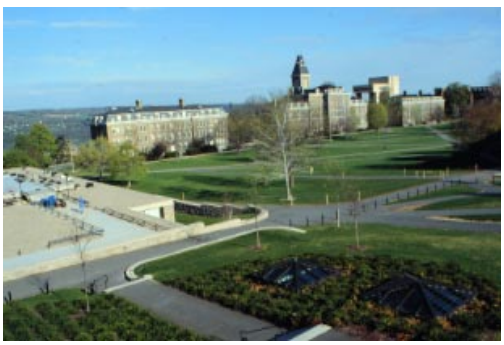
Introduction to the Building Balance Point

Reason for the Balance Point Test- The Building Balance Point Test was developed to explore the thermal life of buildings, by determining the relationship between the internal heat production, building envelope performance, occupant thermal demands and the climatic conditions.

Definition of the Building Balance Point- The balance point is the outdoor air temperature causing building heat gains to be dissipated at a rate that creates a desired indoor air temperature.

The strength of the balance point as a concept is in the way that it relates all of the major energy flows within a building to each other and to the overall fit of the building to its climate.

In conducing the following study of **Kroch Library**, an underground structure, the team sought to determine how this critical position(below the earth's surface) would effect the building's performance.



Hypothesis

How are underground buildings classified in modern HVAC terms—as internally load dominated or as skin dominated?

Given Kroch Library's physical condition it would seem to be an internally load dominated building with a low balance point.

Evaluation standards

Low balance point- building needs constant cooling
internal load= high internal gains, low skin loss

High balance point- building desires heating as main concern
skin loaded= heat transfer through the envelope

This condition results in a building envelope with low skin losses and a low balance point temperature, therefore creating the need for constant cooling. Whether or not the Kroch section is actually this type will be analyzed in this study.

Methods

In determining the building balance point three aspects of the building are research through field verification and reference materials. The three areas include: heat transfer through the building envelope, heat transfer through glazing and building heat gain through occupancy loads.

Purpose- To develop a critique of the building's energy flows and design

Information collected from numerous site visits

Information collected through research

blueprints of the building for square footage
blueprints of building details for material identification
macros for calculating results via Excel




Methods of calculation
For Internal Heat Gains

Lighting Heat Gains- a)Count the light fixtures **(l.f.)** within the building
b) Determine wattage **(W) f**or each fixture.
c) Multiply number of **l.f.** by **W**.
d) Convert **W** to **Btu/hr**.
e) Divide **d** by **square footage** of the building

Occupancy Heat Gains-a) Determine occupancy level as based on amount of seating and office space allotted by architect.
b)Given the use of the building, **40%** occupancy is approximated for all times.
c) Select predetermined activity levels from ASHRAE standards
d) Divide **a** by **square footage**

Equipment Heat Gains-a) Count equipment
b) Count staff
c) Divide **a** by **square footage per person**

Results of visit
For Internal Heat Gain
Lighting Heat Gains-

Type	Number of fixtures		Wattage	Total
4' fluorescent bulbs	1834	*	32	58,688
Relamp quad tube bulbs	191	*	18	3438
				62126

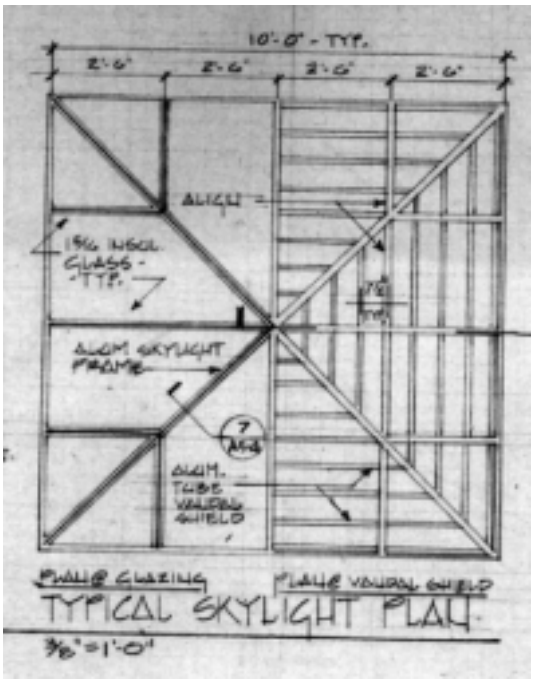
62,126 Watts = 211,973.9 Btu/hr
Total Square footage= 104,397
BTU/hr/sf= 2.03

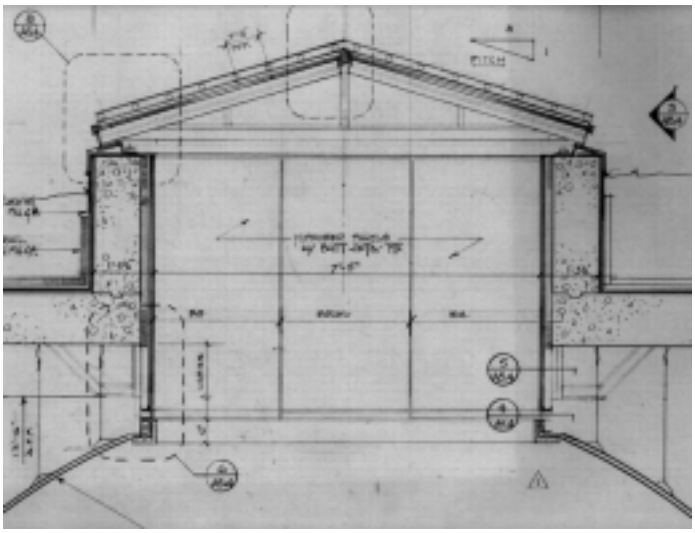
Occupancy Heat Gains

Seating	Number of units
Graduate Carrels	22
Faculty Carrels	12
General	100
Conference	60
Classroom	20
Office	44
	= **258**

Equipment Heat Gains

Type of Equipment	Number of units
Computer	54
Printers	44
Xerox machines	4





Methods of Calculations

For Heat Transfer Rate through Building Envelope

Ground Heat Transfer Rate:

a) Through architectural drawings the perimeter of the building was calculated.

b) Through architectural drawings the construction materials were noted and then calculated for determine the R value.

Wall Heat Transfer Rate:

a) Through architectural drawings the wall surface area was calculated.

b) Through architectural drawings the construction materials were noted and used in determining the U values by adding the resistance of each component and taking the inverse of the total resistance.

Roof Heat Transfer Rate:

a) Through architectural drawings the roof surface area was calculated.

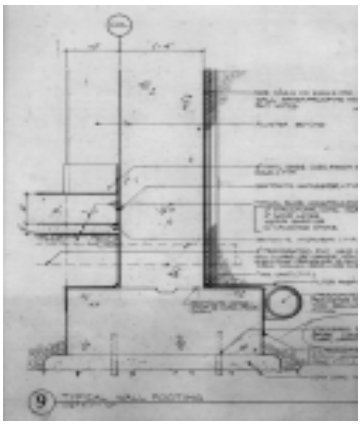
b) Through architectural drawings the construction materials were noted and used in determining the U values by adding the resistance of each component and taking the inverse of the total resistance.

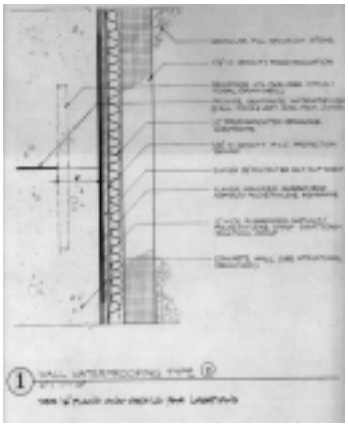
Method of Calculations

Glazing Heat Transfer Rate

a)glazing was investigated and calculated in relation to the total building surface area.

b) Through architectural drawings the construction materials were noted and used in determining the U values by adding the resistance of each component and taking the inverse of the total resistance.





Results

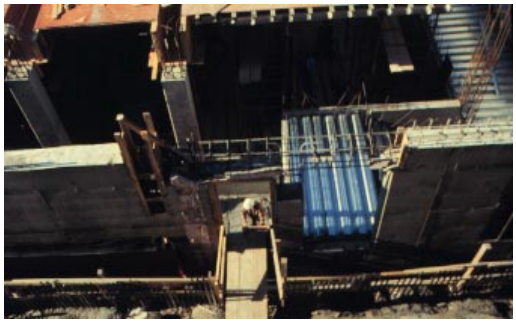
See appendix for graphs and results of investigation.

Conclusions/Lessons Learned

The hypothesis of this study was confirmed. Kroch Library does in fact have a low balance point temperature and requires constant cooling.

The holistic nature of the study gives one a sense of the energy flows through Kroch Library and aids the reader and the performers of this study in understanding the scale and factors that influence the thermal conditions of this space.
Each step evaluates a particular flow path for energy exchange between the building and the environment. The synthesis of this information helps to characterize the buildings metabolism. The resulting data has provided a crude but telling profile of the building's climatic fit.[

The study also reveals the complexity of the conducting this type research on such a unique building. The effects of locating a building underground have only begun to be addressed by this study.



Individual Statement
For J. Scott Walsh

The opportunity to conduct this type of research has been an excellent chance to test and to critically look at many of the issues addressed in this course and to relate them to building performance. The type of analysis that was completed in this project has been invaluable at addressing the complexities and factors involved in accessing building performance. My personal understand of the issues at hand has increased dymatically as a direct result of this research project.

Although our group come to the building balance point research a bit confused and disorganized, I believe that everyone benefit greatly from the research conducted. The complexities of how to collect and to analysis such a great amount of data, at times was overwhelming and made everyone wish for a statistical methods course before the study began. In spite of the difficulties and the unknowns in our building type the study as a learning instrument was invaluable at bring the course themes together as one. Ending the term with the building balance point provided a sense of closure and the opportunity to reflect and synthesis the concepts in a holistic view.

I was committed to during the building balance point in spite of the intense time commitment and lack of certainly along the way. To the best of my ability I attempted to guide the group through the literature and to interpret the flows of information. The collection of data and All in all, this was a very intense, educational experience and I am glad I partook in it.

Individual Statement
For Olalekan Jeyifous

Vital signs indeed! in order to fully appreciate this study I had to force myself to engage the project at a surface in which I could begin to fathom the extent of the data at an intermediate level. Well, that means that all the numbers and facts had to be injected into my cerebrum and then projected into this simple equation: DATA(research)+visual inspection/gross extrapolation(concerning subterrainean structure)= HVAC system which remains virtually consistent in operation as opposed to an

above-ground construct which requires perpetual maintenance to accomodate its sporadic and dynamic surroundings.

Obstacles were many yet I am pleased that the group was able to cooperate in order to compile all the necessary information. My assistance was found in organizing the visual work as well as helping to decipher excel and a few meager attempts at assessing shading coefficients.

All in all, I am overall pleased with the process as well as the outcome and have grown to appreciate the tedious assignments which ultimately fostered a clearer understanding of HVAC systems.

Individual Statement
For Emmanuel Pratt

When the project was initially proposed, I found that this particular study would be quite interesting since it dealt with a hands on investigation of one of the most unique yet tangible buildings on campus . Actually, I had often wondered why the architect had chosen to place the library underground and what type of impact (both structurally and thermally) this would have on the design. Little did I know what we had gotten oursleves into..... we would soon learn all the answers to these questions and more.

Out of all the projects done this semester for HVAC, this vital signs project was the most painstaking yet the most valuable hands down. It required a strategic and innovative approach to investigation (due to the underground design of the building) which required all of themembers to to tap into their creative reesources and properly evaluate the correct method of studies and evaluations. Also, the project required a high level of dedication from each member in terms of collecting specific data in regards to building components and formulas in order to fully comppile a proper study of the infamous balance point.

One of my specific roles in the group dealt with the collection and evaluation of data for the heat gain/transfer rate of the building. This particular study was quite difficult for me since it required a complete study of the building components/materials and an indepth investigation of how to determine and calculate the r and u values .

Looking back on the project, I now realize the impact it had on my understanding and my newfound appreciation for HVAC as it has allowed me to apply many of the principled we learned in class (and even some we didn't) to a modern day example.