The following pages contain a comprehensive building audit for the Alan M. Scaife Hall of Engineering on the campus of Carnegie Mellon University in Pittsburgh, Pennsylvania.

It has been assembled by a team of fourth year architecture students in the 48412 Mechanical Systems class, under the guidance and direction of engineer and professor Gerry Mattern.

Within this document there is information about the various mechanical systems proposed by the original architects, the current condition of each system, and its effectiveness in facilitating a safe building that is comfortable to work in. There is also a series of recommendations made by the team based off of observations, inquiries, and studying of the various systems and their parts.
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In the 1960’s, Carnegie Mellon University experienced a miniature building boom. This marked a new era for the school, and the rapid level of construction which ensued kept pace with the school’s emergence as a center of innovation and exploration in new technological advancements. Within a short period of time, four new buildings were erected on campus, including Hunt Library, Warner Hall, Skibo Hall, and Scaife Hall, which is the subject of the following report. All four of these buildings were significant at the time of their construction for their responses to new technological factors and developments in building systems.

The Alan M. Scaife Hall of Engineering was designed for the Carnegie Institute of Technology by the firm of Altenhof and Bown in 1961 and construction was completed in 1962. Altenhof J. Lewis and Bown B. Phillips, who were also architects of the Pennsylvania State Office Building (1957) and later the Moorhead Federal Building (1964) were invested in revitalization of Pittsburgh during the postwar era. Their commission to design Scaife Hall came with the understanding that they would execute an academic building that would be as much functional as it was aesthetically composed.

When it opened, Scaife Hall housed classrooms and offices for the School of Engineering. Its unusual lecture hall wing, now nicknamed ‘The Pringle’ gave it a unique identity on campus and within the local campus community of Oakland. Now, forty-eight years later, Scaife Hall still retains a presence on campus. It underwent many revisions during the design process, as well as several major renovations since its opening. Documented renovations occurred in 1962, 1963, 1964, 1965, 1966, 1967, and 1987.

With this in mind, it is perhaps a comfort to know that the architects were self-critical and willing to make necessary
alterations in their plans according to what the building was intended to be used for and how the mechanical systems were working or not working. On the other hand, there is limited recorded information about what events precipitated these renovations over the decades, which brings into question the architects’ awareness and understanding of which systems were the best to use, along with how best to implement them.

As one of the team’s tasks was to generate a greater understanding of the building’s performative qualities by studying its history, the high amount of renovations raised concerns. In the renovation that happened just a year after opening, for example, the changes were focused on rewiring parts of the building to provide for more access panels and breakers as well as removing partitions and installing new ones. From studying the original construction documents and comparing them to these revised versions, it is clear that the architects didn’t anticipate certain demands that users would have on the building. Almost half a century after construction of the building, this fact resounds more than ever. The internal layout and function of the building has shifted dramatically from its original composition, resulting in new air flows, heat exchanges, and mechanical and service room requirements. All of this, in turn, has lead to new user interactions in an environment where the demand for control and comfort is ever-growing.

This building audit takes all of these factors into consideration in the criticisms and recommendations that follow.

‘The Pringle’ lecture hall.
Throughout the course of this project, the team had the chance to speak and interact with several different people, each representing a different sector of users within the building. These conversations and interactions proved invaluable to our auditing process, as they revealed the opinions, frustrations, and commendations of those who work within the building each day. It served as a good starting point for further investigations into the building.

1. Facilities Management Services Director
The team contacted Don Coffelt, the director of Facilities Management Services (FMS) on campus. While setting up a meeting with him proved unsuccessful, he did inform us of the importance of such studies, and his genuine interest and willingness to provide us with information was an asset. He pointed us to members of his staff with whom we could speak with in more detail, and recognized that Scaife Hall does need upgrades and improvements.

2. Facilities Management Services Electrician
In addition to Don, we spoke with an FMS Electrician (name unknown) whom we encountered while doing a survey of the building. His primary concern was with the wiring in the building, and at the time when we intercepted him he was investigating the source of an electrical burning smell within the ground floor entry area. His knowledge of the other systems within the building was limited, but he did attest to the fact that Scaife Hall gets many maintenance requests. (Note - the ultimate source of the burning smell was determined to be coming from a grate near the floor in the wall adjacent to the main entrance from Tech Street. The reason for the smell was not determined during our time in the building).
3. Two Elevator Repairmen
During a walk-through of the building, we encountered two elevator repairmen in the basement level working on fixing the elevator. They mentioned that they receive a call every few weeks to come service the elevator, which consistently and repeatedly breaks down. We were afforded a glance into the elevator mechanical room, which was a mess of wires and breakers, most of which were clearly as old as the building itself.

4. Two Staff members within the school of Engineering
Our team’s discussion with these two women who worked in a fourth floor office were the most insightful and useful to us of all our interactions. Both women have worked within the building for several years, and they graciously provided us with a list of positive and negative attributes that they believe the building possesses.

Among the strengths of Scaife Hall, mention was made of the great views, the stable temperatures, the amount of individual control allotted for temperatures, and the recently installed windows.

The weaknesses were far more numerous. They mentioned Scaife Hall’s history of being a ‘Sick’ Building (one of the women was a former Health Services employee as well, and she was knowledgeable in this). While they conceded that the building has gotten much better, especially since renovations made in 1987, they both voiced concern about the illogical placement of bathrooms, the limited access hours to the building, the lack of a fire escape, and the inefficiencies of the metal screen that enshrouds the whole building. With regards to this, they said that the screen, while a good idea in theory, is damaged, difficult to maintain, a hazard to those who touch it (due to its sharp components), and another barricade against proper fire egress. According to the women, Scaife Hall is still considered up to fire code, but a quick look at the outdated alert systems and the lack of emergency stairs reveals that this could only be the case through one specific interpretation of the code, and should certainly be reconsidered and addressed.

Conclusions
Our general conclusions from all of these interactions was that across the boards there is a consensus that Scaife Hall has been slowly improving in its performative aspects. That being said, Scaife Hall still has gross mechanical shortcomings despite the attempts made over the years to address deficiencies in its operability.
Scaife Hall is uniquely situated on the Carnegie Mellon Campus. Its location affords both advantages and disadvantages that greatly affect how the building performs and how it needs to react to the elements and the people who use it on a daily basis.

Scaife Hall is a prominent building on campus because of its proximity to Frew Street and Schenley Bridge. While the building possesses architectural significance, it is not as accessible as it could be in its role as a gateway to a college campus.

There are two primary issues regarding access to Scaife Hall. First, Scaife Hall is completely locked from around 9:00PM until 7:00AM during weekdays and all of the time on the weekends. Second, there is no information desk or public office on the ground floor where a visitor could receive information or direction.
Scaife Hall’s location on the edge of campus makes it somewhat disconnected. It occupies a fringe space and is out of the way for most students and faculty.

Scaife Hall is further isolated from the rest of campus by the fact that no side of the building is directly connected to major campus pedestrian routes. The West side of the building has a steep drop down to Boundary Street, the North side has an isolated and exposed basement level, and the East side has a parking lot. The South side of the building has an entrance that connects to Frew Street, and it is the most accessible side of the building, though oriented away from the campus. The lack of pedestrian access and the existing circulation patterns further alienate the building and the people who work there from the rest of campus.

With its given location at the edge of Carnegie Mellon’s campus, Scaife Hall faces significant environmental factors, the most crucial being solar gains and heat loss due to exposure.

The prominent West face of the building is on a steep hill and exposed to intense solar gain. This is mediated by the shading system of metal louvres. However, this system encases the entire building, blocking gain on other sides that could potentially be positive.

In addition to issues with solar gain, exposure to the winter elements is a big adversity to the location of Scaife Hall. The winter wind in Pittsburgh blows predominantly from the West, and the entire Western face of Scaife Hall experiences significant heat lose due to infiltration, which is exaggerated by the percentage of glazing on the facade. The wind also brings pollutants which stick to the shading device and leave a residue of dirt which is hard to remove and detrimental to the building’s appearance.
CURRENT CONDITIONS

The current envelope of Scaife Hall consists of a double layered facade, comprised of glass windows shaded by inoperable metal louvers. The windows are still mostly original, single-pane glass, though there are some replacement windows which were installed during a renovation over a decade ago. The new windows are double-paned and sealed better than the originals. They exist mostly in the administrative spaces of the ground floor and office spaces on the top floor.

There’s a significant amount of infiltration coming through the windows in general. Of the rooms we explored, most contained just one operable window. Some contained none, and none of the operable windows looked to be usable during the event of a fire or other evacuation emergency because they are too small for a person to fit through.

Glass accounts for about 75% of the facade in Scaife Hall, and the heat loss and infiltration associated with this makes for an inefficient envelope system.

The usefulness of the metal louvers is limited because there’s only a major need for shading on the Southern side of the building and some parts of the Eastern and Western sides. On the Northern side of the building, the louvers block indirect sunlight and views, creating dark interior spaces.

Because the louvers wrap completely around the building, they negate any possible chance of fire escape through the envelope. A person could conceivably step out of the building onto the platforms located in the space between the glass and louvers, but they would find no accessible egress to the ground.

Additionally, the blackout shades used within the classrooms tend to remain down during the day, causing occupants to turn on the lights, as opposed to just opening the shades for natural light.
TO MAKE IT BETTER

To promote better egress and fire safety, our team proposes removal of the louvers on the North, East, and West facades. The building is already in shadow most of the day from surrounding trees and structures. Removing the shading mechanism will allow for better views and, more importantly, will allow the possibility for fire escapes, which could be integrated in a complimentary way to the existing aesthetics of the building.

It is also encouraged that more operable windows be installed and that those windows be more energy efficient. Double-paned low-E argon filled glass windows are recommended for this. Infiltration and heat loss through the glass will immediately be reduced once this done.

Finally, and if nothing else, users of the building should be more informed about how to use the existing shading devices and windows to maximize user comfort and safety. Any existing operable windows should be opened in the springtime and fall (weather permitting) to let in fresh air and reduce mechanical loads. Blackout screens over windows should be raised at the end of each class or meeting to allow natural light into the spaces, and paths of egress should be more clearly marked and defined. In this way, the envelope can be useful to the building and its users instead of a detriment.
The HVAC system in Scaife Hall is outdated and inefficient. During the building analysis a lag in the response time of the HVAC system was perceived. There is a central heating and cooling system which appears to be zoned room by room. The success of this system is questionable though. Most classroom and office spaces have additional electrical baseboard heating along the perimeter of the room which hints at deficiencies. There are many different parts of the building with vastly different heating and cooling requirements which as of now are satisfied only with great strain and expense. A good example of this would be the basement room that houses computer servers which must be carefully regulated to protect from overheating.

The building is positively pressured, meaning that air flows from the inside of the building to the outside. This helps prevent the cold from coming in, but on the other hand the heat also leaks out, increasing the amount of air changes in the building. This is another concern that should be addressed with the air flow systems.

The most noticeable issue with the HVAC is that it doesn’t respond well to temperature shifts and changes in room occupancy. As an example, during the fall our team noticed that the air conditioning would be on in a room while the windows were open. Our conclusion from this is that the system is not efficient enough to keep up with the different demands and conditions imposed on it by both nature and occupants.
The HVAC system needs to be updated or replaced with a more energy efficient solution. Technology exists today for smarter, more ‘intuitive’ HVAC systems that respond faster and more successfully to quick shifts in the microclimate of a building or room. Setback thermostats would also help to reduce energy consumption, especially since the building is locked and unoccupied at night. Sensors should be installed and integrated into the system so that the air conditioning turns off when the windows in a room are open. All of this would improve the efficiency and comfort of the building.

TO MAKE IT BETTER

An operable window in an office. While they do open, these windows allow for very little air flow and do not allow for emergency egress.

Under-window heating. This system exists on almost every peripheral wall of the building.

Ventilation and access to the mechanical rooms in the basement.
CURRENT CONDITIONS

The electrical system in Scaife Hall has been updated and altered several times since the completion of the building. From our observations, this is still a work in progress, as there are still problems with the wiring and lighting that FMS must deal with on a regular basis. Besides the lighting and some of the heating, the electrical system must also provide for the many technological demands of the building, including computer processing, machine shops and labs, and projectors. There is a separate circuit for emergency lights, though these are located sparsely. The main electrical panels are located in the basement, where most of the mechanical systems are also located. Additional access panels are located floor by floor.

Supplemental heating is provided by electrical baseboards located adjacent to windows. There are also electrical heaters built into the walls on each landing of both stairwells. Most of these units seem to be functional.

The lighting in Scaife Hall comes mostly from fluorescent lights. They are housed in fixtures that reflect the light downward. This hardware is relatively new, but with regards to wiring there are some illogical choices of operability. For example, the stairwell lighting can be controlled via a switch that controls two floors of lights. There is one of these light switches present at each level in both stairwells with an additional switch located on the second level that controls all the lights in the stairwell.

Apart from the stairwells, lights are operable on a per room basis. An exception to this exists on the third floor though, where there is no active light switch in the public hallway. Instead, there are covers where the light switches used to be, a hint of a change that was made for reasons unknown.
TO MAKE IT BETTER

The performance of electrical systems in Scaife hall is sufficient, but could be far more sustainable and efficient. More consideration could have been giving to wiring plans and diagrams when the building was constructed, even considering the vast changes in electrical demand that have forced the building to evolve since then.

By linking the lights to sensors, especially those on the third floor, a more successful lighting environment could be established. This retrofit would reduce the amount of time that lights are on without occupants in the building and would save on energy costs.

As mentioned in the previous HVAC section, increasing the number of operable windows would be beneficial, not only for the HVAC system but for the electrical systems as well. The electrical cooling and heating loads would decrease in a building more responsive to the outside temperature. Additionally, baseboard heating units should be updated to provide higher efficiency heating.
CURRENT CONDITIONS

The plumbing in Scaife Hall was difficult to evaluate since the majority of it was hidden. Most of our information was gleaned through observations and exploration of plumbing plans on record in the school library.

The restrooms are generally located in the central core of the building. Interestingly, they are not stacked directly on top of one another. While the second and third floors have the same floor plan, the basement, first and fourth floors have different plans and bathroom configurations.

The restroom layout is such that on several floors there are inadequate restroom facilities for both genders and for the disabled. The first floor has three bathrooms. The ladies room has four toilets and two sinks. The men’s room has three toilets, two urinals, and two sinks. There is also a unisex bathroom. The basement has only a men’s room with two urinals, one toilet, and one sink. The second floor has one men’s and one women’s bathroom, each with one toilet and sink. The third floor has one bathroom for the women with three toilets and two sinks. Finally the fourth floor has only a men’s room with two urinals, a toilet, and a sink. The only restrooms in the building properly equipped for disabled access are the unisex bathroom on the first floor and the two bathrooms on the second floor, all of which look to be newer renovations.

Our team projects that the plumbing situation is a result of the building’s evolution over time. Examining the original plans reveal that the current restroom situation is actually an improvement from the original layout, at least as far as quantity goes. It appears that more bathrooms were added for women and the disabled over time, an indicator of the growing number of women and disabled who attend college.
Aside from the shortage and placement of restrooms, there is a noticeable lack of drinking fountains. The ones that do exist have low pressure, missing or broken parts, and are difficult to get a drink out of. The water that does come out is not chilled enough, though that may just be a personal opinion of the team members.

Lastly, some of the pipes in Scaife Hall that were visible were made of metal, most likely cast iron. These pipes were exposed and uninsulated. Some of them had signs of rust and corrosion on them, along with condensation and moisture.

**TO MAKE IT BETTER**

The problems with the restrooms would be difficult to rectify without extensive work. Ideally there should be at least one women’s and one men’s bathroom on each floor, and they should all be easily accessible by disabled persons. Since fixing this problem would require extensive reconfiguration of the plumbing system, it makes sense to focus on smaller, more doable changes that can be implemented quickly, and generate a longer-term phasing plan to address the restroom situation.

This phased plan should look at the possibility of locating all restrooms above each other as much as possible to facilitate easier navigation of the building and better water flow. Until then, the confusion caused by disparate restroom placement could be ameliorated by implementing better signage.

Smaller changes that could be enacted in the meantime include the installation of more and better drinking fountains. Insulating the pipes would be beneficial in reducing heat loss from hot water travelling through pipes and would also help curb the problems that exist with condensation, deterioration of the pipes, and harmful moisture levels within the walls and floor plates.
CURRENT CONDITIONS

There are some significant issues with the fire safety mechanisms of Scaife Hall. As it stands now, there are almost no sprinklers in the building, the smoke detectors are original to the construction and thus out of date, there are no visible carbon monoxide detectors, and the exterior platforms do not actually function as fire escapes.

The shortage of sprinklers in the building may be a code violation and is a safety issue even in the building has been grandfathered into a fire code. The fire alarm and detector plan that exists on the outside of the building should also be updated to reflect any changes to the building’s interior fire safety mechanisms.

The smoke detectors are clearly original to the building. This may be alright if they are tested frequently and replaced as soon as necessary. However, there are no smoke detectors visible at all in the main lecture hall. This fact was confirmed by studying the building plans and it is a major concern, as large classes are held in this space.

The greatest concern (as far as fire safety goes) is that the exterior platforms around the building are considered fire escapes even though they lack outlets at ground level. Once on the platform, it is impossible to go anywhere except back into the building. In the event that the interior stairs were compromised at any level during a fire, the upper-floor occupants would be trapped.
The types of occupancy and safety measures have changed over the life of the building. Sprinklers should be installed throughout the building, particularly since there is a significant lack of other safety devices. The fire detectors need to be monitored because of their age and replaced if needed. Smoke detectors and alarms also need to be installed in the Lecture Hall and made visible in order to be useful and reassure occupants of their safety. Carbon monoxide detectors should be installed throughout the building too.

The exterior platforms need adequate outlets to ground level in order to actually be considered fire escapes. This would bolster the safety of occupants on the higher floors who currently depend on the stairwells as their only means of egress.
There are a few other issues that the team noticed during the auditing process of Scaife Hall that can be broken down into two main components: the environmental quality of the main lecture hall and the recurring mechanical issues throughout the building.

Apart from aforementioned fire safety concerns, the main lecture hall has several other health and safety concerns. The room feels stuffy and dirty, and upon closer investigation the audit confirmed a heavy accumulation of dust and grime on the vertical wooden slats of the walls as well as the ledges above. The unidentified discolorations on the ceiling may be a result of water damage, and discolorations on the wall further support the room’s reputation for dirtiness.

Additionally, the lecture hall is well-reputed for often being too hot or too cold. To remediate this the back fire escape doors are often propped open during classes, even in the winter, resulting in noise pollution from the adjacent road outside and contributing to a diminished learning environment inside. A functional thermostat and better insulation would help resolve the temperature issues.

There is also a severe problem with mold in the lecture hall. Signs of mold growth were found in the utility closet near uninsulated pipes. This is an immediate health concern, as the space is dark and damp and prone to more severe and dangerous mold growth.

There are recurring general maintenance issues with the building’s mechanical systems. This is of concern because it shows that the fixes made are not lasting. This means that money is being wasted and that potentially larger problems could develop if left unchecked.
Left
Mold growth in the closet of the lecture hall.

Right
Discolorations on the walls of the lecture hall from peoples’ heads as they lean back in their chairs.

Above
Discoloration on the ceiling of the lecture hall.

Left
The location of an electrical burning smell in the entry area of Scaife Hall.
Building Use

Scaife Hall has been reprogrammed over its lifetime in response to changes within the university. The building has shifted from primarily classroom use to primarily office use over its lifetime. The first floor has been partitioned extensively to accommodate these changes, especially the administrative offices. Our team believes that the building should continue this evolutionary process, potentially incorporating more office space and workplaces for graduate students. The part of the building most in need of addressing is the Lecture Hall. If renovated properly, it could become an enjoyable and healthy place for classes to be held.

Sustainability

The sustainable attempts made in the design and construction of Scaife Hall are admirable due to the new and innovative ideas in solar control that were implemented. However, despite these attempts there are shortcomings in the performance of the building envelope. In general, issues related to heat loss and infiltration should be prioritized over issues concerning solar gain.

Do We Start Over?

Starting over is rarely the best option. It would result in the loss of all of the time, money, and energy put into the building. Instead, our team recommends the suggestions made throughout this audit to retrofit the building, thus improving its overall performance and quality of occupation by its users.
Some of the architectural drawings used for this audit are included in the appendix and were obtained from the Architectural Archives of Hunt Library.

File Format: Microfiche

Location: Hunt Library Architectural Archives, Martin Aurand, consultant.

Carnegie Mellon University
Pittsburgh, Pennsylvania

Dates: 1961-1967

Firm: Altenhof and Bown

This audit was prepared for Gerry Mattern’s Environment III: Mechanical Systems Class (48-412) in the School of Architecture at Carnegie Mellon University in the Fall semester of 2010.

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APPENDIX: DETAIL PLANS, CORRIDORS
APPENDIX: SEWER SITE PLAN

Carnegie Institute of Technology
Plan showing proposed sewer from Scaife Engineering Hall through B. & O. Right of Way to 68" sewer on Boundary Street

Scale: 1" = 100'

March 9, 1961

No. S-C2

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