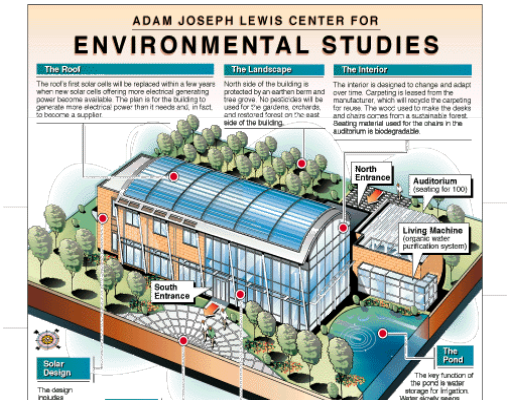
Oberlin College: Adam Joseph Lewis Center for Environmental Studies

Oberlin, OH



EBERHARD ARCHITECTS LLC
2077 East 4th Street, Second Floor
Cleveland, OH 44115
216.452.2592

www.eberhardarchitects.com

Essays on Architecture:

Oberlin College: Adam Joseph Lewis Center for Environmental Studies

Oberlin, OH

Introduction:

Oberlin College (OC) has long been concerned about its image. In 2005, the college began polling its students and faculty to develop a competitive selling identity, which resulted in a "concept of recklessness" defined with regard to the marketing of the college.

The idea met with mixed receptions from students and faculty in a context of recurring budget concerns. But Oberlin has always seen itself as an elitist liberal arts school that unofficially has been known as the "Harvard of the Midwest." OC proudly admits that it is the oldest continuously operating coeducational institution of higher learning in the world, having been founded in 1833, and first to admit African-Americans in 1835 and women in 1837.

In 2019, *US News and World Report* ranked Oberlin College as the 30th best liberal arts college in the country.

The idea of an environmental studies building at Oberlin began in 1992 when Professor David Orr taught a course entitled "Ecological Design," proposing a new environmental center for the college's campus. Twelve public charrettes ensued to address the various program elements that students and the public perceived would be needed.

From the 1940's to 2014, OC was heated by burning coal, the least respectable source for an institution aspiring to any degree of sustainability. With a recent carbon neutrality initiative, OC is converting its central plant to natural gas which will create 40% - 50% less CO2 with no particulates, ash or other carbon contaminants. But natural gas is still a fossil fuel that emits carbon when burned. And fugitive methane emissions during extraction - and a lack of regulation - make actual greenhouse gas emissions from natural gas unclear.

The college's municipal electricity provider has reportedly contracted for 90% of its power from renewable sources. In 2012, OC contracted with SPG Sales & Spear Point Energy to install, a 2.27MW solar array north of the athletic fields on campus property, which is projected to produce 3MKWh/yr, or 12% of the college's power needs.

Determined to position itself as a leader in environmental stewardship, OC retained well-known Will McDonough to design a small 13,000 square foot environmental studies building in the late 1990's.

The college's press release announcing the construction of the project detailed twelve impressive objectives, earning the college international coverage, and the completed project won numerous awards from groups that assumed that the college and McDonough had been truthful in their representations on the performance of the completed project.

However, the project failed to achieve ***ANY*** of the originally stated objectives, and the college for years has deliberately lied about the energy performance and sustainability of the project.

The Hype:

In a 2018 lecture to the Cleveland chapter of the Building Envelope Council, Oberlin Professor John Scofield responded to the campaign by the college and its architect to 'sell' the proposed facility by labeling it a "fraud."

Scofield observed that the project's original budget was $3 million for a facility of only 13,600 sf, which grew to over $6 million, and since completion, has consumed another $2 million ($147/sf) for changes, which yields a project cost of nearly $600/sf! AND, the project entailed a staggering $1.5 million in fees to the architect, engineers and consultants - $110/sf!

Scofield noted that OC President Nancy Dye in addressing the Cleveland City Club in 1997 stated that the facility would generate "no waste water." In 1998, the *New York Times* restated the college's claims that the building would "purify its own waste water" and was "projected to use only 27% of the energy used by a conventional building."

Sadly, this pattern of OC's misrepresentation would continue. And with a professional and popular press hungry for good sustainability stories, OC's proposed project looked better than good. At that time, Will McDonough's name added credibility to the narrative and helped assure that the story received great attention as it became known that buildings were accounting for 40% of the energy consumption in the US and a greater percentage of carbon emissions. Accordingly, OC's press release about its new college building received national and international attention.

A 1998 article in *Building Performance Data* painted a picture of Oberlin's environmental studies building as an all electric facility, requiring only 64 kwh/year for its 13,600 sf, which in itself became the basis for dozens of other articles. The American Institute of Architects gave the building a design award in 1999 - before the project was even completed.

The March/April 2000 issue of *Environmental Design & Construction* featured an article entitled "The Ecology of Design" with claims by David Orr that the building's solar array will produce 69 KW/yr., that heat from the ground would heat water in the winter and that it would pour heat back into the ground in the summer. Clearly the college and Orr were determined, regardless of the facts, to have the nation perceive Oberlin College as a leader in sustainability, despite the fact that an all electric building utilizing coal to produce electricity is hardly a model of sustainability.

But Prof. Scofield - with a PhD in physics - knew that the clay soils in and around Oberlin, OH have low thermal conductivity which causes the temperature of the ground soil to go down as you take heat out.

Above: Lewis Center south elevation
Below: Lewis Center Atrium with waste recovery area removed
Bottom: Lewis Center Section design

The Reality:

As the building was completed in 2000, Scofield attempted to gather information from the design team to use in his teaching. He was given nothing. He conducted his own blower door test to develop an energy audit of the building. He finally got copies of mechanical and electrical change orders from the college's Construction Office to piece together how the building's mechanical system had been

completely changed.

When he discovered that the press release ground source geothermal wells had been abandoned in favor of electric boilers, Scofield approached the municipal electric company for data, and began logging electric data monthly. When the building was completed in January 2000, it had no PV array and was employing 100% electric from a coal-fired plant. Hardly a model of sustainability, to say nothing of its power consumption.

The college and architect McDonough originally claimed that the building would consume only 64 KW/year. In fact, **it consumed 45 kwh *in its first month alone*** and **76 KW in its first two months!**

It its first five years, the building averaged 143 kwh/year, 223% of that claimed by McDonough and the college. Additionally, the college's consultants were measuring demand by Site Energy instead of Source Energy. In any sustainability assessment or analysis, the **source** of the power must be taken into consideration, particularly with electric power plants operating at a typical 33% - 35% efficiency.

Consequently, the building's Site Energy consumption of 35,194 BTUH/sf/yr equates to 107,741 BTUH/sf/yr, which puts the building in the 83% - 88% range of normal buildings, which is good, but far from great.

What Went Wrong?

According to Prof. Scofield, the building's design reflected numerous mistakes by architect William McDonough and his consultants:

- The rooftop photovoltaic (PV) array to harvest solar power was supposed to provide for 100% of the building's power needs. Instead, it provides 35% - 40% of the needed power.

- The rooftop photovoltaic solar cells (PV's) are packed tight together, which requires a crane to repair or replace them.

- In 2002, OC spent $40k on an energy modeling system, but OC NEVER MODELED THE ACTUAL BUILDING DATA!

- Poor project oversight: OC and its personnel were uninformed on the kind of systems and technology a state-of-the-art building of this type would require. OC therefore trusted and expected WM+P to know the science and technology inside and out. They did not.

- OC publicly disregarded the facts regarding the building's design, engineering, anticipated and actual performance.

- Scofield states that the project received substandard mechanical and electrical engineering as evidence by:

- A reliance on electric heat;

- Too many exhaust fans;

- Incorrect heat pump design;

- Failure to take into consideration collateral loads for pumps, parking lighting, etc.;

- Absence of integrated design;

- The building's exterior wall had a thermal performance of only R-13 because there was/is far too much south- and east-facing glass.

- "The engineers did not know what they were doing. They didn't know how to design a heat pump system (Scofield);"

- The building's design "foolishly" used electric resistance heat with a 112kw electric boiler which produced only 50% of the building's heat load demand;

- The 65kw electric boiler for the ground water feeding the heat pumps to feed the air handling units was inadequate. As result, the building was too cold, and the heat pumps would not function.

- Electricity used for domestic hot water instead of more efficient natural gas;

- The "Living Loom" intended as a demonstration area required constant exhaust which evacuated heat and consumed additional energy.

In January 2006, OC added a second solar array over an

adjacent parking lot to help meet the building's power needs.

OC professor John Peterson continued to claim as late as 2011 that the Lewis Center would produce as much power as it used with its additional solar array. But the data from the power company showed that demand of 195 KWh exceeds the 120 KWh provided, even including the added array. So OC continued to misrepresent the facts. In fact, the Lewis Center has never produced more energy than it has used. Scofield asked for a retraction from the college. They refused.

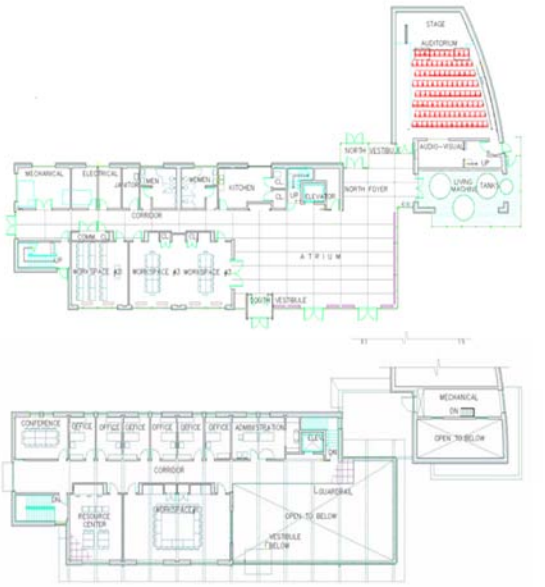
Scofield began going public with white papers, speeches and articles in the national press about the college's denial of the facts because his tenure gave him a degree of immunity. The college responded by hiring a new building manager who they charged with making the building net-zero. So he bought a $70k energy management system to replace the original $40k EMS. The new system saved $5k in power costs in its first full year of service - by disconnecting the electric boiler.

The college has cajoled the PV solar manufacturer to fix malfunctions long after the warranty period, and in 2013, the Lewis Center PV's finally produced more electricity than the building used. Austerity measures produced complaints and in 2017, the boiler was reinstalled.

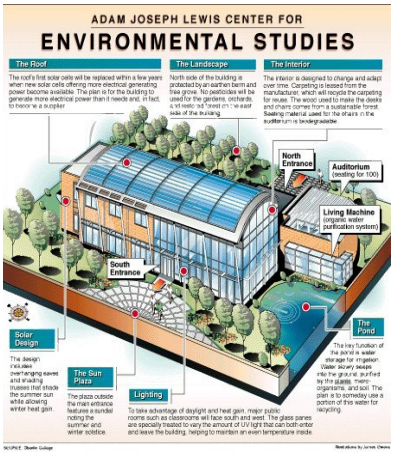
In the course of executing a number of small projects for OC ten years ago, I first learned from our PM that the Lewis Center had failed to meet **ANY** of its original objectives that the college articulated when it announced the project to the world. I learned that the problems pertained to the design of the Lewis Center and its systems, and that the representations made to the college during the design phase which were allegedly known to be false at the time.

I was told that the contractors' maintenance information conveyed to the college's facility and maintenance staff upon completion was incomplete and not fully conveyed, resulting in the failure of OC's facilities staff to maintain the project per the manufacturers' written instructions which also contributed to the shortcomings. So no one party was responsible for the project's failures.

As a member of the Board and Program Committee of the Cleveland Chapter of the Building Envelope Council with a yearly agenda of comprehensive educational programs to elevate knowledge and awareness of building performance issue, I repeatedly contacted the Oberlin College Campus Architect to



Above Left to Right:
1. Lewis Center, First Floor Plan
2. Lewis Center, Second Floor Plan
3. Workspace #1
4. Lewis Center Solar Roof
5. Lewis Center Environmental Graphic
6. Lewis Center original presentation model



request a presentation from a representative of the college on the Lewis Center with the knowledge that such information would prove to be valuable learning lessons to a wide audience. I was told that the college would not make the information public for fear of being embarrassed.

However, Prof. Scofield had begun researching the project at its inception. As tenured faculty, he was not subject to the college's gag rules and when the smoke became clear and Scofield discovered that the college knowingly lied to the press and public about the project and continued to do so for years, he went public.

To this day, McDonough as well posts on his web site the glowing *New York Times* article praising OC for its leadership based on the pre-construction press release instead of reporting on the project's actual performance and failures.

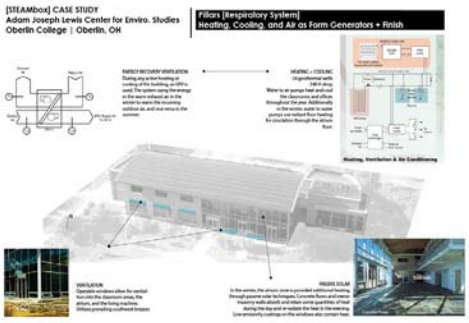
Prof. Scofield has written and lectured extensively on the subject of real performance of buildings based on hard data, and the degree to which LEED and Energy Star certifications bear little indication of a project's actual performance. Scofield has also noted that while much has been written about the goals and intent of the project, little has been written about its actual performance.

Scofield has noted that the building's mechanical design "deviated significantly from its original intent and project description (2002)." Scofield's investigation of the design process is enlightening on a number of levels:

"Throughout 1997, the architect considered and simulated a range of mechanical design concepts. But these energy simulations, although useful for guiding the design process, were not constrained by building codes and other engineering realities that frustrate "real" building projects. In April of that year, WM+P settled on a concept described as a building that would be heated and cooled by geothermal heat pumps, with a backup connection to the College's central steam plant—added, reluctantly, to satisfy concerns of the maintenance department."

"But the first set of mechanical drawings does not support this description. They instead depict a building not with steam backup, but heated by steam and cooled by water circulated through ground wells. The design showed tempered-water heat pumps (similar to those used in motels for distributing heating from a central plant), not ground-source heat pumps appropriate for a geothermal building. In short, the heat pumps **reduced** the efficiency of an otherwise steam-heated system."

"The discrepancy is but a historical footnote because this design proved too costly, and the heat pumps and ground wells were eliminated just days before College trustees met in September 1997 to approve the final building design and its increased $6.11 million budget. A mechanical redesign was authorized. What emerged that fall was a building, without heat pumps, heated with steam from the College's coal-fired steam plant. Construction documents were developed for this design, and the project went out to bid in June 1998."



Above Left: Lewis Center HVAC Design concept graphic
Below Top: Lewis Center aerial with added solar array over parking at left
Below Middle: Lewis Center at dusk
Below Bottom: Lewis Center Auditorium

"Meanwhile, the College spent about $450,000 to extend the campus' southern steam loop to the construction site. These lines have never been used, nor has their expense been included in the Lewis Center budget. Architect William McDonough, in a July 9, 1998, New York Times article, said the building was "…like a tree, that gives more than it takes, that makes oxygen and provides a habitat for hundreds of species…" The article appeared as bids were coming in for a building heated from coal-fired steam supplied by the College's central heating plant."

"Just weeks before the Lewis Center's September 1998 groundbreaking, this second mechanical design was abandoned and another redesign initiated. As I understand it, Professor David Orr agreed to raise additional funds (as high as $250,000) to return to geothermal heat pumps and wells—this time without a connection to the campus steam plant. The building was to use only electric energy so that it might one day be powered by a rooftop photovoltaic array (which generates electricity from sunlight) or a fuel cell."

"Groundbreaking went forward with neither a construction contract nor a mechanical design. Though the mechanical design would not be completed for another five weeks, the architect released a performance data sheet that summarized the building's key features." WM+P's press release knowingly did not reflect the project's reality.

"Included was the projected annual energy consumption: 63,609 kilowatt-hours, which is roughly 20 percent of the site energy used by a conventional building and slightly more than the annual energy expected from a 3,700–square-foot photovoltaic array, thought then to be the largest array the roof could support. In the October 1998 issue of Atlantic Monthly, architect McDonough wrote that "[the Lewis Center] is designed to make more energy than it needs to operate and to purify its own wastewater." Thus began an immense publicity campaign about this building that would be powered by sunlight and produce more energy than it used."

"But the third mechanical design differed significantly from that described by the architect. In a September 1998 memo, WM+P's engineers, Lev Zetlin Associates, wrote of their plans to go forward with a tempered-water heat pump system with the circulating water loop cooled by ground wells and heated with an electric boiler. This "redesign" essentially returned to the very first design of April 1997, replacing heat from steam with electric boilers. The "historical footnote" now becomes important. This redesign would have led to the least efficient heating system possible—a building heated entirely by electric, resistive heat!"

"The details are uncertain, but drawings dated September 18, 1998, showed pumps now taking heat from the ground to heat two-thirds of the building. A 112-kilowatt electric boiler would provide heat to the remaining third, including the atrium and Living Machine, spaces that account for 50 percent of the building's heat load."

"Revised drawings issued a month later included a second electric boiler, as well as two electric air heaters, an electric hot water heater, and nine fans that exhausted air without energy recovery. The electric resistive heating power was nearly double the combined heating capacity of all the heat pumps! The potential electrical use was so large that in December 1998 engineers upsized the building transformer to 500 kilowatts—10 times larger than the photovoltaic array intended to power the building—and similar to the transformer that serves the local Ames department store, a building nearly six times larger! When the construction contract was finally signed in November 1998, it was for a mechanical design that differed significantly from the one described in documents released at the groundbreaking. Furthermore, it was incapable of achieving the design intent."

"Construction of the Lewis Center was completed in January 2000 (the 4,700-square-foot photovoltaic array would be installed 11 months later). One month into occupancy, it was clear that the Lewis Center consumed far more energy than the architect had projected. In another month, it was clear that the assumptions used for the energy projections did not apply to the building that was actually constructed."

"After more than two years of operation we can now evaluate the Lewis Center's energy performance. So far the building has been powered mostly by coal, not sunlight. In its first 27 months of use, the rooftop photovoltaic array produced 70,000 kilowatt-hours of electric energy, only 17 percent of the 420,000 kilowatt-hours of energy consumed by the building (including transformer losses and parking lot lights) during this same period. The bulk of the energy was purchased from the local power company."

Subsequent to Scofield's 2002 article, WM+P and Scofield have independently presented energy simulations for the project as constructed. WM+P managing partner R. Perry has acknowledged that their original projections do not apply to the building as built. Both confirm that the building as designed and constructed will consume two to three times more energy each year than the photovoltaic array can provide.

This is attributed to the WM+P mechanical design completed in October 1998. As Scofield has observed, "The original energy claims were nothing more than

speculation. There is not now and never has been any factual basis for the energy claims for this building. Oberlin has completed an extensive commissioning process verifying that the Lewis Center was built per construction documents and that systems are operating per specifications. This process uncovered many problems that have been subsequently corrected, resulting in lower energy use. But the major causes of excessive energy consumption remain because they are associated with the building's very design."

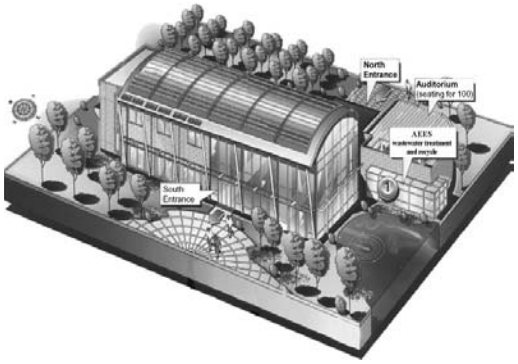
"Actual energy consumption depends on weather, occupancy (how much is the building used), and the inside temperatures maintained during use. In the last 12 months, the energy use by the Lewis Center has decreased to 130,000 kilowatt-hours, of which the photovoltaic array furnished 46 percent. There are many reasons for this reduced energy use, including the fact that northeast Ohio experienced its warmest winter in 50 years. (Indeed, heating energy for all College buildings was reduced by 10 to 20 percent.) This performance, while interesting, does not change any of the facts already presented."

"In evaluating the Lewis Center's performance, it is important to separate energy consumption from the energy generated by the photovoltaic array. A $420,000, 45-kilowatt array can be installed on the roof of any building and instantly lower the amount of energy the building imports. The benefit is clear, but it says nothing about the energy-efficiency of the building itself. As a leading advocate of photovoltaic power has frequently said, you don't make a conventional building green by simply adding a photovoltaic array to it."

"As constructed (absent the photovoltaic array) the building is expected to consume 150,000 to 190,000 kilowatt-hours of electric energy annually, assuming average weather and occupancy. This corresponds to an on-site or site energy use of 35,000 to 45,000 British Thermal Units (or BTU's) per square foot per year. But site energy fails to account for the associated energy consumption and pollution that occur at off-site electrical power plants that run at 30 to 35 percent efficiency. The EPA and Department of Energy use a concept called source energy, which considers the total energy use—on-site and off-site — associated with a building's operation. For the all-electric Lewis Center, the source energy is three times its site energy. Hence the projected source energy use is 110,000 to 140,000 BTU's per square foot per year. One of the ironies of this debate is that Oberlin's Environmental Studies faculty members focus on site energy rather than source energy, ignoring the off-site pollution and energy consumption associated with operating the building."

"The source energy consumption for the average non-residential building at Oberlin is about 130,000 BTU's per square foot per year. Hence, without the photovoltaic array, the Lewis Center is projected to consume about the same amount of energy and cause the same amount of pollution as a conventional College building. Because of its photovoltaic array, it does much better—but the credit goes to the photovoltaic array, not the building

Left Above, Clockwise:
1. Lewis Center Atrium facing south and east
2. Lewis Center Isometric
3. Lewis Center Lecture Hall



design. Oberlin could have achieved far more energy savings by constructing a conventional building at half the cost and erecting photovoltaic arrays on seven other buildings."

What is disturbing about Scofield's findings is that the college and McDonough short-sold the truth - for years.

The college finally began authorizing funds to fix the mistakes. In 2002, OC authorized $100k to replace the 120-kw electric boiler with a ground-source heat pump. But this change increases significantly the amount of heat that will be taken from the ground, lowering the winter water temperature below the acceptable range of the 23 existing heat pumps and requiring that they be changed as well.

And there are many other heating, ventilation, and air-conditioning (HVAC) system design flaws that must be addressed for the building to reach its original target. A timetable and budget for the remedial work has not been made public by Oberlin College.

Building Program:

Programmatically, the building has a very modest program. It contains only seven offices, two conference rooms, one pair of classrooms, one pair of small "workspaces," a small kitchen and a 103-seat lecture hall.

The laminated wood beams and wood roof deck create a warm atypical ceiling for second floor occupancies on the south side of the building - the Resource Center and Workspace #1.

With its two-story atrium upon entry, the building has a second floor that amounts to approximately only 5000 sf. The small size of the project accounts for a portion of its high cost, to say nothing of the magnitude of the fees paid to the architect and engineers - for mucking it up.

Conclusion:

It is important that clients - especially universities - attempt projects like the Lewis Center for Environmental studies at Oberlin College. It is equally important however, that these projects be accessible learning lessons for all. In this regard, Oberlin College and William McDonough + Partners have failed the profession and the College's Board and students.

Oberlin College is doubtlessly proud of the dozens and dozens of presentations created and delivered nationally for the past two decades, heralding the

Left Above, Clockwise:
1. Lewis Center; Oberlin College
2. Third Party PowerPoint Presentation heralding the Lewis Center accomplishments
3. Third Party PowerPoint Presentation heralding the Lewis Center accomplishments
4. Lewis Center Added Solar Array Over Adjacent Parking Lot

Lewis Center for its intended objectives. However, these presentations have erroneously created the impression that the completed project is a model for sustainability when its accomplishments are lessons in marketing excess and inept engineering. The valuable lessons on the importance of aligning design and performance - and measuring results - have been intentionally and irresponsibly masked by Oberlin College and WM+P.

Oberlin College's efforts to strangle the publication of actual performance data on the project and their continued pattern of deception has kept to a minimum any publications and presentations - other than professor Scofield's - on the building's actual performance, and the impact and costs of the remedial initiatives put in place to date.

There can be no argument that the project has the potential to be a rich and meaningful educational opportunity for students and the public to learn about our built environment.

Scofield has focused on the failures in the mechanical design. But even with these, the Lewis Center, with the boiler removed, is more efficient than a conventional building. Its lighting design, extensive use of natural lighting, and HVAC control system are very good at saving energy in ways not found in other campus buildings.

The facility is a bright and pleasant space in which to work and learn. And its rooftop photovoltaic array provides a large fraction of its energy. It is possible that if the College continues to correct the mechanical design flaws, over time the project will move closer to its original energy targets.