I, Gregory Howard Snyder______________________________, hereby submit this work as part of the requirements for the degree of:

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Sustainability Through Adaptive Reuse:
The Conversion of Industrial Buildings

This work and its defense approved by:

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Sustainability Through Adaptive Reuse
The Conversion of Industrial Buildings

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Abstract

As our society shifts from an economy based on industry to an economy based on information, many structures in the urban environment have become abandoned relics of a bygone era, while new facilities rise ever farther from the center city to replace them. Such structures are victims of a disposable society. The current practice of linear production, in which something is produced, used, and discarded is no longer viable. Reducing consumption, recycling, reusing what has been produced, and being more responsive to the environment form the basis of a new way of thinking. Existing and abandoned buildings represent a substantial resource. Through adaptive reuse, many buildings of the industrial era can be continued or brought back into use and contribute to a more sustainable development pattern. Energy embodied in these facilities can be utilized and built upon to rejuvenate not only the structure, but also the community and its users. Once a place of energy and pollution production, the DP&L Third Street Substation is such a facility. Located in an area of Dayton in the early stages of urban renewal, the site is able to build upon the momentum of what has been done around it and further strengthen the area. Through the juxtaposition in the built form of the past idea of industrial progress and the current idea of progress through the concept of sustainable design, its redevelopment as a sports training and rehabilitation center would serve as a both a reminder and as an example.
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1.2 Introduction
Sustainability is becoming an important architectural movement as we begin the twenty-first century. Unlike previous architectural movements driven by stylistic expression, there is an omnipresent reality that is driving this trend: the realization that we are fast approaching the end of the cheap energy era. We can no longer afford to squander our natural resources and pollute our environment. The investment that has already been made in the built environment, be it infrastructure or buildings, must be utilized to the fullest.

I have always been interested in the potential of old buildings. From being involved in renovation work at a young age, to recent experiences in professional practice, the challenge of building upon and improving what already exists has become the focus of my architectural inquiries. The unique constraints and opportunities these buildings present have yielded some of the most satisfying and rewarding projects.

In recent years, this interest has been influenced and reshaped by my exposure to “green” design principles in the classroom and through the observation of the built environment. Oddly enough, it was the juxtaposition of what was being presented and learned in the college classroom, with the perpetual construction of “signature” buildings occurring on campus that led to my interest in applying effective and appropriate sustainable design strategies to existing buildings.

This thesis examines the potential of adaptive reuse projects in sustainable design. These types of projects have the potential to not only conserve material resources, but also to lessen a building’s impact on the environment through energy reduction and conservation via the use of passive design strategies. The reuse of an industrial structure on an urban brownfield site preserves a piece a history, restores polluted land to usable condition, and contributes to a sustainable development pattern.
Chapter One states the thesis and addresses the problems and central questions of adaptive reuse and sustainable design, as well as examines their role in the future of architecture. As natural resources are depleted and the effects of pollution are realized, environmental responsibility is becoming increasingly important in the built environment.

Chapter Two examines the principles of sustainability through William McDonough’s Hanover Principles. The changing definition of sustainability is also explored.

Chapter Three defines adaptive reuse. Issues of rehabilitation, change of use, and preservation are examined. Industrial conversions are then demonstrated through precedents.

Chapter Four addresses the overlapping concepts of adaptive reuse and sustainable design. Applying sustainable design strategies to existing structures, looking particularly at the Audubon House, then leads to the hypothesis that sustainable design and adaptive reuse can be merged by thoroughly understanding the building’s structure and site.

Chapter Five details a methodology for selecting sites and integrating appropriate environmental design strategies into an existing building. Passive heating, cooling, and ventilation are described.

Chapter Six introduces the project. Application of the principles of sustainable design to the concept of a wellness center is introduced. A description of the Powerhouse Fitness and Wellness Center is outlined. The typological precedents are described as a basis for developing the project.

Chapter Seven describes the site. The location for the project is introduced, followed by the history of Dayton and the DP&L Third Street Substation. The condition
of the existing structure is detailed, and the environmental conditions, such as climate and pollution are then addressed.

Chapter Eight examines all of these factors through diagrams which are then analyzed, and appropriate strategies are developed for the facility’s adaptive reuse and the integration of environmental design features.

Chapter Nine introduces the program. It is summarized and then described in detail, with spatial arrangements and spatial descriptions.

Chapter Ten describes the design process. Using images and graphics, the development of the project is recorded.

Adaptive reuse can do more than put a new program into an old building. This thesis examines integrating “green design” into structures that were previously at odds with natural processes. Through the synthesis of the structure and its environment, former industrial buildings can become exemplars of sustainable design practices.
Chapter 1: Problem

1.1 Thesis
Optimizing the overlapping principles in adaptive reuse and sustainable design creates development that reduces environmental impact through material and energy conservation.

1.2 The Role of Adaptive Reuse and Sustainable Design in Architecture
The juxtaposition between the development in the suburbs and the decay in the urban center is jarring. While areas with infrastructure and character are being abandoned, bland developments consume more and more land on the rural-urban fringe. Changing lifestyle demands and public policy have combined to create a development pattern that is unsustainable, and the building industry has created buildings to match.

Sustainable Design seeks to better find harmony between the built environment and the natural environment. “Waste equals food,” the first principle of William McDonough’s “The Next Industrial Revolution,” addresses one of the core issues of the movement, and of adaptive reuse. The current practice of linear production, in which something is produced, used, and discarded, is no longer viable. Reducing consumption, recycling and reusing what has been produced, and being more responsive to the environment form the basis of a new way of thinking. These ideas are directly applicable to building design, and can be exemplified in the adaptive reuse of an existing structure. What was once discarded as obsolete can be recycled and brought to new life.

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1 McDonough, William, and Michael Braungart. The Next Industrial Revolution.
As our society shifts from an economy based on industry to an economy based on information, many structures in the urbanized built environment have become abandoned relics of a bygone era, while new facilities rise ever farther from the center city to replace them. At the current rate of new construction in the United States, it will take less than 40 years to increase the existing building stock by 50%\(^2\). This rate of growth can be slowed by better utilization of the existing building stock. As the resources of the world are increasingly squandered, and land consumed at ever increasing rates, the need for more sustainable forms of development and building construction is pressing.

In the United States, the idea of perpetual progress has been based on the idea that new equals good\(^3\). This has manifested itself in the built environment in past decades as neighborhoods have been razed in favor of parking lots, roads and new buildings. The result is an urban landscape marked by unfulfilled promises of economic development in the form of empty lots and abandoned buildings. Abandoned sites negatively impact the well-being of a community, be it through real or perceived contamination, the “broken windows” theory, and underutilized land.

Industrial buildings that once negatively impacted the environment can become examples of sustainability. The reuse of a building sets an example for more economically and environmentally responsible patterns of development. Adaptive reuse seeks to utilize and build upon the existing infrastructure and its building stock as a means of economically and environmentally responsible development. This idea is not

\(^2\) Eisenberg, David. *A New Context for Building Codes and Regulations*

\(^3\) Langenback, Randolph. *A Future from the Past*. p.4
new. Historically buildings were reworked and adapted to new uses.\textsuperscript{4} Not doing so would have been seen as abnormal. The amount of energy and resources required for construction was recognized by society because the cost of construction and the time involved were much higher.

The balance point between preserving the building’s past, making the structure viable for the present, and achieving sustainability into the future must be found. It is not enough to merely reuse a building, if it continues to be energy inefficient and a detriment to the environment. It is estimated that buildings consume 30\% of our total energy and 60\% of our electricity\textsuperscript{5}.

\textit{Energy, or the lack of it, has shaped the nation’s buildings from time immemorial.\ldots\ldots \text{much of America’s architectural evolution documents a struggle to defeat the less pleasant aspects of climate and environment without energy as an ally.\ldots\ldots \text{But with the onset of the energy crisis, designers have gradually become more aware of their forebears’ struggles and their solutions.}\textsuperscript{6}}

Sustainability is a movement in the field of architecture, which despite its benefits to both the environment and the occupant, has not yet come into widespread use in the urban environment, particularly in Ohio. In urban areas, there are vast amounts of underutilized building stock, while speculative building continues in the suburbs. The adaptive reuse of existing structures is part of a more sustainable development pattern. A methodology for utilizing the common principles of sustainable design and adaptive reuse for redevelopment needs to be developed.

\textsuperscript{5} USGBC. \textit{LEED-NC Version 2.1 Reference Guide}. p. 1
\textsuperscript{6} Green, Kevin. \textit{Research and Design}. 
Chapter 2: Sustainable Design

2.1 What it is

In 1987, The Brundtland Report provided what has become one of the most widely accepted definitions of sustainable development:

“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Change is inevitable, and development that occurs should include not only growth, but the well-being of people, and the stewardship of natural resources. This idea brings out the underlying problem inherent in the practical application of sustainable principles, that of finding the balance point between economic progress and the conservation of the environment.

The origins of sustainability as a global movement go back to the 1960’s, and over time its definition has developed as the idea was refined\(^7\). The first Earth Day occurred in June 1970, the result of a growing concern for ecology in the prior decade. In 1972, *Limits to Growth* was published by the Club of Rome, popularizing the idea of “zero growth” as a reaction against the consequences of the exponential growth that was occurring. Resource conservation was brought to the fore in 1973 with the first energy crisis. In 1980, *World Conservation Strategy*, produced by the International Union for the Conservation of Nature, first used the term sustainability regarding the environment. It was linked to patterns of development. The Brandt Commission, in 1982, raised issues of global policy on the environment, based on the inequities and disparities between the economies in developed and third-world countries. The

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\(^7\) Steele, James. *Sustainable Architecture*. p.1
Brundtland Report, in 1987, introduced the concept of sustainability on an international level, and was where the aforementioned definition was developed. *Agenda 21* was produced as a result of the 1992 Earth Summit, whose purpose was to move environmental concerns to the forefront of economic policy. The six main subject areas addressed quality of life, the use of resources, protecting global commons, managing settlement, chemicals and waste, and sustainable economic development. The fourth area, the management of settlements, was viewed as significant enough for the American Institute of Architects to add an addendum for it in the *AIA Environmental Resource Guide* to emphasize that reducing environmental impact was important for the profession.

Sustainability is not a new phenomenon in the built environment. Architects have a long tradition of what is now known as sustainable design. Vitruvius noted “It is obvious that design for homes ought to conform to diversities of climate.” Before the relatively recent development of climate control systems in buildings, structures used passive heating, cooling, day lighting and ventilation to respond to their environment and to provide for the comfort of the users. Following the energy crisis in the 1970’s, there has been a movement toward buildings that are more environmentally responsible and energy efficient within the context of the larger movement.
2.2 Application of the Hanover Principles

In 1992 William McDonough, an architect and leading figure in the sustainable design movement, developed a set of principles, referred to as the Hanover Principles\textsuperscript{8}, which established the theoretical groundwork for sustainable design.

1. Insist on rights of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable condition.
2. Recognize interdependence. The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.
3. Respect relationships between spirit and matter. Consider all aspects of human settlement including community, dwelling, industry and trade in terms of existing and evolving connections between spiritual and material consciousness.
4. Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems and their right to co-exist.
5. Create safe objects of long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creation of products, processes or standards.
6. Eliminate the concept of waste. Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems, in which there is no waste.
7. Rely on natural energy flows. Human designs should, like the living world, derive their creative forces from perpetual solar energy. Incorporate this energy efficiently and safely for responsible use.
8. Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not as an inconvenience to be evaded or controlled.

\textsuperscript{8} McDonough, William. The Hanover Principles
9. Seek constant improvement by the sharing of knowledge. Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long-term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity.

Humans are part of the ecosystem, and have had, and always will have a significant impact on it. The need to move from an exploitative approach to an approach that seeks to harmonize with natural processes is essential to long term sustainability. The built environment can better respond to the natural environment by working with natural energy flows, rather than functioning independent of them. A holistic approach to design considers a wide variety of concerns, from the materials that are being used in construction, to minimizing the impact of the building on the site, to the well-being of the occupant.

Society must consider the entire cost of manufacturing products or buildings, such that the environmental costs are accounted for: from the embodied energy to the life cycle cost. Regardless of the techniques used to put a value on environmental assets, no valuation is entirely accurate since a consensus on the intrinsic values and biodiversity cannot be quantified in monetary terms.\(^9\) The goal is to ensure the restoration of renewable resources and to slow the consumption of nonrenewable resources while alternates are found. In construction, this has implications for the choice of materials used. Issues of recyclability and the release of chemicals via outgassing address the impact on current users and the impact on future generations. The idea of material resource conservation can be applied to the reuse of existing structures in lieu of new construction. The principles also allude to the responsibility to cleanup contaminated

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\(^9\) Langston, Craig and Ding, grace. *Sustainable Practices in the Built Environment.* p. 33
sites, or brownfields, rather than abandoning them. Under these scenarios, there is no waste at the level of infrastructure and investment in built environment, but rather a continual evolution of uses.

Most energy exists as available or stored forms of solar energy\textsuperscript{10}. The sun’s energy creates heat, drives the winds, is used in the water cycle, and in photosynthesis. It is an inexhaustible source of energy, estimated to provide enough energy in a minute to supply the world’s energy needs for a year. The energy is clean and its harnessing can have little impact on the environment. Strategies that maximize the potential of solar energy should be incorporated into architecture, whether it is in the use of active or passive responses. Buildings can not only use the sun as a source of energy, but through its orientation and articulation, make maximum use of daylighting, heating, views, and ventilation, all of which are directly related. Designing to maximize what is available naturally rather than recreating it mechanically, lessens the HVAC loads and fossil fuel use. It also helps to keep people connected to their environment.

Design cannot solve all of the issues of sustainability. It can however bring the built environment more into sync with natural processes. Sustainability acknowledges that nothing lasts forever in its original form, and seeks to facilitate change and evolution over time. This requires a new way of approaching the design and construction of buildings that embraces open information and collaboration. It also entails a respect for the welfare of individuals and the environment, and the relationship that exists between them.

\textsuperscript{10} Langston, Craig and Ding, grace. \textit{Sustainable Practices in the Built Environment} p. 177
Green design refers to a holistic approach to design and construction\textsuperscript{11}. This involves an integrated design process, from the design team to the final occupants, and takes into account a range of factors, from material resources to community sensitivity. The end goal is a high performance building that is ecologically responsible and minimizes the impact on the environment. The adaptive reuse of existing structures can fulfill many of the aims of sustainability.

\textsuperscript{11} USGBC. \textit{LEED-NC Version 2.1 Reference Guide}. p.1
Chapter 3: Adaptive Reuse

3.1 What it is

Adaptive reuse is described as “developing the potential of additional use and wear for a functionally obsolete building.” It is essentially the recycling of a building. Commonly associated with historic preservation, the process involves more than restoration. Rehabilitation is the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values. Rather than seeking to continue the building’s existing use through upgrades, or restore it to a specific time period, adaptive reuse seeks to find new uses for it. Adaptive reuse does not have to involve a significant piece of architecture to be successful. The concept is not constrained by what the building used to be, but respects the history and structure as a new program is inserted.

There are potential economic and social advantages to adaptive reuse. If the building is in good structural condition and is easily adapted to its new program, there are economic advantages. These include the potential for lower construction cost, lower land acquisition cost, and less construction time depending on the extent of the work done. A factor in the feasibility of redevelopment is the ability to purchase a site with an existing structure and its infrastructure at a price that is a relative bargain when compared to finding vacant land and building new. Adaptive reuse has also become a strategy for the conservation of energy, an economic issue in terms of the use of

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14 New River Valley Planning District Commission. The Adaptive Reuse Process p.4
resources, as they become scarcer. Razing urban sites in the hope that something new will be built essentially eliminates an asset and wastes all the investments that have gone into the site previously. Economic development is not generated from scratch\textsuperscript{15}. Development activity occurs when there is a perceived demand for space, not because there is vacant land. Vacant land is only valuable if demand for it exists. Conversely, underutilization and excess capacity drive down land value. Existing building stock is often an underutilized resource that can be used to house and grow new and small businesses, due to the lower cost per square foot for space in older structures compared with new developments.

The social advantages of adaptive reuse include providing a link to the past and the revitalization of a neighborhood. Rather than attempting to remove an area’s problems by razing structures, the realization that existing buildings provide a neighborhood’s “sense of place” has come to the fore. The physical revitalization associated with reuse positively impacts the surrounding neighborhood, often encouraging upgrades in surrounding structures.

*Cities need old buildings so badly it is probably impossible for vigorous streets and districts to grow without them. By old buildings, I mean not museum piece old buildings, not old buildings in an excellent and expensive state of rehabilitation ...but also a good lot of plain, ordinary, low value old buildings, including some run down old buildings.*\textsuperscript{16}

There are several problems that face building conservation\textsuperscript{17}. The first is the idea of perpetual progress in which development is continuous and unquestioned. The concept that anything new is inherently good undermines the value of what already

\textsuperscript{15} Langenbach, Randolph. *A future form the Past*. p. 7
\textsuperscript{16} Jane Jacobs. *Death and Life of Great American Cities*.
\textsuperscript{17} Langenbach, Randolph. *A future form the Past* p. 4
exists. Planners have viewed old buildings as an economic impediment, which is exemplified by the number of areas deemed blighted. Traditionally they have viewed these buildings as obsolete for any purpose other than that for which it was originally intended. Cities have also razed areas to create new development to enhance their image. The municipalities build their modern identity at the expense of their historic roots.

3.3 The Conversion of Industrial Buildings

Industrial buildings are one of the most important building typologies of the past two centuries, as they demonstrate the technological development of the country through their architecture. Furthermore, they represent the cultural and social values of their times. The progression they document has yielded a growing interest in industrial building preservation as part of a mixture of diverse building types to more accurately represent the past. Industrial sites are often brownfields. A brownfield is an “abandoned, idled, or under-used industrial or commercial facility where expansion or redevelopment is complicated by real or perceived environmental contamination.” The buildings also represent an economic opportunity as they are generally more durable and yield higher quality space for a lower cost than can be built in new construction of the same scale.

A methodology for the conversion of industrial buildings has been adapted from the process described by Walter C. Kidney, an architectural

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18 Kidney, Walter C. Working Places p. xi
20 Kidney, Walter C. Working Places p. 4
historian specializing in industrial structures. The process consists of the following steps.

1. Identify the current plans and prospects for the building.
2. Identify the owner and relevant basic information.
3. Determine the condition of the building and its utilities.
4. Survey the neighborhood and its present routes of access and get hard information on the neighborhoods future.
5. Identify possible ways in which the building can be reused.
6. Check the laws, codes and regulations governing the proposed use or uses.
7. Involve public officials and agencies early on in the process.
8. See what “good will” can do for you.
9. Determine demand for the proposed use and comparable costs for similar space
10. Engage the public.
11. Identify financial resources, both direct and indirect, that are available.
12. Determine operating expenses and taxes.
13. Prepare a feasibility study.
14. Prepare a developer’s package, or pro forma, for the lending or funding institutions, or possible partners.

A successful example of this approach is Canal Place in Akron Ohio\textsuperscript{21}. The site was formerly the B.F. Goodrich Company encompassing 90 buildings on 55 acres, and employed 28,000 people at its peak. In 1987, after almost 100 years of operation, the company ceased all manufacturing operations and relocated its headquarters to the suburbs. Demolition and restoration were set to cost the company $18,000,000 over five years. Covington Capital Corp., a development corporation, saw the potential in the site. Working with the B.F. Goodrich Company and the city, it was able to have the site re-zoned, and redeveloped 27 buildings on 38 acres as a mixed-use, multi-tenant facility.

\textsuperscript{21} Oleksuk, Denis K. “Creative Solutions to the Rehabilitation of Old Industrial Buildings: The Case of Canal Place, Akron, Ohio.”

Fig. 2 Canal Place, Akron Ohio, before and after redevelopment
Canal Place’s redevelopment was based on market need. Project goals included providing low cost space for small to medium sized businesses; creating a campus like environment and a vibrant activity center; offering space for expansion; spurring the local economy by creating new jobs. The adaptive reuse of these facilities was accomplished not by the traditional renovation to match need, but matching the new users to the existing facilities to minimize cost. Having tenants share the use of docks, restrooms, etc. resulted in lower cost, but required screening of prospective tenants to assure harmony within the complex. Selective demolition for the creation of parking and improved infrastructure was done as required. The campus environment allows for amenities that would not be available to individual companies affordably, such as maintenance, security, a day-care, cafeteria, and a copy center. The facility has generated continued tax revenue from what would have been abandoned property. Community involvement and support for the venture has been strong.

Another successful adaptive reuse project involves one of Cleveland’s abandoned powerhouses. One of the primary advantages stimulating the reuse of the former powerhouse for the Cleveland streetcar system was its location in the urban core. It was converted into an entertainment, commercial, and business center. Originally built in 1896, a major addition was completed in 1905. By 1960, the facility was rendered obsolete by the move from trolleys to buses for the city’s mass transit. Subsequently used for storage, the city saw the building as a liability when it acquired the site and offered the facility for sale, expecting the building to be razed in the early 1970’s. The building was purchased by a development team which saw potential in its size (72,000 square feet), excellent structural condition, and its location in the Cleveland “Flats”

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Kidney, Walter C. *Working Places*. p. 113
entertainment district. Levels were added in the boiler and machine rooms. The existing facades were for the most part preserved. The large stack was retained and marks the entry courtyard to the complex. The redeveloped complex contains a theater, restaurants, shops, offices, and studios. The resulting complex contains nearly 150,000 gross square feet. With its mix of uses, the facility is active 21 hours a day. Cooperation from the city of Cleveland was crucial to the project for resolving building and fire codes. It was to Cleveland’s advantage as well, as the city benefited from the development and its associated tax revenue.

The ability to have a variety of different and successive uses in industrial buildings is demonstrated in another adaptive reuse project at the former headquarters of the Denver City Cable Railway Company. The Cable Building was redeveloped as a commercial building. Built in 1889, the facility was closed in 1900 when the car line was converted to electricity. For the next seventy years, the building changed uses ranging from manufacturing to storage. In 1971, the Denver Urban Redevelopment Authority purchased the building with the intent that it be demolished. Historic Denver, a preservation organization, successfully bid for the property and it was subsequently redeveloped, housing offices on the second floor, the Old Spaghetti Factory on the first floor, and parking in the basement. Each floor encompasses 17,000 square feet. Still in good condition, the original construction was heavy masonry walls, timber floors and roof, with cast iron columns.

Specialized programs such as theaters have been successfully inserted into former powerhouses, as exemplified in the Hallie Flanagan Davis Powerhouse Theater. Located in an unused powerhouse on the Vassar College campus, the facility addressed

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24 Kidney, Walter C. Working Places. p. 120
the need for a new theater, and the lack of a budget for new construction. The size, volume of space, and location made the building a good site for the new theater. The 5,200 square foot facility, as completed, was estimated by the architect to have saved 20% over the cost of demolishing and rebuilding. Elements of the existing structure were reused to maximize efficiency. The machine pits were used for stage traps, the interior crane for holding rolling lights and curtains, and the underside of trusses to support a catwalk and safety netting to allow for versatility in setups. A series of platforms were installed for performances and audience seating with adjustable frames to change elevation.

As shown, the advantage to re-using industrial buildings is often their location in the urban fabric. Many of these facilities have the flexibility of use afforded by large open floor plans due to their original function. Their structural capacity can support many new programs from offices and lofts to manufacturing and theaters.

“Erected to withstand extraordinary loads, to last out the seasons without repairs, and to provide a large area of versatile space, an industrial building is first and foremost a constant that accommodates many variables.”

Industrial buildings are viable candidates for adaptive reuse due to the ability to accommodate a variety of new uses or programs.

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Chapter 4: How they Relate

4.1 Material and Resource Conservation

Adaptive reuse and sustainable design are trends in architecture that have many overlapping principles. In an era of sprawl and declining urban cores, more sustainable means of development must be utilized. The adaptive reuse of existing facilities in the core of the region can benefit the inner city tax base and slow the development of greenfields on the periphery. The built environment is one of the most important economic, social and environmental investments made by man, accounting for approximately 40% of the GDP. Additionally, buildings consume approximately 50% of the world’s primary energy production. When these factors are considered together, the impact of buildings on the natural environment is enormous, in light of both the resources needed to construct them, and the amount of energy needed to operate them.

Energy production and consumption, developments, and resource use are major sources of greenhouse gas emissions, which contribute to global warming. In the United States, buildings consume 37% of the energy and 68% of the total electricity produced annually, 75% of which is produced by burning fossil fuels. Reductions in the amount of energy used in the construction and operation of buildings have a dramatic impact on the amount of pollutants released into the environment.

The majority of energy consumed in buildings is used for heating, cooling, and lighting. Reducing the reliance on mechanical and electrical systems by supplementing them with natural ventilation and lighting results in buildings that have less

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26 Langston, Craig and Ding, grace. Sustainable Practices in the Built Environment, p. 3
27 Langston, Craig and Ding, grace. Sustainable Practices in the Built Environment, p.130
environmental impact, and a positive economic impact as occupants are more productive and operating costs are reduced. It is these types of synergies that green design fosters.

The embodied energy alone in existing building stock makes a compelling case for its reuse. The energy invested in a 5 ton steel girder equals 257 million Btu’s, the equivalent energy in 2,000 gallons of gasoline. This energy consumption would be eliminated if the girder were left in place instead of demolishing it and replacing it elsewhere.²⁸

The United States Green Building Council (USGBC) attempts to define and quantify what constitutes a “green building” in the form of the LEED rating system²⁹. This standard is voluntary. It is consensus based, draws on all members from all aspects of the building industry, and is market driven. LEED, which stands for Leadership in Energy and Environmental Design, is a nationally recognized standard for evaluating sustainable design in buildings. It can be used as a design guideline for rethinking the process of design when environmental concerns are given priority, and as a means of understanding the relationship between adaptive reuse and sustainability. The LEED Reference Guide, a resource document produced by the USGBC, and intended to support use of the rating system, provides strategies for addressing environmental concerns. The process is applicable to not only new construction, but also to the reuse of buildings.

The Material Resources Section of the LEED guide notes that construction and demolition wastes constitute around 40% of the solid waste in the United States³⁰. It is

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²⁸ Maddex, Diane. New Energy from Old Buildings. p. 20
²⁹ USGBC LEED-NC Version 2.1 Reference Guide. p.1
³⁰ USGBC LEED-NC Version 2.1 Reference Guide. p.185
noted that one of the effective strategies to address this is to reuse existing buildings. This addresses not only waste concerns, but also pollution concerns involved with material production and delivery, habitat disturbance, and infrastructure improvements. Building reuse extends the life of existing buildings, conserves material resources, retains cultural resources, and reduces waste and other environmental impacts. The USBC encourages retaining as much of the shell, walls, floors, and partitions as possible during the redesign process\textsuperscript{31}.

4.2 Retrofitting Sustainability

Randolph Croxton, chief architect for the Audubon House and nationally recognized leader in the areas of environmental and sustainable design, has written that at the heart of a good environmental concept is the reality of economy\textsuperscript{32}. His approach looks at the elementary problems of everyday buildings, and instead of treating the symptoms, he addresses the causes. Croxton notes that evidence can be seen in the workplace where comfort levels cannot be maintained due to varying thermal conditions around the building being treated in uniform ways. Lawsuits and sick days due to poor air quality and repetitive stress injuries are also results of poor design. Another area of concern is the lack of occupant orientation to and connection with the outside. Croxton notes that it is possible to integrate the internal dimensions of the building with the external concerns. For him, this means that not only is there a need for occupants to be aware of changes in weather and season, but that the design of the building can address larger environmental issues such as resource conservation, ozone

\textsuperscript{31} USGBC. LEED-NC Version 2.1 Reference Guide. p.194
\textsuperscript{32} National Audubon Society. Audubon House: Building the Environmentally Responsible, Energy Efficient Office.
depletion, and others. The Croxton Collaborative has since come to articulate these aims in a value driven design process where the value lies in the sustainable, the environmental, and the humanistic dimensions.

Sustainable Design in a renovation project is exemplified by the Audubon Headquarters in New York City, designed by The Croxton Collaborative. The first principle of this project was the reuse of an existing structure. Sprawl and the spread of suburbia destroys natural habitat, and this would have been contrary to the organization’s mission. While it would have been easier to incorporate environmental design strategies by building from scratch in the suburbs, rehabilitating an existing building in the urban environment reduced material use, utilized existing infrastructure, allowed for mass transit use, and left a green-field intact. Residual benefits include preserving a historic structure, contributing to the vitality of the neighborhood, and improving the local economy. Another important principle embodied in the building was energy conservation and efficiency.

Several strategies were employed to accomplish these goals. The use of daylight and natural ventilation were maximized, energy efficient windows and HVAC were incorporated, and the existing structure was maintained as much as possible. Designing with daylight was a priority, and the integrated design approach led to many other benefits. An open floor plan was laid out to maximize the penetration of natural light, further helped by varying partition wall heights. Ambient light levels were reduced to 25-30 foot candles and supplemented by task lighting where it was needed, which is able to be controlled and adjusted by the user. Light colors help to reflect light. The choice of fixtures and controls further reduce energy consumption.

Windows and insulation were carefully selected to minimize energy loss, while high efficiency HVAC was designed and implemented for minimum energy
consumption. The HVAC system delivers heating and cooling via gas fired chillers. Emissions of pollutants are minimized and CFC’s (Chlorofluorocarbons) are eliminated. Indoor air quality is critical for the well being of buildings occupants. The ventilation system, in conjunction with material selection, minimizes VOC’s (Volatile Organic Compounds) in the air. Fresh air is introduced to the system at roof level, where the cleanest air is available. It is thoroughly filtered and exchanged at a constant rate of 26 cubic feet per minute.

Recycling and resource conservation were other important ideas used in the building design. Five main areas were addressed by the building: Recycling the building by renovating an existing structure; recycling construction debris; utilizing building materials with a high-recycled content; programming and designing a physical in-house recycling system; establishing guidelines for purchasing recycled office products and waste reduction initiatives.

The Croxton Collaborative uses the word “optimization” to describe the approach used in the Audubon House. Priorities shifted from investing in materials to investing in people, such that productivity and well-being are enhanced. Every design decision was about value, leading to enhanced levels of energy efficiency, air quality, light quality, thermal comfort, and a connection to the exterior. All of this was achieved within the overall market rate for new construction of a similar building type. Croxton proposes that these goals are achievable in all buildings, new and renovated, if changes are made in the way priorities and incentives are directed in development.
Chapter 5: Design Methodology

5.1 Site selection

LEED establishes guidelines to determine sites with urban redevelopment potential and for the reuse of an existing building. These are intended to be used during site selection for the project\textsuperscript{33}. The existing site conditions and the condition of the existing building are examined to identify not only potential contamination and structural integrity, but also the proximity to mass transit stops and existing infrastructure. Additionally, site acquisition costs are factored in. It is noted that appropriate site selection can minimize urban sprawl, conserve green fields, reduce automobile use, and minimize runoff effects. The USGBC encourages channeling development into urban areas with existing infrastructure to achieve a minimum density of 60,000 sf per acre\textsuperscript{34}. Urban re-development helps “restore, invigorate, and sustain” communities, keeping them viable. It is noted that these sites often involve the rehabilitation of existing structures, decreasing construction waste and new material use. However, there are also potential problems with this type of project, including air quality, soil contamination, limited day lighting opportunities, and limited space. Mitigating these situations is encouraged elsewhere under the LEED guidelines.

The economics of site selection are critical for an adaptive reuse project, determining the project’s viability.\textsuperscript{35} Three market situations describe potential sites. The first scenario involves an area where the properties are in good upkeep, but the market demand has decreased, resulting in building vacancies and scattered parcel vacancies.

\textsuperscript{33} USBGC. LEED Critical Path: Site
\textsuperscript{34} USGBC. LEED-NC Version 2.1 Reference Guide. p.19
The second scenario is exemplified by a neighborhood with visible deterioration and a surplus of vacant land due to poor demand. The third scenario is an area with significant disrepair, abandonment, and little private investment. The first scenario, in which the structure is in good condition, but the market is weakening for the current use, marks the ideal scenario for a building reuse. Unique residential or commercial developments have the best chance of succeeding at capitalizing in changing economic functions and markets in the central city.

The selection of the appropriate building for an adaptive reuse project is the most important factor in an adaptive reuse project. Not all buildings merit reuse. In some cases, the site may meet all the criteria for a sustainable development, but the facility is not suitable due to structural defects, square footage deficiencies or excesses, the extent of alterations needed for a new program, or the inability to overcome code compliance issues. In short, some projects require more work than would be economically viable.

The structural condition of a building is determined in a two phase assessment. The Phase One assessment assembles whatever information is known about the building and current zoning and planning requirements, and the new program that will be inserted into the structure. A visual inspection of the facility is meant to determine any structural deficiencies and can also address issues of square footage and potential costs for making the building suitable for the new use. The process begins with a review of the available data. Type of construction and load paths should then be identified. A visual inspection of the building then looks for defects in structural members, connections, walls, floors and decks, and the foundation. Following this inspection, structural failure considerations are addressed ranging from local failures to the potential

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means of failure. The loads on the building are then estimated and a determination
made of whether the structure is adequate and if a more detailed assessment is needed.

The Phase Two Assessment is a more detailed and comprehensive analysis which
includes visual observations and testing.\textsuperscript{38} The strategy is based on determining where
the detailed analysis is needed. For example, the floor deck and trusses might be
examined if the new loads were expected to be greater in the proposed use. Material
tests can be done, but load testing of the individual members is the most definitive and
cheapest method. In some cases, a mathematical model may be developed.

5.2 Environmental Design Strategy

Having determined that the building is situated on a sustainable location and is
structurally intact, determining appropriate environmental strategies for use in the
project can be addressed. Analyzing site conditions provides the starting point for this
process. In order to design in harmony with the environment, the designer has to
understand the microclimate.\textsuperscript{39}

As every microclimate and site situation is different, the designer must start with
the best available information published. The National Oceanic and Atmospheric
Administration (NOAA) has extensive information available. Many reference guides for
designers have been compiled using NOAA data. Lechner’s \textit{Heating, Cooling, Lighting}
provides basic climatic data, and describes climatic regions which are used as a basis for
strategy selection. The microclimate is also influenced by the surrounding buildings,
landforms, and bodies of water. Local modifying effects can only be ascertained by

\textsuperscript{39} Lechner, Norbert. \textit{Heating, Cooling, Lighting} p. 68
measurements and observations on site. Once climatic information has been gathered, it can be applied to the building.

The LEED reference guide notes that there are three fundamental strategies that can increase energy performance: demand reduction, use of free energy, and increasing efficiency\(^{40}\). Design strategies detailed in this section attempt to address these energy issues.

Solar orientation and exposure is an important factor in sustainable buildings. The effect of the sun on a building and its site is dynamic throughout the day, and changes throughout the year. This relationship can begin to be understood through vertical and horizontal sun-path diagrams, which are two-dimensional representations of the sun’s path across the sky.\(^{41}\) The horizontal sun-path diagram is useful for gathering information on the altitude and azimuth of the sun, and is used to determine sun penetration and shading into the building at any time of the day and year. The vertical sun-path diagram is useful for documenting the solar window by mapping the horizon over the diagram to determine when the sun will be blocked. The information can be used to create shadow studies, which impact solar gain through windows, the quality of both interior and exterior spaces, and appropriate landscaping based on exposure.

This information is then used in conjunction with the existing conditions of the building’s massing and its fenestrations. The diagramming can inform the strategies then selected for optimizing the relationship to the sun. A building’s window placement is essential to energy efficiency in a building, especially in a reuse situation. Existing single pane glazing should be replaced with higher efficiency units, and air infiltration eliminated by better seals and a tighter thermal envelope. Beyond the physical

\(^{40}\) USGBC. LEED-NC Version 2.1 Reference Guide, p.137

\(^{41}\) Lechner, Norbert. Heating, Cooling, Lighting p. 131
characteristics of the window, the application and location of the glazing directly affects passive solar heating, natural lighting and its distribution, and natural ventilation and thermal comfort through its operability. Window synergies are further demonstrated by the provision of views. Old buildings tend to have high floor to ceiling heights and large windows, which make these strategies particularly applicable when introducing sustainability into a reuse project.

Day lighting addresses several needs, including issues of energy, biological needs, and aesthetics.\(^\text{42}\) The movement of the sun over the course of the day fills a human need to respond to natural rhythms, and also animates and changes the character of the space. In general, natural illumination is effective 1½ to 2 times the height of the window head into the depth of the room\(^\text{43}\). The use of natural daylighting has significant impact on energy consumption in a building. In some building types, approximately 40% of a building's energy use is for electric lighting\(^\text{44}\). These lights are on throughout the day in typical buildings, often despite the availability of natural light during this time. This corresponds to the peak demands for electric use in the summer. The use of day lighting thereby reduces operating costs of a facility through not only the cost of operating the lights, but also in the reduction of cooling loads associated with the heat they generate. Daylighting's other benefit comes in the potential use of the heat gain that can be generated during colder parts of the year.

A passive solar energy system collects and transports heat by non-mechanical means.\(^\text{45}\) To maximize the benefits of this system, buildings located in temperate climates should be elongated on the east-west axis to maximize exposure for the collection of

\(^{42}\) Lechner, Norbert. *Heating, Cooling, Lighting* p. 364  
\(^{44}\) Lechner, Norbert. *Heating, Cooling, Lighting* p. 364  
solar radiation. There are three basic passive design concepts that are common in new construction and that can be applied to reuse and retrofit projects.\textsuperscript{46}

Direct gain occurs when solar energy penetrates the south facing windows and warms the interior where it is stored in a thermal mass. In a retrofit, this entails optimizing the windows based on their orientation to best deal with issues of heat gain and loss at different times of the day. South facing windows have a net gain, while east and west windows invert over the course of the day. North facing windows are net losers. Retrofitting is sometimes problematic because the system is integrated into the building facade.\textsuperscript{47} However, it is relatively simple to take advantage of the windows that already exist. The rule of thumb for estimating south facing glazing in Climate Region 3 for direct-gain and Trombe Walls is 28\% of a room’s floor area in south facing glazing.\textsuperscript{48} The thermal mass required for direct gain is 3 square feet of 2” to 4” directly exposed brick or concrete per square foot of glazing, or 6 square feet of 2” to 4” for reflected solar radiation. Windows should be double or triple glazed.

Placing layers of glazing in front of a thermal mass wall produces a Trombe Wall\textsuperscript{49}, which stores the heat created by solar energy, and gradually transfers the heat into the interior. The mass can be made of concrete, brick, or containers of water. Mass walls transfer heat to the interior directly by radiation and indirectly by convection. Convection can occur if there is space between the glass and the wall. Vents at the top and bottom of the wall allow air to be reheated and released into the interior. As a rule of thumb, each square foot of glazing should be matched by one square foot of thermal

\textsuperscript{46} Maddex, Diane. \textit{New Energy from Old Buildings} p. 137
\textsuperscript{47} Mazria, Edward. \textit{The Passive Solar Energy Book} p. 109
\textsuperscript{48} Lechner, Norbert. \textit{Heating, Cooling, Lighting} p. 150
\textsuperscript{49} Lechner, Norbert. \textit{Heating, Cooling, Lighting} p. 153
mass, 10” to 16” deep for brick or concrete and 8” or more for water\textsuperscript{50}. The glazing should be at least 1” from the mass wall. In a retrofit, large expanses of masonry wall with southern orientation are ideal for this purpose.

Another strategy is the incorporation of a sunspace. Essentially, a sunspace consists of a greenhouse attached to the south facade of a building in which air is heated and vented into the main interior space. A guideline for the heating potential is that one and a half square feet of sunspace can provide heat for one square foot of the adjacent interior of the building\textsuperscript{51}. The slope of the glazing should be between 50\textdegree{} and 60\textdegree{}. The vents to the interior of the building should be a minimum of 10\% of the glazing area. The thermal mass required for 1 square foot of glazing is 1 square foot of masonry wall 8” to 12” thick. The space should be able to accommodate large temperature fluctuations and will not always be able to be occupied. In addition to providing heat, the greenhouse provides a means for growing vegetation. In a retrofit application, this requires an addition, and therefore may have limited potential in urban areas due to street proximity and shade from surrounding structures. It might be employed in a penthouse situation.

These systems often use a masonry mass for heat storage\textsuperscript{52}. The thick masonry or concrete walls and floors commonly found in older construction, especially in commercial and industrial facilities, provide this thermal mass. This tends to minimize indoor temperature fluctuations, as the heat collected during the day is gradually

\textsuperscript{50} Lechner, Norbert. Heating, Cooling, Lighting p. 157
\textsuperscript{51} Mazria, Edward. The Passive Solar Energy p. 111
\textsuperscript{52} Mazria, Edward. The Passive Solar Energy p.134
released at night. Approximately 65% of heat loss in buildings occurs at night\textsuperscript{53}. Floors and interior walls generally require a minimum of four inches in thickness, but vary by amount of glazing and application as noted previously. Color also plays a role. The high mass areas are generally of darker color to absorb heat, whereas low mass interior partitions would be light colored to reflect the light onto high mass areas. Darker masonry floors with long periods of direct sunlight should be avoided, as day time heat gain can be excessive.

Natural ventilation is facilitated by the introduction of operable openings. Placement of the openings is critical to successful air movement. Cross ventilation is most affective when the openings are located on opposite walls, creating movement from a strong positive air pressure to a strong negative pressure area.\textsuperscript{54} The depth of the space being ventilated and the obstructions within become the limiting factors of successful airflow. Openings should be low for comfort ventilation. In general, the intake and outlet size are the same, but if there is a size differential, the intake should be smaller to maximize the indoor air stream.

Passive summer cooling is the result of two factors: wind and the indoor-outdoor temperature differential.\textsuperscript{55} Cooling through ventilation occurs in the form of comfort cooling and of night flush cooling\textsuperscript{56}. Comfort cooling relies on bringing in air from outdoors and using evaporation to cool the occupants. Night flush cooling cools the indoor air at night by opening the intakes and exhausts fully. During the day, minimal outdoor air is taken in and the thermal mass is used as a heat sink for occupants. Natural ventilation not only affects indoor thermal comfort, but air quality as well. This

\textsuperscript{53} Mazria, Edward. \textit{The Passive Solar Energy} p.136
\textsuperscript{54} Lechner, Norbert. \textit{Heating, Cooling, Lighting} p.260
\textsuperscript{55} Mazria, Edward. \textit{The Passive Solar Energy} p.265
\textsuperscript{56} Lechner, Norbert. \textit{Heating, Cooling, Lighting} p255
technique works best in places where fluctuations between daytime and nighttime temperatures are a minimum of twenty degrees.

Air flow is the result of natural convection due to temperature or pressure differential. Two different effects, the Bernolli and the stack, can be applied in combination for maximum results in a building. The Bernolli effect relies on negative pressure at the roof, which is a result of the increase in air velocity as height increases, to create a differential in static pressure to draw air out of the building. It relies on wind. The stack effect relies on interior convection that draws air from an intake located low in the building and exhausts it from a vent located high above. This effect is not dependent on the wind, but is weak. The effect can be strengthened by maximizing the distance apart of the intake and exhaust.

Shading devices also impact cooling by reducing external heat loads. Horizontal louvered overhangs provide the most flexibility. They allow low winter sun to enter, and keep high summer sun out while preserving the view. They represent the best selection for southern, eastern, and western exposure. Horizontal louvered overhangs have the added advantage of allowing heat to escape from in front of the window, while preventing snow buildup or water collection that would occur with solid overhangs. A moveable overhang is recommended if both passive heating and shading are important. A rule of thumb for determining the overhang length in Climate Region 3 is diagramed to the left. Angle “A” representing full shade is 63° and originates at the sill, and angle “B” representing full sun is 55° originating at the head. The overhang will extend to the

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57 Lechner, Norbert. *Heating, Cooling, Lighting* p. 258
58 Lechner, Norbert. *Heating, Cooling, Lighting* p. 219
full shade line during over-heated periods and retract past the full sun line during under-heated periods.

The thermal envelope of an existing building is important to reducing the heating and cooling load. As stated previously, the windows are one area where efficiency can be increased. The addition of insulation is another option. The insertion of wall insulation can greatly reduce heat loss, but can have an adverse effect on the aesthetic in historic buildings in which the original wall material is exposed. It will also negate the effects of thermal mass walls. One solution would be to prevent heat transmission on the north side of the building, while allowing southern walls to remain. Adding a layer of insulation to the exterior of the roof is feasible in a retrofit and enables the interior features of the space to remain. Other options include a green roof, which relies on the mass of earth over the building, or a roof pond, which relies on the mass of water to insulate the building. The feasibility is determined by the structural capacity of the building. For example, the 6” to 12” depth required for a roof pond to provide stable indoor temperatures would have a dead load of 32 to 65 pounds per square foot. Another strategy to deal with this issue is to use thermal planning to put programmatic elements into areas that take advantage of exposure. For example, spaces that can tolerate or need cooler temperatures should be used as buffers on the north side of the building.

The application of these techniques in a reuse project can have an impact on the historical character of the building. This raises the debate about preservation versus the economic realities of the present. The need for energy efficiency and the changes that a building would require to attain this may impact its traditional appearance. Some zoning

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59 Mazria, Edward. *The Passive Solar Energy* p.113
60 Lechner, Norbert. *Heating, Cooling, Lighting* p. 440
districts require the historic character of a property to be retained and preserved. This also has implications if historic tax credits are to be used, as the guidelines issued by the secretary of the interior clearly state that the alteration of features that characterize the property should be avoided. Renovations that strike a balance between highlighting qualities and features from the building’s history, while reflecting the needs and sensibilities of the present are needed.

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Chapter 6: The Project

6.1 Introduction

Revitalization and rejuvenation are directly linked to ideas about energy. These themes are common to both adaptive reuse and the fitness and health of an individual. Similarities exist in both areas related to the need to maximize the potential inherent in what exists in order to continue productively into the future. Concern for the health and well-being of individuals and their interaction with the environment is an underlying issue of sustainability, and this theme will provide the philosophy for a Wellness Center.

Utilizing the former DP&L Steam Plant on Third Street in Dayton, Ohio, the Powerhouse Sports Center, as it is preliminarily being called, will incorporate features currently not in the surrounding community, and will try to link the neighborhood and downtown Dayton with a destination that will draw people. The Powerhouse Sports Center is conceived of as a private facility that combines elements of fitness and relaxation to promote a sustainable lifestyle for those working and living in and around Dayton, Ohio. Through its programs and its architecture, emphasis will be placed on natural processes and environmental responsibility. Located in a former industrial area on the fringe of downtown, the facility seeks to contribute to the redevelopment of the neighborhood by providing amenities and demonstrating the potential of adaptive reuse. The once vacant building will, through its own revitalization, begin to enliven the community through the services it provides.

The Powerhouse will provide a number of amenities above and beyond a traditional fitness center. The idea is that the facility is not just a place for exercise; it is a club that promotes a healthy lifestyle. Areas for competitive sports will be provided. The facility will have a range of exercise equipment and machines, as well as offering a
number of programs that stress mental and physical health, such as yoga and gardening. Some of what is grown will be used in the food that is prepared and served on site. Small and large gathering spaces promote interaction with other users and provide spaces for seminars and events to occur. Aquatic activities will be available, while a spa and massage area will continue the theme of physical and mental rejuvenation.

The users of this facility will not only be the residents of the surrounding neighborhoods and those who work downtown; it is intended that the center have a city wide draw due to the visibility and uniqueness of the facility and its philosophy. The membership of the club is primarily expected to be young professionals, who would be using the facility before and/or after work during the week. The club would anticipate that most users on weekends be residents from the adjacent urban area, and those who live in the suburbs.

6.2 Goals

Solutions for integrating “green” design elements into structures that were originally conceived with no concern for this perspective will be demonstrated. The Powerhouse seeks to take the idea of the original use of the building, that of production, and transform the idea from the old industrial paradigm, the linear production of a product, into the sustainable philosophy of the holistic building of a person’s wellness. It is to provide a healthy environment conducive to strengthening the body and the mind. Through its holistic approach, from the building to the programs offered, the wellness of the individual is integrated with the wellness of the environment, and this relationship is emphasized.
This facility intends to provide a model for reintegrating former industrial sites back into the fabric of the community, and for adaptive reuse projects integrating sustainable design strategies. There are a range of issues surrounding this idea in the context of an urban area. Issues of historic preservation, urban renewal, resource conservation, integration of new technologies into existing structures, and environmental responsibility are raised. The major emphasis of this project is examining the relationships between adaptive reuse and sustainable design. Sustainable design encompasses a wide range of issues many of which cannot be addressed in the context of this project. The aspects that will be addressed by this facility include: redevelopment of an urban site as part of a mixed use community; material conservation through the adaptive reuse of an existing structure; improving energy efficiency and occupant comfort through passive environmental design strategies.

6.3 Strategies

The facility will be more than a structure housing fitness equipment; it will be a “green" exercise machine itself. The theme of movement will be expressed. The circulation through the building will connect the programmatic functions into a sequence of experiences, providing not only access, but a means to view the environmental strategies employed in the facility. User interaction with the building is desired, from the ability to control the lighting and temperature in one’s space, to the use of traditionally functional elements such as stairs for exercise. To promote the club’s use, a reduced rate will be given to those in the adjacent loft developments, positioning the club as an amenity for the residents, while removing the need for the developers to build fitness areas in their buildings. Because of its location, the use of public transit and
bicycles will be encouraged for local residents, but parking will also be provided on site and through arrangements with the adjacent Public Market for those who travel by car.

An interaction between the user and nature is desired. The connection to the outside will be emphasized through a variety of views, exterior spaces, and natural lighting and ventilation. This will be accomplished through multiple means of accessing exterior gardens and courts from the interior spaces. These spaces will use native plants and vegetation to restore some areas of the site to a more natural condition. The introduction of natural ventilation and the wider range of indoor temperature fluctuation allowed through the use of passive heating and cooling will also provide occupants with a connection to natural processes and rhythms.

The energy strategies to be incorporated in the project are based on recommendations by Norbert Lechner on climatic design priorities for climatic region three, the location of the site for the project, and the characteristics of the structure to be reused. This region has a comfort period of fourteen percent of the year. It is warmer than the comfort period twenty percent of the year, while the majority of the time, sixty-six percent, it is cooler than what is considered comfortable. Because of this, the three main design priorities address keeping heat in and cold out, protecting from cold winter winds, and letting winter sun in. Lower priorities address the brief but high temperatures and high humidity that occurs in summer through keeping out hot air, protecting from the summer sun, and naturally ventilating for cooling.

Specifically, the passive design strategies that will be incorporated involve the use of daylighting, natural ventilation, and passive heating and cooling. These strategies are described in Chapter 5 in detail. Material resource conservation will be addressed via the

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62 Lechner p.86
retention of existing infrastructure and building structure and shell. Site design entails the integration of structures, circulation, and infrastructure with both the natural and cultural environments. The site plan will seek to integrate the structure with the neighborhood and downtown. Permeable surfaces, green roof technology, and indigenous plants will be used to mitigate storm water runoff.

There are several examples of fitness and sports centers that address similar the issues of integrating a specialized program into an urban condition and demonstrating a sustainable design ideology. Talacre Community Sports Centre addresses the idea of sustainability in this typology through its use of passive design features, similar to those that will be addressed in the Powerhouse. The facility seeks to reduce energy consumption through the use of natural light and ventilation. Using a shallow undulating roof with roof lights provides natural light. These are supplemented by artificial lights whose controls are linked to daylight levels to maximize energy efficiency. Louvers are employed to shade the reception area, which is oriented to the southwest. Natural ventilation is achieved through a natural stack affect assisted by an airfoil mounted on the roof. The architectural features support a program that includes volleyball, netball, basketball, football, tennis and badminton.

Birmingham YMCA is an example of an indoor sports program resolving itself in an urban condition on multiple floors, similar to the strategy and site that will be used for the Powerhouse. The 87,000 square foot fitness center addresses the desire of the YMCA to attract a larger and younger membership through its proximity to nearby offices in the downtown. The gymnasium, indoor running track, and pool are stacked to

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64 RIBA Journal February, 2003. p 42
65 Architectural Record August, 1987 p 96
address the site limitations on footprint. Functions that require less natural light, such as weight rooms, services, and racquetball courts were placed in the core of the building. The elevation employs glass block and strip windows, illuminated by the activities within, to draw people to the building.

Though the program is specialized, a fitness center can incorporate sustainable design. An urban site necessitates the use of multiple floors to accommodate all the programmatic elements needed for a full range of exercise opportunities. The reuse of a brownfield adds another dimension of complexity, through environmental and spatial restraints. Using strategies similar to those in Talacre and Birmingham, the Powerhouse in Dayton will demonstrate that a multi-story health and wellness center employing passive design can be integrated into a former industrial building on an urban site.

Fig. 18 Birmingham YMCA: exterior, plan, and section
Chapter 7: The Site

7.1 Context

The former Dayton Power and Light Third Street Substation is located on the eastern fringe of downtown Dayton, Ohio. Formerly the site of a steam plant, the property and remaining structures at 617 East Third Street currently sits vacant. Considered a brownfield, the approximately one and one-half acre site, meets the criteria for an adaptive reuse project through its good structural condition, proximity to downtown, and access to transportation. The neighboring buildings, which are similarly sited and in good condition, are slated to be developed into lofts, demonstrating that there is continued interest and demand to warrant development in this neighborhood. The steam plant in particular is a good candidate for redevelopment due to its unique history and architectural features. The site's potential is not without its drawbacks. There are issues of potential contamination and abatement, and limitations of working within the existing structure. However, these concerns are outweighed by the benefits of restoring the site, the cost of acquisition, and the quality of the spaces created. As the site is a brownfield, it will be eligible for city mitigation programs prior to development.

Downtown Dayton is roughly bounded to the north and east by the Little Miami River. To the south and east the elevated railroad tracks form another physical division. The site of the steam plant falls within these borders, and is centrally located between several successful redevelopment projects in the vicinity. Fifth-Third Field, home to minor league baseball team the Dayton Dragons, is two blocks to the north. Slightly farther north and east is the Entrepreneur’s Center, a business incubator, and “Tech Town,” a brownfield site and a city priority for redevelopment that was recently awarded a state grant for infrastructure improvements to support new economic development. The
Cannery, a former warehouse converted into lofts and retail space, is located one block to the east. It is one of seven residential conversions that have happened on the eastern fringe of downtown, all of which are within walking distance of the site. The center of the central business district, Kettering Tower, is located five blocks to the east. Three blocks to the south is the business and entertainment center of the Oregon district, a thriving historic residential neighborhood. Adjacent on the east is the Second Street Market.

Fig. 21  Views from the site to the northwest and northeast

Fig. 22  Site vicinity
The existing stacks atop the building are visible from several places around downtown, and provide the visual landmark for the facility. From a car, on approach to the city via State Route 35 from the east or west, the site is visible to the north at the Keowee Street exit and in the stretch of highway between Wayne Avenue and Jefferson Street. From the East, on Third Street, the building is visible for multiple blocks. From the North, the building can be recognized from many vantage points, including the river. Notably, the stacks are recognizable from the inside the ballpark. Views of the facility are limited from the West due to the adjacent structures in downtown Dayton.

From the facility, there are several notable views. The view to the North includes a panorama of industrial era buildings, many of which have been converted to other uses. The ballpark is visible, as is the adjacent imposing Mendleson’s Warehouse, a local landmark. The railroad is prominent in most of the eastern and southern sightlines. The Cannery lofts are to the southwest. There is no view directly west from anywhere within the existing building, due to the neighboring building. However, from the northern part of the site, the downtown skyscrapers are clearly visible, as is the case when standing to the south of the building, looking west.

7.2 History

In 1921, Dayton Power and Light Company began construction of the Third Street Steam Plant on the property. The facility was constructed as part of the central business district steam system, which has since been abandoned. The building, which fronts Third Street, was completed in the Classical Revival Style, an architectural treatment common in many industrial buildings in that era. Within its masonry walls and high ceilings, the open floor plan housed turbines. The original smokestacks, which rose over one hundred feet, were in place at his time. Throughout its history, the building was
reconfigured and added on to, to meet the changing technologies and methods used for its production processes. The first major addition, located on the east side of the structure, was completed later in the same style as the original building to house water treatment equipment. Later, a less articulated brick structure was built to the northeast corner of the complex. In 1948, an addition to the north of the original structure, the largest piece of the Third Street Substation, as it was then referred to, was completed to house coal fired furnaces. The facility was built around a steel structure, which supported all the machinery needed in the conversion process. A railroad spur provided coal to the complex, which was unloaded via a gantry and placed into the hopper under the cover of the large roof overhang. The hopper then released the coal at the base of two furnaces. The heat produced was used to create steam which was then piped out into the loop. The resulting smoke and pollutants were captured at the top of the furnace and released through the dual stacks atop the building. During the time of the plant’s operation, a coal storage area was enclosed on the corner of Third and Webber, and a water tower was built to maintain adequate pressure. It was in the middle of the twentieth century that the plant reached its peak use and state of development. At some point subsequent to the building of this addition, the facility was converted from coal burning to oil burning, resulting in the removal of the original masonry stacks, along with the northeast building and the water tower. The original gantry rail was also removed. Oil storage tanks and a delivery system were installed to supply the new source of energy. By the turn of the century, the facility was closed. After sitting idle for years, the facility was made available for sale, along with other DP&L obsolete properties. The original building is eligible for, but is not currently listed on, the National Register of Historic Places.
7.3 Existing Conditions

The description and analysis of the existing conditions is divided into four sections: the South Building, constructed in 1921; the East Building, built subsequently; the North Building, built in 1948; and the Site. Descriptions of the buildings, as they are being referred to, will begin with a general discussion, and will then proceed to a discussion of the construction, structural integrity, spatial characteristics, and unique features. Proceeding floor by floor beginning in the basements and working up, the entire complex will be examined. Refer to Appendix A for complete as built drawings.
The South Building

The building has masonry bearing walls with a brick exterior on the South and West facades. Originally an open floor plan housing turbines, the singular space is divided into eight bays defined by the pilasters supporting the steel trusses above. Each bay has a large arch-top window, which nearly fills the space between the pilasters. Each window has a square transom window, placed between the trusses. On the exterior, the pilasters are articulated in the brick pattern. Below the transoms, the water table is articulated into a line of banding. The windows and casing are in various states of repair. The footprint of the building is approximately 50 ft x 120 ft, for a total of 6,000 sf. Access to the rest of the facility is via two doors to the East Building, one door to the North Building, and an access stair to the basement.

The basement space varies in height between approximately 10 ft and 15 ft. It covers the entire footprint of the building. The structure is concrete, as is the floor. Originally the space was lit by a light well located on the south façade between the building and the sidewalk along Third Street. The windows have been in-filled, and the well filled with dirt. There is an excess of water on the floor, due to a faulty valve on a water main entering the building.

The main level, located approximately three feet above grade, has been subdivided to accommodate various functions, after the turbines were removed. The space is 27 ft high from the concrete floor to the bottom of the trusses, which decrease in depth as they span from south to north, causing the ceiling to slope. The space is still very well lit with natural daylight from the south. On the western end of the space, a two story CMU infill structure fills two of the bays, stopping short of the trusses, and housed restrooms and lockers for the workers, as well as a meeting room. The southern half of the remaining space has been in-filled with offices. These 8 ft high spaces are
constructed of gypsum partition walls. A large cylindrical tank was added in the eastern end of the space, extending through a circular hole in the floor to the basement, and penetrating the ceiling above. This tank is visible on the exterior.

The East Building

Similar in character to the South Building, the exterior features the same brick treatment and continues the horizontal band. The three story structure is divided into two bays on the south elevation, with the third floor set back. The interior structure is steel, with the beams spanning east-west. They are supported by the exterior walls and steel columns at the midpoint. There is limited deterioration in the exterior trim and all the windows are missing or in disrepair. The roofs are flat, and are surrounded by parapets.

The basement is approximately 5 ft in depth, and provides access to any sub-floor components of the first floor equipment. The space is divided by steel columns. There is no exterior access to the basement.

The main floor of the East Building aligns with the floor of the adjacent South Building. Most of the interior space is currently occupied by stairs and equipment in disrepair. There are windows on both the east and south elevations. The approximate size of the footprint is 50 ft x 35 ft, for a total of 1650 sf.

In section, the second floor is configured like an L, creating two spaces. The southern half of the floor has a low ceiling, distinguished by the arched windows on the south elevation. The northern half is characterized by the high ceiling and a steel stair to the third floor. The plan is the same size as the main level.

The third floor is approximately 700 sf, and is located over the northern section of the second floor. Windows provide ample daylight, but are in need of replacement.
The North Building

Distinguished by the steel structure on the interior, the building was essentially a framework to support equipment for the steam production process. As such, the intermediate floor configuration and height varies. The footprint at grade is approximately 100 ft x 50 ft, for a total of 5,000 sf. While the interior structure is sound, there remain numerous pieces of equipment that are in various states of repair. The elevator does not function, and will need to be repaired or replaced. The coal hopper is intact.

The exterior of the building is primarily brick, metal panel, and louver infill. The west façade is no longer in tact; corrugated metal panels now cover the elevation. The east façade is intact on the upper levels, but requires some repair on the lower levels. The north façade is dominated by the steel coal hopper, and the large roof overhang. The south elevation overlooks the roof of the south building, and is generally in good condition. The facility is topped by a flat roof, upon which two metal stacks rise.

There are two levels located partially or completely below grade, the basement and the operations floor. The basement level has a concrete floor, while the operations floor, which is approximately ten feet below the finished floor elevation of the south building, has a terrazzo floor intact.

There are three intermediate floor levels. Floor surfaces vary between steel grates and concrete on these levels, and heights vary from ten to fifteen feet. There are three sets of open steel stairs connecting these levels with the upper floor and the operations level. The second and forth bays are currently occupied by the furnaces, which are clay and brick. The structure of the hopper occupies the north quadrant of the floor plan.
The first of these floors is located almost two feet above the floor level of the South Building.

The upper level has a concrete floor with grates along the north wall to allow light to penetrate to below. The ceiling is 20’ off the finished floor. Access to the top of the hopper and the roof are available.

The Site

There are several distinguishing features on the approximately acre and a half site. The building’s 13,000 sf footprint occupies the southwest portion of the parcel. The facility is offset from the adjacent building by approximately twenty feet, creating two courtyards. The southern courtyard and the northern courtyard are separated by a concrete wall, the remnant of a former construction that also forms the north wall of the northern half. It is believed that at least a portion of the space contains a continuation of the basement level of the north building. The foundation of the original stack is also buried in the area. The courtyard contains masonry debris from prior demolition.

To the north of the complex, the abandoned concrete structure of the gantry rail stands approximately thirty feet from the North Building, and remains in good condition. It extends across nearly the entire width of the property, along with abandoned railroad tracks which run parallel to it. North of the gantry, an alley bisects the property. This alley has been vacated by the city. Land north of the alley is occupied by a gravel parking lot.

On the southeast corner of the parcel is a concrete retention basin, approximately ten feet high. This houses two oil tanks, approximately thirty feet in diameter each. The area between it and the building has been cleared, but the former structure’s foundations lie buried near the north and east sides of the main buildings.
The former light well occupies space between the building and the sidewalk to the south of the building.

7.4 Environmental Factors

Dayton is located at 39°45'46" North, 84°11'48" West. The site is in the Miami River Valley, north of Cincinnati, at the juncture of the Great Miami River, the Stillwater River, the Mad River, and Wolf Creek. After the flood of 1913, numerous water-control dams and levees were constructed to control these rivers. According to the United States Census Bureau, there are 166,179 people in the city, which has a total area of 56.6 sq mi. Refer to Appendix B for climatic information.
Chapter 8: Analysis

8.1 Site

There are several features of the site as it exists that will support sustainable design strategies. The axis of the building runs east-west, for southern exposure. The southern façade is unobstructed, allowing for maximum solar orientation. The larger adjacent building to the west protects the structure from harsh westerly sun and winter wind. The abandoned site’s restoration would contribute to land reclamation and urban redevelopment. Refer to Appendix A for complete as-built drawings.

Access

Pedestrian access is accomplished by means of an extensive network of sidewalks, which are located on all the streets in the vicinity. While it is presumed that individuals interested in fitness would be willing to walk farther, especially those in an urban environment, research indicates that the average person is only willing to walk approximately five minutes, equivalent of about 2000 feet or 4/10ths of a mile, to a service or transit stop before deciding to drive. This puts many of the residential developments completed in recent years on the eastern side of downtown within easy walking distance. Downtown office buildings and the majority of the older residential areas are slightly beyond this limit.

Public Transportation in Dayton is provided by RTA, the Regional Transportation Authority, in the form of busses. In keeping with LEED guidelines for a sustainable site, there are two bus stops located within a quarter-mile of the site. The corner of Sears and Third and the Second Street Marketplace are on the bus route. Although the system is countywide, vehicular use is still by far the dominate mode of transportation in the city.
Automobile access to the site will primarily be in the form of the surface level roads that compose the street grid in the downtown area. The two primary two-way, north-south streets in downtown Dayton are Main Street, which runs through the central business district, and Patterson, which runs along its eastern edge. Patterson is located two blocks east of the site. Keowee Street, located two blocks to the west of the site, just outside of downtown, is also a primary access road. There are also two primary two-way, east-west streets. Fifth Street, located on the southern edge of the central business district, connects the site to the Oregon district, and Third Street, upon which the site sits, connects east and west side neighborhoods to downtown. Access from outlying areas is achieved via two highways: Interstate-75, which runs north and south, and State Route 35, which runs east and west. Access to and from I-75 is via Third Street. Access from 35 is available via Patterson Street and east on Third Street. However, the most direct route to and from the site is via Keowee Street and west on Third Street.

Density

The site area totals 80,400 square feet. The footprint of the existing building is 13,000 square feet, and an addition is expected to have a footprint of 7,000 square feet. This leaves approximately 60,400 square feet of space to accommodate the outdoor program. The expected square footage of the project is 50,000 square feet. This would not meet the goals of LEED of 60,000 square feet of development per acre on its own. However, coupled with the 130,000 square foot development occurring on the adjacent site’s 26,000 square feet, the redevelopment of the entire block exceeds this goal, achieving 74,000 square feet per acre.
Exposure

The building’s axis is east-west, allowing for southern exposure on 10,750 square feet of the façade, indicated in yellow on the diagram. This amounts to 36% of the building's total façade. The roof areas also share this exposure. This would allow each section of the 13,000 square foot roof to accommodate a green roof system.

Using shadow diagramming, an addition wishing to utilize passive solar heating would have to occur on the southeast corner of the site, to avoid being shaded during the winter months. This also shows that the lot on the north side of the site would be better able to accommodate outdoor activities throughout the year than areas near the structure.

**Fig. 34** Solar exposure on site

**Fig. 35** Comparison of composite shadows cast on June 21 and December 21 from 9 a.m. to 3 p.m.
8.2 Structure

Having completed a preliminary walkthrough of the facility and made a visual inspection of its condition, the facility appears compatible with the preliminary spatial and square footage requirements of the program. The sustainable agenda of the facility also appears feasible. It is acknowledged that the passive systems will not eliminate the need for a mechanical system. They will reduce the lighting, heating, and cooling loads. The goal is a system which integrates not only the goals of natural day lighting, passive heating and cooling, and natural ventilation, but integrates the entire building complex into a cohesive whole.

Through the preliminary walkthrough of the facility and visual inspection of the condition of the structure, it can be assumed for purposes of this project that the structure is sound. There are two primary structural systems in the facility. A masonry bearing wall with steel beams and trusses supporting concrete floor slabs is found in the South and East buildings, shown in the diagrams as green. A steel frame of I-beams supporting concrete slabs and masonry infill is found in the North Building, shown in the diagram as blue.
Material and Resource Conservation

The primary intent of adapting an existing structure is to reuse as much of the existing structure and façade as possible to conserve materials and resources. Preliminary analysis for the insertion of a health and wellness center indicates that the space can be used most effectively by removing all non-original elements from the facades and floor plates. The original structure will be retained in its entirety. The southern facades will be retained. However, the removal of large portions of the façade of the North building will occur. This allows anticipated additions to be integrated into the existing facility. All interior partition walls will be removed. Select pieces of infrastructure and machinery could be retained and incorporated into the design, but it will be assumed for this analysis that they will be removed. The effect of this strategy is two-fold: to retain the historical character of the spaces, while allowing maximum flexibility of use. The diagram illustrates this strategy on the first floor.

There are approximately 30,000 square feet of façade in the current configuration. The removal of the aforementioned sections totals approximately 3,500 square feet. This demonstrates that 88% of the shell is being retained, which meets the LEED goal of 75% reuse.

Fig. 37 First floor plan before and after demolition. Partitions and shell to be removed shown in red.
8.3 Solar
Daylighting

As the existing structure relied heavily on natural lighting when it was originally built, reintegrating daylighting into the reprogrammed facility will be a priority. The southern facades have adequate fenestration, and due to their orientation, have direct sunlight readily available. Using the guideline that effective daylighting penetrates 1.5 times the height of the window, the yellow areas indicate current daylight adequacies. The large windows and their clerestories provide adequate natural daylighting for nearly the entire depth of the space in the South Building. The basement level will have access to daylight via a restored light well. Due to the original function, daylight is not available to most of the interior of the North Building.

Fig. 38 Existing window

Fig. 39 Diagrams showing daylight penetration throughout existing building.
Using the guideline that a multistory building can have full daylight available to the 15 ft zone around its perimeter, and partial daylight within the next 15 ft, the building was diagramed assuming windows were inserted as needed on the perimeter. The main hall will incorporate the existing fenestrations to retain its historical facade. As the light is coming mainly from one direction due to the adjacent north building, a means for allowing light in from other sides to reduce glare and produce a more evenly lit space is necessary. There is a need for mitigating the light coming into the space from the south for user comfort. Shading and diffusing the light can be achieved by the addition of horizontal louver overhangs, as described in chapter 5. Light shelves can also help diffuse the light. For thermal reasons, minimal openings will be made on the north façade.

The areas shaded yellow indicate where adequate lighting can be achieved from perimeter windows. The areas shaded brown represent inadequate light. The introduction of a central atrium can achieve desired lighting levels in the interior of the facility. It would also more evenly distribute light throughout the spaces.

**Fig. 40** Diagram of potential daylight penetration utilizing new fenestrations.

**Fig. 41** Daylight potential utilizing central atrium
Passive Heating

**Direct Gain** guidelines for effective passive heating via direct solar gain require that the amount of south facing glazing equals 28% of the floor area to be heated. Calculations were completed on all south facing spaces. In the current configuration, no space can use direct gain as a heating system. See diagram for results. The South Building’s Turbine Room comes closest at 17.5%. To retain the historic south façade, no additional fenestration will be cut.

**Trombe Walls** follow the same guidelines regarding south facing glazing. Several areas would be candidates for this system. The south façade could be converted by retaining the existing window configuration and glazing over the elevation below the line of trim and between the pilasters. The penthouse on the North Building and the third floor of the East Building could use similar strategies. Mass would need to be added to the penthouse wall.

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**Fig. 42** Direct gain analysis

**Fig. 43** Trombe Wall analysis
Sunspaces use the guideline for the heating potential that 1.5 square feet of sunspace can provide heat for one square foot of the adjacent interior of the building. These strategies could be used to assist other systems in three areas: the penthouse, the third floor of the East Building, and the light-well on Third Street, which assists in heating either the basement or Turbine Room. Even when using an angle on the glazing of 50 degrees for maximum efficiency, none of the spaces can passively heat the entire space adjacent to them.

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<tr>
<td>Light Well</td>
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Fig. 44 Sunspace analysis
8.4 Ventilation

The prevailing breeze in Dayton comes from the southwest throughout the year. The building was originally designed to passively ventilate using a system of louvers and grated floors that were assisted by exhaust fans mounted on the roof. The North Building lends itself to natural ventilation. The current configuration allows for cross ventilation through louvers on all orientations of the penthouse. The grated floors and roof vents allow for the stack effect to naturally ventilate the spaces from the basement to the penthouse.

The South and East Buildings previously relied on operable windows for ventilation, but they are currently inoperable. The East Building relied on cross ventilation, while the South building vents through roof mounted fans. Positive air pressure exists on the south elevation, while a negative air pressure is developed on the north elevation.
The existing glazed openings can accommodate operable windows that can be used as air intakes. A central atrium would contribute to the building’s passive ventilation. A minimum of 15 CFM of outdoor air per occupant is required for common spaces, while the fitness areas require more. Using the existing stacks as a means for exhaust, the stack effect can be incorporated to draw air from low in the building and at its perimeter up into the center of the building mass and out the top. The South Building’s courtyard on the southwest presents an opportunity for introducing ventilation into the interior stack from the direction of the prevailing breeze. An atrium would also begin to unify the disparate elements of the complex.

Fig. 47 Wind flow through building as it exists (above) and as proposed (below)
9.1 Summary

Fig. 48 Spatial adjacencies
### Indoor Spaces: Support Areas

#### Common Spaces

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<td><strong>Total</strong></td>
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**Total**

|   | **7120** |
### Indoor Spaces: Fitness

<table>
<thead>
<tr>
<th>Indoor Spaces</th>
<th>Details</th>
<th>Square Footage</th>
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<tr>
<td><strong>Exercise</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 Basketball</td>
<td></td>
<td>6216</td>
</tr>
<tr>
<td>23 (2 @ 74'x42')</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Racquetball Courts</td>
<td></td>
<td>3200</td>
</tr>
<tr>
<td>(4 @ 40'x20')</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 Exercise Machines</td>
<td></td>
<td>1900</td>
</tr>
<tr>
<td>26 Aerobics/Dance/Yoga (instruction Rooms)</td>
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<td>2700</td>
</tr>
<tr>
<td>27 Free Weights</td>
<td></td>
<td>1200</td>
</tr>
<tr>
<td>28 Storage Spaces (3 @ 120 sf)</td>
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<td>360</td>
</tr>
<tr>
<td><strong>Pool</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 Lap Pool (75'1 x 60')</td>
<td></td>
<td>4500</td>
</tr>
<tr>
<td>29 Pool Deck</td>
<td></td>
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</tr>
<tr>
<td><strong>Lockers</strong></td>
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<td></td>
</tr>
<tr>
<td>30 Men's</td>
<td></td>
<td>3000</td>
</tr>
<tr>
<td>31 Women's</td>
<td></td>
<td>3000</td>
</tr>
<tr>
<td><strong>Spa</strong></td>
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<td></td>
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<tr>
<td>32 Massage (4)</td>
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<td>33 Hot tub (3)</td>
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<td>34 Sauna (2)</td>
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<td>35 Therapy Pools (4)</td>
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### Outdoor Spaces

<table>
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<th>Courts</th>
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<td>Tennis (2)</td>
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<td>(36'x78')</td>
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<td>Basketball (2)</td>
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<td>(50'x50')</td>
<td></td>
<td>Bicycle</td>
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<td>Climbing Wall</td>
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<td>Bicycle Storage</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>10756</td>
<td></td>
<td>15450</td>
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<table>
<thead>
<tr>
<th>Landscape</th>
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<tbody>
<tr>
<td>Courtyards</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Roof</td>
<td>10000</td>
<td></td>
<td></td>
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<tr>
<td>Landscape</td>
<td>10000</td>
<td></td>
<td></td>
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<tr>
<td>Entry Plaza</td>
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<td></td>
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<tr>
<td></td>
<td>22000</td>
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**Total**

48206
## Summary of Spaces

<table>
<thead>
<tr>
<th>Net Interior Space</th>
<th>Net Exterior Space</th>
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<tr>
<td>Common Spaces</td>
<td>Courts</td>
</tr>
<tr>
<td>Administration</td>
<td>Landscape</td>
</tr>
<tr>
<td>Amenities</td>
<td>Vehicular</td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
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<td></td>
</tr>
<tr>
<td>Locker</td>
<td></td>
</tr>
<tr>
<td>Spa</td>
<td></td>
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<td><strong>Net Area</strong></td>
<td><strong>48206</strong></td>
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<tr>
<td><strong>Grossing Increment</strong></td>
<td><strong>12536</strong>  (30%)</td>
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**Gross Area** 50146
9.2 Spatial Descriptions

Spaces, activities, and adjacencies outlined in the summary are described in detail, in the same order. Descriptions are outlined as follows: use; users; adjacencies; equipment; spatial qualities.

Common Spaces

**Lobby** 1,200 sf

The lobby is the public entry to the facility. It transitions between the interior and exterior, and provides a controlled access point. This space collects and orients incoming visitors and members throughout the operating hours of the facility. The area should be directly adjacent and connected to the entry plaza, reception area and restrooms, and near the administration. There should be a variety of seating for occupants waiting for others and display space.

**Reception** 200 sf

The reception is the check in area and the information area for users. The receptionist monitors the lobby area. The staff is the only user of the space. The area should be adjacent to the administration areas and directly connected to the lobby, with sightlines to the entry. There should be a reception counter and workspace behind.
Public Restrooms 200 sf

The restroom is a convenience meant for those entering the facility or waiting to leave. The users of the facility are the primary occupant, as staff will have their own restroom. They should be adjacent to the lobby. Each contains two toilets and one lavatory.
Administration Spaces

Secretary Area  120 sf

The secretary area is used by staff for clerical work. It should be adjacent to the reception area, and to the staff offices. Functions include word processing, telephone calls, records and paperwork retrieval. The area should contain two workstations, fully furnished.

Staff Offices  6 @ 120 sf ea.

These are private offices for the staff to use and share as needed. The spaces should be separated from the main circulation path of the building, and adjacent to the secretary area. The offices should each include a desk, file cabinet, and three chairs. Access to daylighting, views, and natural ventilation is needed. General lighting should be kept to a minimum and should be controlled by photo sensors and motion sensors. Task lighting should be incorporated into the workstation. These offices need not be isolated, allowing for an open office configuration. The director’s office should provide some separation as it will be needed for private meetings.

Records Room  120 sf

This room houses information on the users and the staff for office use, including but not limited to membership information, training progress, and contracts. The space should be adjacent to the secretary’s area, and able to be locked. The room needs to be climate controlled. 20 linear feet of file cabinets and a small counter are required.
Storage  120 sf
Adjacent to the secretary’s area, this room houses miscellaneous office supplies and can also function as the copy room. A minimum of 12 linear feet of both base and wall cabinets are required. Counter space should be lit under the cabinet. The space should be easily accessible to all staff.

Meeting Room  200 sf
Adjacent to the offices, this space is used for both staff meeting and meetings with visitors. This is a private space, acoustically and visually separated. A table with seating for ten should be provided, and additional seating should be available along the perimeter. The lighting should be controlled by the user and able to accommodate presentations or meetings.

Break Room  200 sf
The break room is for staff use only. The space should be adjacent to the meeting room. It should contain a table with seating for 8 and a kitchenette. A coat closet and pantry should also be included for storage of personal items. The room should be self contained and separated from the other spaces.
Amenities

Snack Bar 120 sf
Adjacent to the primary circulation route, and adjacent to the lounge, this area is for users to purchase healthy snacks or drinks while at the facility. It is meant to be a convenience, and a casual gathering spot. It should have 8 linear feet of serving counter, 8 linear feet of prep counter, 16 linear feet of base cabinets, and 16 linear feet of wall cabinets, and a refrigerated display and storage unit.

Lounge 800 sf
Adjacent to the snack bar, this area provides casual seating and dining areas for users. The space is always accessible to users, though the function will vary by the time of day. The snack bar will be in operation whenever the facility is open. Seating should be mixed, with tables for 2 and individual seating as well, for occupancy of 20. Games such as chess or pool are encouraged to be included for recreation.

Shop 360 sf
Adjacent to the lobby area, the shop provides a venue for purchasing both fitness accessories and licensed apparel. The shop is divided into 240 sf of showroom and 120 sf of sales space. The space should have visual connections with both the lobby and the primary circulation. It is open limited hours.
**Club Room**  1600 sf

The club room is a multifunction space that serves as a large gathering room for meetings, presentations, and dining. It has an adjacent kitchen. The space should have access to views, natural daylight, and ventilation. Direct access to adjacent outdoor spaces is desired. The space should have limited access from the primary circulation routes as it will sometimes be rented for private use, while other times it will be available to all users. The restaurant function will be open for limited breakfast lunch and dinner hours varying throughout the week.

**The Kitchen**  240 sf

The Kitchen provides support space to the Club Room, to which it is adjacent. It is intended to provide a staging area for large catered dinners, or the prep area for regularly scheduled meals of limited menu, such as café type food. The requirements for ventilation, fireproofing, and sanitation for kitchens shall be observed per the building codes.

**Meeting Rooms**  2 @ 200 sf

The meeting rooms are available for use by either staff or users and their location varies throughout the building. A table with seating for 8 is needed in each. These spaces should be easily accessible from primary circulation routes.
Maintenance

Office  120 sf

This space is for the head of facilities and is used for an office and maintenance records. It should have access to natural daylight and ventilation. It should be adjacent to the workshop and the receiving area. A desk and file cabinets should be provided.

Storage  120 sf

This room is used for janitorial supplies, maintenance tools, and miscellaneous equipment. It should be adjacent to the workshop. The room should be able to be locked. This area is for staff use only.

Receiving  120 sf

Adjacent to the dock and office, this is where deliveries are accepted. A visual connection to the dock is needed. This is a transition space where items are received and sent to the appropriate location in the facility.

Dock  120 sf

This outdoor space is adjacent to the receiving area. The dock should accommodate delivery trucks and vans. An overhead door and a man-door are required for access into the building.
Workshop  240 sf

The workshop provides an area for equipment and building component repair. This is for staff use only. The space is adjacent to the maintenance office and storage. Tool storage shall be provided in cabinetry. Work tables shall also be provided.
Exercise

Indoor Courts (Basketball Courts)  2 @ 47’x50’

Two indoor half court basketball courts based on NCAA regulation court size are included. They are intended for recreation league 3 on 3 basketball games on evenings and weekends, and practice during the day. The basketball hoops are to be located 10’ off the playing surface per NCAA regulations, as are other relevant dimensions. Lighting should be evenly distributed over the court, and adequate ventilation is required. Access to natural light and ventilation is required. Some seating should be provided for players and spectators.

Racquetball Courts  4 @ 40’x20’x20’

The courts are regulation size and intended for 1 on 1, or 2 on 2, games of racquetball. Hard surface walls, a wood floor, and evenly distributed lighting are required, as is adequate ventilation. It is desired that a passersby or those waiting on court time be able to watch the game.

Exercise Machine Room  1900 sf

Spatial requirements include 12’ ceilings, structural capacity of 150 lb/sf live load, and 20% more cooling load than common spaces to facilitate a range of equipment. Acoustical mitigation is needed. Access to natural light and ventilation is required.
Free Weight Room  1200 sf
Spatial requirements include durable finishes, and 20% more cooling load than common spaces to facilitate increased ventilation requirements. Athletic floor finishes to absorb noise and impact are needed. Cushioned training surfaces and mirrored walls are necessary. Access to natural light and ventilation is required.

Instruction Rooms  3 @ 900 sf
Wood floors and wall mirrors are needed in these spaces to accommodate a range of activities including yoga, aerobic exercises, dance and training. Access to natural light and ventilation is required. Some seating is required at the perimeter.

Storage Spaces  3 @ 120 sf
These spaces are meant to provide support space for the aforementioned exercise spaces. They should include open shelving on one wall, and be able to be locked. These areas are for staff use only.
Pool

**Lap Pool  75’ x 60’**

The Lap Pool is based on the requirements for an NCAA short course swimming pool for collegiate competition. There are 8 lanes of 7’ width. A minimum water depth of 4’ is required, but 7’ is preferred. Daylighting should be the primary means of illumination during daylight hours.

**Pool Deck  2500 sf**

The pool deck is 10’ wide around the lap pool to accommodate circulation and seating. Water resistant surfaces with non-slip finishes are required. The space should have access to views, daylighting, and natural ventilation. South facing areas should double as sun spaces.
Lockers

**Men’s** 3000 sf
Should be adjacent to the exercise and pool areas. Users include all people using the facility. The space is for changing clothing, storing personal belongings, and showering. Access to natural light and ventilation is required. 70 lockers, 3 water closets, 3 urinals, and 5 showers should be included.

**Women’s** 3000 sf
Should be adjacent to the exercise and pool areas. Users include all people using the facility. The space is for changing clothing, storing personal belongings, and showering. Access to natural light and ventilation is required. 70 lockers, 7 water closets, and 5 showers should be included.
Spa

Massage  4 @ 80 sf  
These rooms are used for muscle relaxation and stress relief. They are adjacent to the spas. There will be 2 occupants, the masseuse and the client. A centrally located table should be provided. The space will be visually secluded and contained for possible aroma therapies.

Hot Tub  3 @ 100 sf  
Adjacent to the spas, these spaces are for relaxation. They should be contained spaces for thermal and humidity control. There are separate men’s and women’s hot tubs, and one common. There will be up to 8 users at a time. The water should be 30” deep and have seating along the perimeter.

Sauna  2 @120 sf  
Adjacent to the spas, these spaces are for relaxation. They should be contained spaces for thermal and humidity control. There are separate men’s and women’s saunas. There will be up to 8 users at a time. The space should be lined with redwood and have seating around the perimeter.
Therapy Pools  
4 @240 sf

Four separate pools: Hot Plunge, Cold Plunge, exercise pool, stationary lap pool. 
The pools are meant for rehabilitation. Users can be self directed or under the direction of an instructor. They should each have their own subspace, but do not require enclosed spaces. The pools vary in depth from 4 to 8 feet deep.
Courts

Tennis Court  (2) 36' x 78'

The outdoor tennis courts are meant for user recreation. They are based on NCAA regulation court size and dimension. Fences to contain the ball are required around the perimeter, and this feature will be used to secure the courts at night. The courts should have access to full daylight.

Basketball Court  (2) 50’ x 50’

The outdoor basketball courts are meant for user recreation. They are based on NCAA regulation court size and dimension, but are half-courts not intended for competition. Fences to contain the ball are required around the perimeter, and this feature will be used to secure the courts at night from non-members.

Climbing Wall  500 sf

The outdoor climbing wall shall be at minimum 30’ high and 30’ wide with a clear floor area at least 15’ deep. This area will require supervision, and the ability to be secured.
Landscape

Courtyards 1000 sf

These small spaces are meant for staff and user relaxation and mediation. They should be located adjacent to the facility with easy access. Hard-scape features should be no more than 50% of the total size. Landscaping should be appropriate to the exposure and orientation of the space. Seating shall be for 1 to 4 people per space.

Green Roof 10,000 sf

The green roof areas serve several purposes: reducing heat island effect, reducing building run-off, increasing insulation, providing outdoor “garden” space. At least 75% of the total roof shall be green, and of that at least 30% shall be accessible by users. There shall be a variety of planting types and intensities appropriate to the region.

General Landscape 10,000 sf

The landscaping of the site shall be appropriate to the region, requiring minimal upkeep and intervention by staff. The landscaping should provide buffers between functions and between the facility and the street. Additionally, the landscaping shall contribute to the reduction of water runoff on the site.

Entry Plaza 1,000 sf

A Hard-scape area adjacent to the lobby and drop-off area that provides a transition from indoor to outdoor spaces. Bench seating and bike racks are needed.
Vehicular

Parking 12,000 sf / 40 spots

The parking area on site shall accommodate 50% of the required parking, while the remaining spaces will be accommodated by on street and off-site parking. The on-site parking lot shall be of pervious material to reduce run-off and of light color to reflect heat. Required handicap parking will be adjacent to the drop-off, while remaining spaces will be placed away from the entry to encourage walking.

Drop Off 2,500 sf

This area is for vehicular drop off and shall be adjacent to the entry plaza and the vehicular drive.

Bicycle Storage 200 sf

Bicycle storage shall be located adjacent to the entry plaza and shall accommodate bicycles for 10% of the staff and users. This space will be outdoors, but covered, and shall be visible from the lobby. Bikes will be secured by the user.

Service Area 750 sf

The service area shall be located adjacent to the loading dock and visible from the receiving area. This area shall accommodate 2 trucks at the dock and have parking for 2 other vehicles. The service area shall be separate from the user entry, and shall accommodate waste pick-up and recycling bins. This is for staff and delivery use only.
Chapter 10: Design

Fig. 49 Sketches of Design Concepts

Fig. 50 Schematic Design
Appendix A: As-Built Drawings
Appendix B: Climatic Information

<table>
<thead>
<tr>
<th>Dayton Temperature</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
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<td>Avg. Temperature</td>
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<td>74.2</td>
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<table>
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<th>Dayton Heating and Cooling</th>
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<th>Mar</th>
<th>Apr</th>
<th>May</th>
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<th>Jul</th>
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<th>Sep</th>
<th>Oct</th>
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<tr>
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http://www.climate-zone.com/climate/united-states/ohio/dayton/
### Dayton Weather Indicators

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<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
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<th>Nov</th>
<th>Dec</th>
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<td>Precipitation (inches)</td>
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<td>3.2</td>
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<td>2.5</td>
<td>3.1</td>
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<td>&lt; 0.05</td>
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<td>2.1</td>
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### Other Dayton Weather Indicators

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<td>Percent of Possible Sunshine</td>
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<td>48.0</td>
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<td>72.5</td>
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<td>73.5</td>
<td>76.0</td>
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Bibliography


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