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Piece to the Puzzle: Sustainable Elements Fitting Together

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Piece to the Puzzle:
Sustainable Elements Fitting Together

By

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Project Abstract

Sustainability, green, and eco-friendly are very popular topics right now. Those words and many like them are being used in almost every industry. But it’s not just a trend, it’s a necessary movement. Using green building elements as a starting point for design, just as site, typology, and clients’ request are used, is how a sustainable building is created. These elements must be adjusted for every site because local materials, climate and community all play a role.

Deep investigation of the projects context is important. There are many factors of the site to consider. Physical aspects while important are just a small portion of site analysis. Climatologic data must also be analyzed, especially for sustainable buildings. City guidelines and codes should be known from the very start of design. It can also be useful to know the history and expected future of the site.

Speculative office buildings are flexible in plan allowing for changes without waste. It allows for different users to occupy the same space adding variety to the building. The addition of community space, such as a coffee shop, gives the building life after the nine to five workdays. A building like this can be beneficial in a small town.

An office building that embodies green architecture for a community that needs one is what sustainability is all about. This thesis project is to achieve that.
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Sustainable and Green are key words to eco-friendly architecture. Through research and analysis an understanding of the difference between the two, the relationship they have to each other, and what role they play into architecture design and building industry.
**Sustainable** — in general refers to the ability to maintain balance of a system, and that balance needs to be maintained over a long period of time. So sustainability must meet the needs of the current generation, but cannot comprise the ability of the future generation to meet their needs.

The movement toward sustainability is a movement towards redesigning society’s needs so they can be accommodated with long-term carrying capacity of the environment.

**Green**: reduce many of the harmful impacts that buildings have on our environment and inhabitance.

Green is to design for energy efficiency, use renewable energy resources, create healthy indoor environments, specify building materials and resources that are sustainable, and provide efficient use of water.

Sustainable and Green have often been used interchangeably but they are very different. Green is actually a small part of Sustainability.
There is an imminent need for sustainable or green architecture - Architecture that is beneficial to the owner/manager, occupants, visitors, and community; architecture that is responsive to the global needs of the planet and its resources. Green buildings save money by using less energy and fewer resources: they reduce heating, cooling, electricity, and water needs; they improve the quality of air and lighting, creating healthier and more productive occupants.

- Buildings represent 38.9% of the U.S. primary energy use
- Buildings are one of the heaviest consumers of natural resources
- In the U.S. buildings account for 38% of all CO₂ emissions
- Buildings represent 72% of U.S. electricity consumption
- Buildings use 13.6% of all potable water, or 15 trillion gallons per year
- Buildings use 40% of raw materials globally (3 billion tons annually)
- 170 million tons of building-related construction and demolition debris was generated in the U.S. in 2003
- Around 5 million office buildings exist today
- Over 18% of the continental U.S. is developed

Source- (U.S. Green Building Council, Inc., 2009)
Precedence Study

There are a large number of sustainable buildings from the past and present. To help narrow the search and be more applicable to this project limits where set to 50,000 square feet and commercial office spaces, for a precedence study. Sustainability can be achieved in a number of ways: three of which are LEED, Passive, and High Performance. These three cover different approaches and examine a range of sustainable methods.
LEED – Leadership in Energy and Environmental Design, a program of the U.S. Green Building Council (USGBC), was designed to evaluate environmental performance from a whole building perspective over the life cycle of the building. LEED provides a definitive standard for what constitutes a green building in design, construction, and operation.

The LEED ranking systems are designed for rating new and existing commercial, institutional, and residential buildings.

The ranking systems are organized into five environmental categories.

- Sustainable Site - 26 pts.
- Water Efficiency - 10 pts.
- Energy and Atmosphere - 35 pts.
- Materials and Resources - 14 pts.
- Indoor Environmental Quality - 15 pts.

The points a project earns are added together to determine what level of certification it shall receive.

- Certified - 40 – 49 pts.
- Silver - 50 – 59 pts.
- Gold - 60 – 79 pts.
- Platinum - 80 – 100 pts.

An additional category, Innovation in Design (6 pts.) addresses sustainable building expertise as well as design.

Finally, Regional Priority (4 pts.) acknowledges the importance of local conditions in determining environmental design and construction.

A problem of LEED lies here in the point and certification system. All too often the point system is used as a check-list late in the design development stage of a project. The result is often marking off what the project has and tacking on what is needed to reach a certain level of certification. This creates buildings that do not embody sustainability, but use sustainability like ornamentation.
Santa Clarita Transit Maintenance Facility
Santa Clarita, CA, 2005, 22,000 SF, Gold

Rice Straw bale envelope
- Local rice bales would normally be burned

Under-floor Air Distribution

High Performance Glazing
- Clerestory and Skylight daylighting

Stormwater collection and treatment

Water efficient fixtures and grey water reclamation system

Local recycled Materials

Winrock International Global Headquarters
Little Rock, AK, 2004, 24,000 SF, Gold

Oversized Gull-wing Roof
- Blocks sun
- Collects rain water

75% recycle rate
- Created recycling infrastructure for the city

Under-floor Air Distribution
- Later added water source geothermal heat pump

Fixed windows
Tarlton Corporation Headquarters
St. Louis, MO, 2004, 21,000 SF, Silver

North window daylighting
Brownfield Redevelopment
Construction Waste Management
Recycled and Low-emitting Materials
Locally Manufactured Materials
**Passive** — buildings that do not use mechanical, but natural, means to light, heat, cool and/or ventilate their spaces.

Passive Lighting — optimizes natural sunlight to illuminate the space. The use of windows, clerestories, and skylights allow sunlight into the spaces. Light shelves can reflect light and give indirect light to spaces. The concerns of passive lighting are the amount of heat gain, UV rays, and glare that can affect the space.

Passive HVAC — uses the sun to heat spaces, and air movement to cool and ventilate spaces. The use of operable windows and wing walls bring in air for ventilation. Thermal chimneys move the heat out of a space, and thermal masses release heat into the space.

Many historic buildings where designed passively out of necessity. Before electricity or mechanical systems, passive means was the only way to light, heat, or cool spaces. Now buildings are doing so to eliminate energy costs.
Eastgate Center
Harare, Zimbabwe, 1996, 31,600 SM, Biomimicry

- Modeled after African Termite Mounds
- Mostly Naturally Ventilated and Cooled
  - Uses 10% of the energy
- Deep overhangs shade out summer sun
  - Low- winter sun can get in
- Constructed of available local resources
- Occupiable Roof
  - Central atrium brought in daylight
- Air-conditioned
  - Sealed windows
- Built to withstand time
- Demolition waste was reused

Larkin Building
Buffalo, NY, 1906 – 1950, 5 stories, Daylighting
San Francisco de Asis Mission Church  
Ranchos de Taos, NM, 1772, 4,400 SF, Adobe

Only Local Materials
Thermal Mass walls
Indirect Natural Lighting
Cross ventilation and thermal chimneys
High Performance — buildings that can meet or exceed LEED criteria. They can also focus to be more sustainable in the building’s energy usage.

Near zero, net-zero, and positive energy buildings are examples of high performance buildings. They generate the equivalent of the energy they use; by a combination of energy generation and efficient systems.

With an increase in technology high performance architecture is getting more and more effective. Increase in efficiency and practicality leads to more successful projects.
Elithis Tower
Dijon, France, 2009, 54,000 SF, Positive Energy

- Emits six times less greenhouse gases
- Environmentally friendly materials
- Primarily uses daylighting
- Recycles internal heat gain
- 330 solar panels on the roof

NASA "Sustainable Base" Ames Research Center
Moffett Field, CA, Construction, 50,000 SF, Zero-net Energy

- Near zero energy consumption
- Uses 90% less potable water
- Intelligent control technology
- Ground source heat pumps
- Solar water heating
- Site stormwater management
Greensburg, Kansas

The project location is downtown Greensburg, Kansas. The town is in need of office spaces as they rebuild to be a sustainable city. Already completed buildings can be example of what the city wants and the sustainable elements that they wish to characterize.
City of Greensburg, Kansas – Is located in the southwest part of Kansas. Greensburg was incorporated and named Kiowa County seat in 1886. In the 1960s Greensburg’s population peaked at around 2,000 individuals. The population in 2006 was 1,389. It is home of two tourist attractions: The Big Well and a Pallasite Meteorite. The Big Well is the world’s largest hand-dug well, and the Pallasite Meteorite is a 1,000 lb. meteorite making it also the world’s largest.

Greensburg was like any other Small Town America. It had a medium age of 45.6 years; with mostly only a high school education for those over 25. The average per capita income was $18,054 in 2000. Greensburg’s economy was based in the agricultural tradition along with the railroad and oil. The county’s chief crop is wheat. The largest employers of Greensburg are the school, hospital, and the city and county government offices.

On May 4th, 2007 an EF-5 tornado hit Greensburg, KS, destroying 95% of the town and killing eleven people. In its wake the community set forth to rebuild a prosperous future through sustainable community design. Recovery and Comprehensive plans were developed through community input to help the community become a socially, economically, and environmentally sustainable city for current and future generations.
Greensburg, KS – as the city builds it encourages sustainability through a number of programs that have been created. All public facilities that are city, county, or state owned are to be designed to LEED Platinum criteria; and all other public buildings are encouraged to do the same.

547 Art Center
2008, 1,670 SF, Gallery and Interpretive Center, Platinum

- 3 – 600 watt wind turbines and 8 roof mounted solar panels
- Ground source heat pumps and thermal mass floor
- Reclaimed wood and recycled materials
- Green roof
- Operable skylights
- Collected rainwater is used for irrigation

Business Incubator
2009, 9,580 SF, Retail and Commercial, Platinum

- Use of daylighting
- Ground source heat pumps
- Solar panels provide 10% of energy
- Grey water system
- Stormwater control
- Storm resentment materials
What elements exist which, chosen from categories of an array based on characteristics and interrelationships, will combine to create a green building?
Thesis Narrative

Sustainability cannot be added onto the end of a project. Sustainability will only be successful when green building elements are incorporated throughout a project.

Each project is unique; site, type, and community all needs to be considered in order for it to be sustainable.

It is important that each green building element be considered for each project. These elements need to be evaluated by how well they work with other building or green elements, structure typology, and site.
Interlocking connection – Green elements are dependent on each other in order to create a functional building. Each element displays its own characteristics and its interrelationships with other elements.
Smooth connection – Each green element is independent from the others. One element could change or be eliminated without changing the project. The elements characteristics are displayed but not their interrelationships to each other.
Blended connection – The green elements relies on each other creating a complete project. Each element has their own characteristics and interrelations but they may not be obvious.

The last concept is in the spirit of sustainability. Each element needs the other for the project to be fully functioning ecologically, economically, and logistically. However, the esthetics of the building cannot rely only on the interactions and raw characteristics of each element.
It is important to understand different green building elements and how they work or don’t work with other elements for each project. A matrix could be used to lay out green elements into categories.

The five LEED environmental categories plus the Regional Priorities lend themselves well to be the categories of the matrix. A number of areas are located within each category. A number of green elements lie within each area.

Simple icons are used to make reference throughout the matrix easier. These icons illustrate each category, area, and element.

The matrix is used by moving from the categories to areas to the green building element that is of interest. Each element has a page that shows the function, characteristics, and positive and negative relationships. This outlines ways to effectively use each green building element for each project.
See Appendix (pg. 91) for complete matrix.
A functional project must work through how program, climatologic data, local design guidelines, and site combine in schematic design and a project matrix.
Program

Speculative Office building with multiple office suites, public conference room, and community coffee shop.

Five open plan offices ranging from 2,125 to 3,210 square feet. Three are on the ground floor and two on the second floor. Two shared conference rooms, one per floor.

Bicycle storage and changing/shower rooms.

Shared work rooms.

Public and private courtyard and roof garden.

Atrium type lobby with coffee shop.
Greensburg, KS Climatologic Data

Solar — Greensburg’s high sun angles in the summer months suggest shading devices that allow for the lower winter sun to penetrate. The amount of solar radiation in the summer and high average electromagnetic energy suggest that solar collection is good year around.
Wind – Greensburg is in one of the windiest parts of the U.S. Wind speed averages remain consistently high year around. Spring brings the highest gust and summer brings south winds that can add ventilation, building cooling, and fresh air. Harvesting wind is a viable option for energy.
Rain — Water is a precious resource for Greensburg. A low annual rainfall indicates that rainwater cannot meet the building’s water requirements. But collection and conservation is important to reduce water demands.

Average monthly rainfall

Temperature — Greensburg lies in a cold, humid climate zone. Summer temperatures are high while the temperature in the winter can be frigid. The average diurnal swing is 24 degrees.

Average minimum, maximum and monthly temperatures

Heating and cooling degree days — Space heating is more important than space cooling.
Soil – The loam soil of Greensburg drains well and is nutrient rich. The dryness of the loam soil makes it not an ideal soil for geothermal heat pumps.
Native Plants — Plants native to Greenburg are accustomed to the local climate. They require little water and adapt for the change in seasons. Native plants are ideal for courtyard and green roof plantings.

Forbs and Wildflowers
- Ashy Sunflower
- Black Eyed Susan
- Blanket Flower
- Butterfly Milkweed
- Compass Plant
- Plains Larkspur
- Heath Aster
- Hoary Puccoon
- Indian Paint Brush
- New England Aster
- Prairie Coneflower
- Curled Dock
- Purple Prairie Clover
- Rocky Mountain Zinnia
- Rose Verbena
- Spiderwort
- Stiff Goldenrod
- Giant Goldenrod
- Thickspike Gayfeather
- Big Flower Coreopsis
- Wild Hyacinth
- White Beardtongue
- White Wild Indigo

Grasses and Sedges
- Big Bluestem
- Blue Grama
- Bottlebrush Sedge
- Buffalo Grass
- Burr Reed Sedge
- Bushes Sedge
- Canada Wild Rye
- Fox Sedge
- Great Plains Flatsedge
- Fowl Managrass
- Indian Grass
- Leavenworth’s Sedge
- Little Bluestem
- Prairie Cordgrass
- Prairie Dropseed
- Porcupine Sedge
- Rattlesnake Grass
- Rice Cutgrass
- Side-Oats Grama
- Switch Grass
- Common Scouring Rush

Shrubs and Trees
- Aromatic Sumac
- Ash
- Black Jack Oak
- Bur Oak
- Chinquapin Oak
- Dogwood
- Eastern Cottonwood
- Hackberry
- Kentucky Coffee Tree
- Lead Plant
- New Jersey Tea
- Osage Orange
- Pawpaw
- Pin Oak
- Redbud
- Red Cedar
- Red Oak
- Sand Sagebrush
- Sycamore
- Wahoo
- Yucca
Greensburg Comprehensive Plan and Design Guidelines — Greensburg has developed an extensive Master Plan and list of Architecture Design Guidelines.

The community of Greensburg believes that function should be the primary architecture feature in Greensburg. By combining functional design with modern technologies and materials, Greensburg can create an integrated downtown core that reveals the individual character of the businesses while maintaining the overall character and the goals to become a model of sustainability. Greensburg's style will represent the community's history and progressive spirit.

Some of the more prominent architectural features from the Architectural Design Guidelines that were important to follow were the requirements of sixty percent glass on the ground level Main Street facade and buildings that take up three or more lots should include architectural details that divide the building into smaller portions. Massing was used as a means to incorporate daylight into the building, create unique character and interesting spaces, and create variety in the pedestrian facade.

Design guidelines that were not followed were only eliminated after careful consideration of appropriateness. For single story facades the guidelines require a minimum height requirement of twenty feet. With a fifteen foot roof elevation, five foot parapet was unnecessary, a three foot parapet that doubles as a guard rail seemed more efficient. The guidelines also suggested that brick be used as a façade treatment, but with concrete walls a brick veneer would be only ornamentation.

The creation of a pocket park adds green space to the block and allows the south sun in for daylighting. The courtyard can be used for both the building occupants and public.

See Greensburg, KS homepage, greensburgks.org, for their comprehensive plan.
ARCHITECTURE DESIGN GUIDELINES

The Hundred Year Building
- Is the building constructed and material such that it will age gracefully and require minimal maintenance? (p. 8)

ARCHITECTURAL EXPRESSION
- Does the architectural style and expression fit in with surrounding buildings? (Should not dominate or overwhelm neighboring structures) (p. 8)

BUILDING USES
- Does the project incorporate a variety of uses or add a new use to the block where it is located? (p. 9)

RESIDENTIAL USES
- If the project on Main Street or Kansas Avenue includes second or third story residential spaces, are their private entrances located in the alley or on side streets? (p. 9)
- Do first story entrances on side streets encroach no more than five (5) feet onto the right of way? (p. 9)

GROUND FLOOR USES
- Are first story spaces on Main Street and Kansas Avenue reserved for commercial or retail uses? (p. 10)
- Are the primary commercial and retail entrances located on Main Street or Kansas Avenue? (p. 10)
- If sidewalk cafes have more than one row of seating, do the plans include a railing or other barrier between the sidewalk and the building? (p. 10)

MASSING AND ARTICULATION
BUILDING HEIGHT
- If the project is on a corner lot, does it achieve a height of thirty-five (35) feet (two stories)? (p. 10)

MASSING DIVERSITY
- Does the building use creative massing to incorporate natural light and views? (Creative massing should have a distinct purpose.) (p. 10)

MATERIALS
DURABLE, HEALTHY, AND EFFICIENT MATERIALS
- Are the building materials recycled, reused, rapidly renewable, and/or locally harvested materials? (p. 10)

FADE MATERIALS
- Does the facade incorporate more than one material or color to avoid monotony? (p. 10)
- Does the facade use bright colors only for detail and earth tones or raw materials for larger areas? (p. 10)
- Do the facade use brick, stone, precast concrete, wood, metal, or glass and avoid vinyl siding or mirrored glass, artificial or simulated materials, and reflective glass? (p. 10)

INTERIOR MATERIALS
- Does the interior use finishes and furniture low in toxins and volatile organic compounds? (p. 10)

PUBLIC ART
- If projects incorporate public art, does it help visitors understand the history and purposes of Greenberg? (p. 10)
- Public art should not interfere with the streetscape or inhibit walking, biking, or driving (p. 10)

FENESTRATION AND TRANSPARENCY
DAYLIGHT AND HEAT GAIN
- Do windows or door openings on the east and west sides of a building have controls, such as shading or blinds? (p. 10)
- Are windows in offices or residential spaces operable? (p. 10)

PATTERN
- Are windows well proportioned and do they establish a rhythm with the building and neighboring structures? (p. 10)

TRANSPIRANCE
- Do ground floor architectural details incorporate at least 60% transparent materials? (There is no maximum requirement.) (p. 10)
- Does transparent glass not qualify as transparent materials? (p. 10)
- Do second and third floors incorporate at least 30% transparency? (There is no maximum requirement) (p. 10)

ENTRANCE IDENTIFICATION
- Are entrances easily located and accessible? (p. 10)
- Are entrances protected from the elements and establish relationships between public and private domains with architectural details and materials that contribute to the cultural identity of Greensburg? (p. 10)

PROJECTIONS
AWNINGS, CANOPIES, SUNSHADES AND CORNICES
- Do awnings, canopies, sunshades and cornices provide adequate clearance for pedestrian traffic? (p. 12)
- Are projections fit in with streetscape elements? (p. 12)
- So second and third story projections, including balconies, extend no more than three (3) feet beyond the property line? (p. 12)
- Are first story cornices project no more than three (3) feet (p. 12)
- Are projecting elements created from appropriate, durable materials? (p. 12)
- Are projecting elements safely mounted to the building? (p. 12)

BALCONIES AND PROJECTED WINDOWS
- Is there at least a twelve foot vertical clearance between the projecting element and the sidewalk? (p. 12)
- Do first story projecting windows extend no more than one (1) foot beyond the property line? (p. 12)

SIGNAGE
- Does individual storefront signs maintain a pedestrian scale? (p. 13)
- Is the signage ground level or otherwise washed with light from a concealed light source? (Signs should be back lit or include digital displays) (p. 13)
- Does the business have no more than one blade sign that does not exceed six (6) square feet? (p. 13)
- Is the blade sign installed at a height that prevents physical contact with pedestrians? (p. 13)
- Are sign materials complimentary and consistent with architectural materials, and are they durable and easily maintained? (p. 13)

ROOFS AND PARAPETS
- If a building incorporates two or more pitches in its roof structure, is it designed for adjacent properties to abut on either side, and does it allow for proper drainage away from existing or future buildings? (p. 13)
- If the design includes parapets, do they achieve visual interest by including special architectural details, stepping, or stepping? (p. 13)
- If the design includes parapets, do they serve as a means of wayfinding? (p. 13)

KEY SITES/ CORNERS
- If the building is on a corner lot, does it create a gateway to downtown and provide a means of wayfinding? (p. 13)

LIGHTING
- Is exterior lighting kept to a minimum? (p. 14)
- Does lighting highlight architecture design features or public art displays and/or enhance pedestrian safety? (p. 14)
- Does lighting create a quality of color? (p. 14)

WATER
- Does the building incorporate green building practices, such as gray water, wastewater treatment and other renewable water sources? (p. 14)
- Does the building incorporate a biological treatment system to recycle graywater and wastewater and cisterns or other renewable water systems? (p. 14)

ENERGY
- Does the building incorporate green building practices, such as high efficiency heating/cooling systems, fixtures and appliances? (p. 14)
- Does the building incorporate renewable energy sources on-site? (p. 14)

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SITE DESIGN GUIDELINES

SITING AND ORIENTATION

SETBACKS
- Does the building setback not exceed five (5) feet from the front property line? (p. 25)
- If the building is set back, does the setback have a functional purpose or enhance the street wall? (p. 25)

GAPS
- Does the building footprint fill the width of its parcel to avoid gaps on Main Street? (p. 26)
- Is the building designed so a neighboring building can abut on the north and south sides, or does it create a pocket park within the parameters below? (p. 26)

POCKET PARKS
- Is the pocket park accessible from the public sidewalk? (p. 24, 26)
- Does the pocket park facilitate and block circulation from alleys to Main Street? (p. 26)
- Does the pocket park incorporate seating, hard and soft landscapes, and a central design feature? (p. 26)
- Does the pocket park reduce runoff and/or creatively store stormwater for reuse? (p. 26)
- Pocket parks should not exceed one parcel width or twenty-five (25) feet and should be at least fifteen (15) feet wide. (p. 26)
- Downtown blocks should have no more than two pocket parks. Does the project maintain this limit? (p. 26)

TEMPORARY GAPS
- Are temporary gaps landscaped and maintained by the landowner until further development occurs? (p. 26)

CONSISTENCY AND SCALE
- Does the design balance the building mass and height with the surrounding neighborhood? (p. 27)
- Does the three-parcel building design feature articulated to maintain a human scale? (p. 27)
- If more than three parcels are used, is the building facade articulated to maintain a human scale? (p. 27)
- Does the project maintain current parcel size unless the parcel is being split to create a pocket park, mid-block crossing, or view corridor? (p. 27)

SUSTAINABLE SITE STRATEGIES

FOOTPRINT / LOT COVERAGE
- Does 20% of the lot consist of permeable surfaces or open space? (p. 28)

SOLAR ORIENTATION
- Do buildings work together to create optimal solar orientation with varied building stories and building tiers? (p. 28)

HIERARCHY
- Are all service or secondary entrances (including loading docks) located on the alley? (p. 29)

SECONDARY / TERTIARY STREETS
- Does the development featuring alleys and side streets reflect the qualities of downtown as a whole in terms of materiality, access to light, and landscaping? (p. 30)
- Are alleys kept open as secondary access points to businesses and other uses? (p. 30)
- Are trash and recycling containers located in alleys and screened from the view of the public? (p. 30)
- Is the pavement in alleys appropriate for vehicular, pedestrian, and bicycle traffic, and does it properly manage stormwater? (p. 30)

PARKING
- Does the project satisfy parking needs with on-street parking? (p. 31)
- If on-street parking is required, is it placed behind buildings, and is it shared between daytime and nighttime uses? (p. 31)
- Are surface parking lots properly screened from neighboring parcels with landscaping, natural, high-quality materials, or a fence with a height no greater than forty (40) feet? (p. 31, 35)
- Do surface parking lots use high reflectors, materials, an open grid, pervious pavement systems, or appropriate landscape shading to reduce heat island effect? (p. 31)
- Do surface parking lots use permeable pavement systems and stormwater collection and storage if their size decreases on street? (p. 31)
- If the plan includes additional surface parking, does it identify priority parking for hybrid or alternative energy automobiles? (p. 31)

ICONS, LANDMARKS, AND GATEWAYS

ICONS AND LANDMARKS
- Are historic or new icons and landmarks woven into the fabric of the city with visual connections such as vertical design elements, paths, and signage? (p. 32)

PLACEMAKING AND NAVIGATION
- Do signs, paths, and other visual elements aid in wayfinding and create a rich, referential and memorable experience for residents and visitors? (p. 33)

EASEMENTS AND SIGNLINES
- Does the project plan protect the visual connection between the County Courthouse and the Big Well and City hall? (p. 33)
- Does the plan create signlites that connect important elements in town? (p. 33)

GATEWAYS
- Does the project plan use signage, architectural details, public art, or signature landscaping to create gateways that signify arrival into downtown? (p. 20, 29, 34)
- If yes, are the gateways simple in design rather than complex or flamboyant? (p. 34)

LANDSCAPING
- Are native or xeric plants used? (p. 35)
- Do additional plantings use durable materials and harmonize with the Main Street streetscape design? (p. 35)

WATER
- Do projects include native plantings to manage stormwater with raingardens and/or bioswales? (p. 36)
- Are storage systems, such as rain barrels or cisterns, used to capture rainwater for reuse? (p. 37)
- If the project plan incorporates paved areas, are pervious options used to reduce runoff qualities? (p. 37)
Site Location – The site is centrally located site in the core of downtown. The site is located on Main St. between Florida and Wisconsin Aves.
Site Description – The site is level and five lots wide (150 feet by 130 feet). There is a newly constructed building to the north that has a brick façade and metal siding side walls. An existing basement is located on the site along with a rock wall on the south property line. The main public façade is to the east along Main St.

Look at the site form across Main Street

Look at Main Street from within the site
Newly constructed building that neighbors the site to the north.

Basement that is located in the site
Existing rock wall that edges the south and southeast boundary of the site

Remnants of a terracotta tile drive.
Schematic Design

Volume/Area Studies

Full site coverage – building covers the entire site

Open courtyard - outdoor courtyard incased by Building and existing wall

Larger courtyard and uncovered basement – courtyard extend to the alley and opens to the existing basement

Tiered for south sun – create layers for maximum daylighting
Main St. Facade Studies

Simple U to create difference – create three masses

More variety in mass

Additional height variations

Different angles – Create different Architectural styles
Refining Form

Additional space to the back – cover a larger percentage of the site

Clarify form – refine levels
Transparency
Glass to give different architectural character, add daylighting, and point of interest
Each project must develop its own matrix. It is important to have a project matrix that reflects the building type, site, and desired esthetics.

Research into Greensburg’s wants, the site and context, and typology of a spec. office building lead to the selection of elements in each area of each category.

Local materials and climate help to determine how each element is used.

See Appendix (pg 108 ) for complete Project Matrix
Some of the matrix applied to the project
Final Design Documentation

Final images of the project illustrate a sustainable building using designed and technological elements.
Office 1
2,127 SF

Office 2
3,127 SF

Office 3
3,051 SF

Mech. room

Conf. room

Bike storage

Open to Below

Level 1
The basement is that of the existing basement structure that is on the site. The fireplace, built-in, and doorways remain.
Wind — The wind turbine can harvest wind from the northeast and south: catching the primary wind direction of summer and winter. It can also catch the wind from the west, southwest and southeast.

Wind Energy
2.5 kw wind turbine
13 mph average mean wind speed
≈ 3644 kWh/yr
Solar Panels – There are 6,880 Square Feet of solar panels on the south facing roof slopes.

Solar Energy
- 639.17 Square meters of solar panels
- 4.93 kWh/m² average electromagnetic energy
- ≈ 3,151 kWh/yr

Total energy collected
≈ 6,795 kWh/yr
Rainwater Collection – Over 13,500 square feet of the roof is used for rainwater collection. The northern portion is a gull-wing collecting the water to the center and draining into a pipe on the west. The middle area is a flat roof with roof drains. The southern single-slope roof drains to the south. The rainwater is collected and stored in rain barrels on the southern green roof and used for irrigation and grey water.

<table>
<thead>
<tr>
<th>Rainwater Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>13,510 Square Feet of collection surface</td>
</tr>
<tr>
<td>22.35 Inches average annual rainfall</td>
</tr>
<tr>
<td>≈ 125,000 gallons per year</td>
</tr>
</tbody>
</table>
The winter sun is allowed to penetrate deep into the building and is used to help heat the space through solar gain. The summer sun is shaded outside the building to reduce heat gain.
Winter Solstice —
A barren trellis lets sunlight deep into the building.
Equinox – Vine plant grows up the trellis to shade the glass from the sun helping reduce thermal gain, allows diffuse light in
Summer solstice –
Thick vines cover the trellis, shading the glass and a portion of the courtyard, keeping the sun’s heat from the building and making the courtyard usable.
Conclusion –

The idea of putting together a project through the use of green building elements can lead to a number of different results. Through context; site, user, and typology, the best design can be achieved. It is only at this point that a project can be sustainable.

In this thesis project a great understanding of Greensburg, Kansas was reached. Using climatologic data the building responds to the sun, wind, and rain, and proper mechanical systems and ground coverings were chosen.

Through the city’s comprehensive plan and guidelines the building responds to the desires of the citizens and users. This building achieves the aesthetics of being a symbol of their history and progressive spirit. It is a building for the current and future generation.

A speculative office building lends itself well to sustainability. It is the type of building that is rebuilding community needs. Its open floor plan allows for a variety of occupants and changes with little to no energy or waste. The inclusion of community space, coffee shop, and the ability to rent out the conference rooms add additional life to the building beyond the eight hour work day.

The building uses local materials and other green architectural and mechanical elements. Concrete from Greensburg and locally harvested straw bales makes up the highly insulated envelope. Green roofs and cool roofs reduce the heat island effect, while solar panels and a wind turbine collect energy. Rainwater is collected and stored on the site, then reused. The interior is filled with recycled, local, and renewable resources.

The sustainable solution of this thesis project was only reached after piecing together green building elements with site data, users’ wishes, and building type.
Bibliography


Appendix

Design Matrix – Use as a master for developing individual project matrix.
Project Matrix – The matrix made especially for this thesis project.
Building Elements – A sample of the green building elements for this project.
Design Matrix – This is the master matrix from which elements can be chosen for the project matrix. Each area has elements within it that can be applied to a project. Looking at the elements characteristics and relationship allow sustainable choices to be made.
<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
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<tbody>
<tr>
<td>Sustainable Site</td>
<td>Site</td>
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<tr>
<td>Water Efficiency</td>
<td>Storm Water</td>
</tr>
<tr>
<td>Energy &amp; Atmosphere</td>
<td>Transportation</td>
</tr>
<tr>
<td>Materials &amp; Resources</td>
<td>Heat Island</td>
</tr>
<tr>
<td>Indoor Environment Quality</td>
<td>Light Control</td>
</tr>
<tr>
<td>Regional Priority</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>カテゴリ</th>
<th>サブカテゴリ</th>
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<tbody>
<tr>
<td>持続可能なサイト</td>
<td>環境</td>
</tr>
<tr>
<td>水効率</td>
<td>多雨</td>
</tr>
<tr>
<td>エネルギー &amp; 大気</td>
<td>構築</td>
</tr>
<tr>
<td>材料 &amp;資源</td>
<td>回収/再使用</td>
</tr>
<tr>
<td>室内環境質</td>
<td>空気</td>
</tr>
</tbody>
</table>
|地域優先 | 気候 | 太陽 | 風 | 植物
<table>
<thead>
<tr>
<th>Water Efficiency</th>
<th>Use Reduction</th>
<th>Low Volume Fixtures</th>
</tr>
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<tr>
<td><strong>Efficient Landscape</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>Irrigation – pg W2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Plant selection</strong></td>
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</tr>
<tr>
<td><strong>Reuse</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Recycled Grey Water</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Use of Rain Water</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water Treatment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy and Atmosphere</td>
<td>Energy Generation</td>
<td>On-site energy – pg E1</td>
</tr>
<tr>
<td>-----------------------</td>
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<td>------------------------</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>HVAC – pg E3</td>
<td>Insulation</td>
</tr>
<tr>
<td>Refrigerant Management</td>
<td>No Refrigerants</td>
<td>No CFCs</td>
</tr>
<tr>
<td>Materials and Resources</td>
<td>Recycle/Reuse</td>
<td>Recycled Material</td>
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<tr>
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<tr>
<td>Waste Management</td>
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<td>Construction Waste</td>
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<td>Regional Materials</td>
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<td>Manufactured</td>
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<tr>
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<td>Rapid Renewable</td>
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</table>
## Indoor Environmental Quality

<table>
<thead>
<tr>
<th>Ventilation</th>
<th>Mechanical</th>
<th>Natural</th>
<th>CO₂ Monitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Quality</td>
<td>Restrict Smoking</td>
<td>Pre-Occupancy</td>
<td>Low-Emitting</td>
</tr>
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<td>Lighting</td>
<td>Daylight</td>
<td>Mechanical</td>
<td>Control – pg Q10</td>
</tr>
<tr>
<td>Thermal Comfort</td>
<td>Control</td>
<td>Mechanical – pg E3</td>
<td>Natural</td>
</tr>
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<td>Views</td>
<td>Natural</td>
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Regional Priority

<table>
<thead>
<tr>
<th>Climate</th>
<th>Moisture</th>
<th>Temperature</th>
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<tr>
<td><img src="image1.png" alt="Climate Map" /></td>
<td><img src="image2.png" alt="Moisture Graph" /></td>
<td><img src="image3.png" alt="Temperature Graph" /></td>
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<table>
<thead>
<tr>
<th>Solar</th>
<th>Solar Angles – pg R3</th>
<th>Solar intensity</th>
</tr>
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<tbody>
<tr>
<td><img src="image4.png" alt="Solar Map" /></td>
<td><img src="image5.png" alt="Solar Angles Graph" /></td>
<td><img src="image6.png" alt="Solar Intensity Graph" /></td>
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</table>

<table>
<thead>
<tr>
<th>Wind</th>
<th>Wind Speed</th>
<th>Wind Direction</th>
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</thead>
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<tr>
<td><img src="image7.png" alt="Wind Map" /></td>
<td><img src="image8.png" alt="Wind Speed Graph" /></td>
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<table>
<thead>
<tr>
<th>Plantings</th>
<th>Planting Zones</th>
<th>Native Plants</th>
<th>Ground Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image10.png" alt="Planting Maps" /></td>
<td><img src="image11.png" alt="Planting Zones Map" /></td>
<td><img src="image12.png" alt="Native Plants Map" /></td>
<td><img src="image13.png" alt="Ground Conditions Map" /></td>
</tr>
</tbody>
</table>
Green Building Elements – This is just a small sample of the building elements that are contained in the matrix. Each page describes the characteristics, functional relationship with other elements and the building design, benefits, and limitations of the element. This will help to determine what will work for a project and how they work with other elements.
COOL ROOF / HEAT ISLAND / SUSTAINABLE SITE

FUNCTIONAL RELATIONSHIPS:

POSITIVE:
- Good with most roof types and shapes.
- Can be used with Storm Water Collection systems. Energy efficient.

NEGATIVE:
- Can not be used with a Green Roof system, can be used next to one.

CHARACTERISTICS:
- Comes in a variety of styles that may be appropriate for different building/roof type. Can be selected from a variety of colors and materials. Each has their own solar reflectance and thermal emittance.

BENEFITS:
- Reflects heat, Energy savings, Works in a variety of locations and roof type, Aids in the mitigation of the urban heat island.

LIMITATIONS:
- Does not work on every roof in every location, Over time climate, solar radiation and pollution can reduce solar reflectance, Requires regularly scheduled upkeep and cleaning
IRRIGATION / EFFICIENT LANDSCAPE / WATER EFFICIENCY

FUNCTIONAL RELATIONSHIPS:

POSITIVE:
Using collected storm water, reusing grey water and/or open ended
ground source heat pump as a water source. Working with the selection
and placement of plants and sprinkler locations aid in a more controlled
and even watering. Permeable pavement reduces any run off.

NEGATIVE:
If not used correctly it can be waste water. Using potable water.

CHARACTERISTICS:
Deliberate and controlled watering
of the landscape.

BENEFITS:
Beautifying and supporting landscape and site.

LIMITATIONS:
Require the use of water for non human need.
Some areas have many options to them and can become many different elements.
WIND TURBINE/ ON SITE ENERGY/ ENERGY GENERATION/ ENERGY AND ATMOSPHERE

FUNCTIONAL RELATIONSHIPS:

POSITIVE:
Use the roof lines and building shape to accelerate wind speeds and focus wind direction to get the most out of the wind turbine.

NEGATIVE:
They can effect the wind conditions on the site. Free-standing turbines may require a fall zone according to codes. Some don’t like the looks of wind turbines.

CHARACTERISTICS:

VERTICAL AND HORIZONTAL WIND TURBINES CAN BE ATTACHED TO THE BUILDING OR FREE-STANDING ON THE SITE

BENEFITS:
Produce energy for building use or to sell back to the grid.

LIMITATIONS:
Turbines need to be positioned so that the primary wind direction is harvested. The wind has to be blowing.
HVAC/ ENERGY EFFICIENCY/ ENERGY AND ATMOSPHERE
MECHANICAL/ THERMAL CONTROL/ INDOOR ENVIRONMENTAL QUALITY

FUNCTIONAL RELATIONSHIPS:

POSITIVE:
Use with natural ventilation and passive heating and cooling methods to reduce the load. Use energy generation to power the mechanical system.

NEGATIVE:
Can use excessive energy.

CHARACTERISTICS:
USE ENERGY EFFICIENT HVAC SYSTEMS THAT FILTER THE AIR AND PRODUCE HEALTHY HAIR.

BENEFITS:
Produce healthy air at comfortable temperatures.

LIMITATIONS:
Requires area for the cooling towers or well-fields.
HARVEST / REGIONAL MATERIALS / MATERIALS AND RESOURCES

FUNCTIONAL RELATIONSHIPS:

POSITIVE:
Raw materials refined locally. Materials can be used traditionally or innovatively to improve the success of the building.

NEGATIVE:
Small scale harvest may be inefficient and use excessive amounts of energy or resources.

CHARACTERISTICS:
The gathering of raw goods from the region of a particular design project. Refined or manufactured for the use in construction and finish of the building.

BENEFITS:
Reduce shipping needs. Improve local economy.

LIMITATIONS:
Limits to the regional materials.

Greensburg, KS. harvested materials.

Must re-examine for each location.
CONTROL / LIGHTING / INDOOR ENVIRONMENTAL QUALITY

FUNCTIONAL RELATIONSHIPS:

POSITIVE:
Time studies of solar angles. Understanding solar heat gain. Use with mechanical lighting system. Give individual control and directional or task light.

NEGATIVE:
Blocks views. Thermal mass could not gain the heat.

CHARACTERISTICS:
An individual has a need and right to be able to control the amount, type and quality of light of the space that they are occupying.

BENEFITS:
Adjustable shading allows for the majority to be satisfied.

LIMITATIONS:
Cannot make everyone happy. Problems with even distribution of light.
SOLAR ANGLES / SOLAR / REGIONAL PRIORITY

FUNCTIONAL RELATIONSHIPS:

POSITIVE:

NEGATIVE:
Over design for daylighting.

CHARACTERISTICS:
The study of where the sun is in sky at any given hour, day or month. Examine the effects that these angles will have on your project.

BENEFITS:
Daylighting, Energy generation. Reduction of HVAC need.

LIMITATIONS:
Surrounding of the project may change and alter the solar affect.

Greensburg, KS, sun angles.
Must re-examine for each location.
Project Matrix – The following elements are the ones that are being used in this thesis project. References can be made back to the matrix elements. These elements were chosen on their relationships with each other, the site, building type, and users’ wishes.
<table>
<thead>
<tr>
<th>Water Efficiency</th>
<th>Use Reduction</th>
<th>Low Volume Fixtures</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Energy and Atmosphere</td>
<td>Energy Generation</td>
<td>On-site energy</td>
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<tr>
<td>Energy Efficiency</td>
<td>HVAC</td>
<td>Insulation</td>
</tr>
<tr>
<td>Refrigerant Management</td>
<td>No Refrigerants</td>
<td>No CFCs</td>
</tr>
</tbody>
</table>

- **Energy Generation**: Represents the generation of energy, possibly through solar panels.
- **On-site energy**: Indicates energy generated on-site, possibly from renewables.
- **Energy Efficiency**: Suggests efficient use of energy, possibly through insulation or glazing.
- **HVAC**: Heating, ventilation, and air conditioning units.
- **Insulation**: Materials used to prevent heat loss or gain.
- **Glazing**: Windows and glass, possibly indicating energy-efficient glass.
- **Natural Ventilation**: Diagram showing natural ventilation, possibly through windows or exhaust fans.
- **Thermal Mass**: Likely refers to the use of materials with high thermal mass, helping to stabilize indoor temperatures.
- **Refrigerant Management**: Indicates the use of refrigerants, possibly with a focus on CFC-free solutions.
- **No Refrigerants**: Indicates the use of models or systems without refrigerants.
- **No CFCs**: A symbol or text indicating the absence of CFCs, which were once common in refrigerants but are now considered harmful to the ozone layer.
<table>
<thead>
<tr>
<th>Materials and Resources</th>
<th>Recycle/Reuse</th>
<th>Recycled Material</th>
<th>Material Reuse</th>
<th>Building Reuse</th>
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<tbody>
<tr>
<td>Waste Management</td>
<td></td>
<td>Construction Waste</td>
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<td>Occupant Waste</td>
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<td>Rapid Renewable</td>
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<td>Certified Wood</td>
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## Indoor Environmental Quality

<table>
<thead>
<tr>
<th>Ventilation</th>
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<td><strong>Thermal Comfort</strong></td>
<td>Control</td>
<td>Mechanical</td>
<td>Natural</td>
</tr>
<tr>
<td><strong>Views</strong></td>
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<tr>
<td>Regional Priority</td>
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<tr>
<td><img src="image1" alt="Climate Map" /></td>
<td><img src="image2" alt="Moisture Chart" /></td>
<td><img src="image3" alt="Temperature Graph" /></td>
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<td><strong>Solar Angles</strong></td>
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<td><img src="image7" alt="Wind Map" /></td>
<td><img src="image8" alt="Wind Direction" /></td>
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<td></td>
</tr>
<tr>
<td><strong>Wind</strong></td>
<td><strong>Wind Direction</strong></td>
<td></td>
<td></td>
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<td><img src="image9" alt="Plantings Map" /></td>
<td><img src="image10" alt="Native Plants" /></td>
<td><img src="image11" alt="Ground Conditions" /></td>
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</tr>
<tr>
<td><strong>Plantings</strong></td>
<td><strong>Native Plants</strong></td>
<td><strong>Ground Conditions</strong></td>
<td></td>
</tr>
</tbody>
</table>
Acknowledgements and Dedications

I want to thank all of you who have been involved with the last six years of my life. I have grown from the knowledge, friendship, and memories that will last a lifetime.

I dedicate this book to –

Mom and Dad, Thank you for always being there for me. I know that you are only a phone call away. Thanks for raising me the way you did, making me who I am for today and tomorrow. Your love means the world to me.

Amy, Thank you for being my best friend. It is hard to believe that I didn’t even know you when I started in Architecture. And now, well you can finish this sentence.

Sharon Kuska, Thank you for being my thesis advisor. Your guidance and knowledge through the past year has been vast. I will miss our weekly meetings.