2012

Building Information Modeling and Historic Buildings: How a Living Model Leads to Better Stewardship of the Past

Haley West Van Wagenen
University of Pennsylvania

Building Information Modeling and Historic Buildings: How a Living Model Leads to Better Stewardship of the Past

Abstract
This thesis examines an alternative way of documenting historic buildings through the use of Building Information Modeling (BIM). By creating a model that responds to real-time data updates and serves as a central repository for information about a building, owners, operators and preservation professionals can better monitor conditions within a building and plan for its future. A model can catalogue every element and assembly, providing an inventory of the building's parts. By assigning phases to past building campaigns, professionals gain a better understanding of a site's chronology. Simulation of energy and water consumption assists professionals in becoming stewards of both historic and environmental resources. This thesis demonstrates that BIM is an appropriate, and advantageous, documentation method for historic buildings. The documentation of historic sites is focused on these primary activities: the capture of information about a site and the organization, interpretation, and management of that information. The requirements for documentation - measured drawings, a written narrative and large-format black and white photographs - remain the same. This method does not account for one major factor: change. It cannot respond to changes, renovations, and repairs. It does not serve as an up-to-date reference for understanding the current state of a building. Historic buildings face many challenges to their survival, often due to a lack of information about them. BIM leads to a more informed and more relevant historic structure report.

Keywords
building information modeling, bim, historic structure report, sustainability, database

Disciplines
Historic Preservation and Conservation

Comments
Suggested Citation:

Van Wagenen, Haley West (2012). *Building Information Modeling and Historic Buildings: How a Living Model Leads to Better Stewardship of the Past*. (Masters Thesis). University of Pennsylvania, Philadelphia, PA.

BUILDING INFORMATION MODELING AND HISTORIC BUILDINGS: HOW A LIVING MODEL LEADS TO BETTER STEWARDSHIP OF THE PAST

Haley West Van Wagenen

A THESIS

in

Historic Preservation

Presented to the Faculties of the University of Pennsylvania in
Partial Fulfillment of the Requirements of the Degree of

MASTER OF SCIENCE IN HISTORIC PRESERVATION

2012

____
Advisor
Fon S. Wang, AIA, LEED AP BD+C
Lecturer in Historic Preservation

____
Reader
Michael C. Henry, PE, AIA
Adjunct Professor of Architecture

____
Program Chair
Randall F. Mason
Associate Professor

to my family

Acknowledgements

To my advisor, Fon Wang: thank you for your patience and for your expert criticism. I am grateful for your encouragement and complete confidence in me.

To my reader, Michael Henry: thank you for your knowledge of and your interest in this topic. Your comments, questions, and support were invaluable.

To Randy Mason: thank you for always encouraging me to think outside the box, to be bold with my opinions, and to push the boundaries of the preservation field. You and Frank Matero have created an environment where students can test ideas, question the status quo, and forge their own paths in an ever-changing profession.

To Megan Cross Schmitt: Your thesis was a most helpful jumping-off point, and I am thankful for your feedback during this process.

To my friends and colleagues at Skidmore, Owings & Merrill: thank you for providing me with the resources and expertise I needed to make this project happen.

To my classmates: thank you for being a diverse and thoughtful group. I feel lucky to have been part of such a great class.

Finally, to my dear family and friends: thank you for your support, comfort, reassurance, and prayers. Your unwavering confidence in my abilities and your encouragement sustained me. Special thanks to Mom, Dad, Hilary, James, Hunter, and Peter. I am blessed to be part of such a loving family, and I thank God for you.

Table of Contents

Table of Contents

List of Figures

Chapter 1: Introduction

The documentation of historic sites is focused on these primary activities: the capture of information about a site and the organization, interpretation, and management of that information.[1] It has changed little since the documentation standards for the Historic American Buildings Survey, often the basis for historic structure reports, were established in 1933. Despite advances in technology and the near-universal adoption of computers, the requirements - measured drawings, a written narrative and large-format black and white photographs - remain the same. Unfortunately, this method of documentation does not account for one major factor: change.

The greatest challenge in maintaining historic buildings is managing change. Time, natural forces, and people all affect the way buildings function in the environment. The current method of building documentation in a historic structure report (HSR) provides a significant amount of information, but it is only a snapshot in time. It cannot respond to changes, renovations, and repairs. It does not serve as an up-to-date reference for understanding the current state of a building. It is static.

This thesis will examine an alternative way of documenting historic buildings through the use of Building Information Modeling (BIM). Current documentation methods do not lend themselves toward managing the continuous

---

[1] François LeBlanc and Rand Eppich. "Documenting Our Past for the Future." *The Getty Conservation Newsletter* 20, no. 3 (Fall 2005): 6. http://www.getty.edu/conservation/publications_resources/newsletters/pdf/v20n3.pdf

changes to buildings. By creating a model that responds to real-time data updates and serves as a central repository for information about a building, owners, operators and preservation professionals can better monitor conditions within a building and plan for its future. By assigning phases to past building campaigns, professionals gain a better understanding of a site's chronology. A model can catalogue every element and assembly, providing an inventory of the building's parts. Simulation of energy and water consumption assists owners and managers in becoming better stewards of both historic and environmental resources. Finally, a BIM model seeks to become a living HSR for managing historic properties.

While this thesis will not address every advantage of BIM over the traditional historic structure report, it seeks to demonstrate that BIM is an appropriate, and advantageous, documentation method for historic buildings. A model's parametric capabilities make it an excellent tool for testing the advantages and disadvantages of potential renovations. When one part of a building changes, all of the associated drawings and views change as well. This allows for quick detection of clashes between building systems, structure, and architecture. Further, a model can be broken down into phases that reflect everything from major renovations to smaller maintenance repairs, which in turn, creates a visual chronology of the building that supplements photographs and a written narrative. A BIM model is a useful tool for energy simulation, as it becomes a primary source of information for energy modeling software. It also reflects the multifunctional qualities of BIM. Information entered once contributes to multiple forms of output.

This method of documentation should be carefully considered as a way to develop a “living” HSR that responds to change over time. Historic buildings face many challenges to their survival, often due to a lack of information about them. Assumptions about cost, building integrity, and energy consumption are made based on little hard evidence. In creating a model that can test renovation scenarios, catalogue quantities of materials for costing, provide three-dimensional views of spaces, and inform energy simulation programs, BIM leads to a more informed and more relevant historic structure report.

Chapter 2: Current State of Historic Building Documentation

2.1 Introduction to Documentation

Documentation of historic sites in the United States began in 1933 when Charles E. Peterson proposed a program that would record the histories of American buildings and put unemployed architects to work during the Great Depression. The Historic American Buildings Survey (HABS), under the umbrella of the National Park Service, was born and stands as the oldest federal preservation program in the country. Its goal was to document the nation's architecture from monumental sites to vernacular building types. Using a set format of measured drawings, large-format black and white photographs, and written narratives, HABS set the standard by which most buildings are documented in this country. This systematic approach to documentation set a framework for the foundation of historic structure reports and established a method for recording built heritage that is still in use today.[2]

Though HABS has clearly defined standards for archival documentation, there is no universal standard for digital projects.[3] Proprietary software and different file formats may create problems with archiving digital material for future use. While organizations like the General Services Administration (GSA), the National Institute of Standards and Testing (NIST), and the American Society for Testing and Materials (ASTM) are all working to establish standards for digital

---

[2] Catherine C. Lavoie. "The Role of HABS in the Field of Architectural Documentation." *APT Bulletin*. Vol, 41, No. 4, Special Issue on Documentation, 2010, 19.

[3] George C. Skarmeas. "From HABS to BIM: Personal Experiences, Thoughts, and Reflections." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 51.

practice, particularly for BIM, nothing has been adopted to date. Since digital archives are relatively new, many practitioners are reluctant to fully depend on a medium that has not yet proven its reliability over time. Fears about the longevity of digital documents may be allayed by maintaining hard copies of the documents until more is known about the long-term stability of digital material.

2.2 Historic Structure Reports Today

A historic structure report (HSR) is a key tool in preservation planning that provides documentation of a site's history and existing conditions, recommended treatment options and, sometimes, a record of the actual work done.[4] It is the primary document used to guide the treatment of historic properties.[5] The exact format is not always the same, but the general components of the report vary only slightly. Measured drawings, photographs, and a written narrative describing the background, significance, and physical features of the building comprise the site history. An existing conditions survey includes field notes on sketches or measured drawings and photographs illustrating the types of decay. Materials investigation and testing may follow the conditions survey as part of the information gathered to support the recommendations for treatment. (Figure 2.1) With this information, a series of treatment options and requirements for work gives property owners a better basis on which to make decisions regarding

---

[4] U.S. Department of the Interior, National Park Service. *Preservation Brief 43: The Preparation and Use of Historic Structure Reports.* http://www.nps.gov/hps/tps/briefs/brief43.htm

[5] Billy G. Garrett. "Revision of the National Park Service Guideline for Historic Structure Reports." *Standards for Preservation and Rehabilitation, ASTM STP 1258*. Stephen J. Kelley (ed.). 1996, 109.

stewardship of the property.[6] Those pieces - the history, conditions, and treatment recommendations - comprise the HSR.

The preparation and final product of the HSR have limitations. Chief among them is the inability to reflect both minor and major changes over time. The reports are prepared at a fixed point in time but are not often considered documents that should be continuously updated over the life of the building. A 1996 article on the revision of the HSR lists seven reasons, according to Ed Bearss, Chief Historian for the National Park Service at the time, why the reports have problems. They are as follows: (1) improper formats, (2) inadequate integration of historical, architectural, and archaeological research, (3) too costly, (4) research is not relevant to the specific needs of the resource, (5) incorrectly used to support interpretation, (6) do not address the issues listed in the task directives, and (7) the opinion that any intervention requires the preparation of a complete HSR.[7]

To address these issues, the National Park Service formed a task force to revise NPS-28, which is the Park Service's internal guide for cultural resource management. The three main recommendations to come out of the assessment were provisions to first, give more power to the regional historical architect to determine the scope of new HSRs, second, to place more emphasis on the

---

[6] U.S. Department of the Interior, National Park Service. *Preservation Brief 43: The Preparation and Use of Historic Structure Reports.* http://www.nps.gov/hps/tps/briefs/brief43.htm

[7] Billy G. Garrett. "Revision of the National Park Service Guideline for Historic Structure Reports." *Standards for Preservation and Rehabilitation, ASTM STP 1258*. Stephen J. Kelley (ed.). 1996, 109-110.

physical characteristics of a structure and the eventual treatment options, and third, to standardize the format of an HSR into three categories - history, treatment and use, and record of treatment.[8] While this restructuring addressed some of the organizational problems of the HSR, it failed to address the topic of change over time.

The importance of early and accurate documentation of a site cannot be overstated. The best decisions are the ones that are the most informed, so it is imperative that a site's history and current conditions be understood from the beginning of any project. Documentation is important not just to provide a record of a building but also to inform owners and property managers how it might best be changed.[9]

The statement of significance and existing conditions summary only tell part of the story. Access to all existing design, maintenance, and contract documents gives further insight into how the building evolved and how it has been maintained.[10] It is helpful to know what did and did not work as treatment options so that mistakes are not repeated. Early examination of the site also minimizes change orders during the construction phase, which results in time and cost savings.[11] Creating a searchable database rather than a static

---

[8] Ibid., 110.

[9] Kate Clark. "Informed Conservation: The Place of Research and Documentation in Preservation." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 5.

[10] Kelly Streeter. "Information Technology for Building Documentation." *APT Bulletin.* Vol. 41, No. 4, Special Issue on Documentation, 2010, 33.

[11] Ibid., 34.

document increases the likelihood of the building documentation being used for maintenance and operations. The HSR has the potential to provide the necessary documentation, if its definition is expanded to include serving as a manual for ongoing use.

2.3 Past Attempts to Incorporate Technology Into the HSR

A few attempts to incorporate technology into the HSR have had varying degrees of success. For several years practitioners have acknowledged that electronic recording of historic data is more commonplace and becoming the preferred method of documenting buildings as well as accessing that documentation. The Historic American Buildings Survey (HABS) remains rooted in paper archives because of the uncertainty surrounding the longevity of electronic records. However, it has been active in increasing access to its records by digitizing many of its assets for retrieval from an online database.[12] Since many HSRs use HABS documents as a primary source, the idea of using a digital database for specific buildings and expanding access to the information within them may not be far away.

An early attempt to bring all of the data about a historic site into one place was tested using a web-based model called the Historical Architectural Documentation System (HADS).[13] Based on studies showing that information is

---

[12] Blaine E. Cliver, John A. Burns, Paul D. Dolinsky, and Eric Delony. "HABS/HAER at the Millennium: Advancing Architectural and Engineering Documentation." *APT Bulletin*. Vol. 29, No. 3/4, Thirtieth-Anniversary Issue, 1998, 34.

[13] Anat Geva. "A Multimedia System for Organizing Architectural Documentation of Historic Buildings." *APT Bulletin*. Vol. 27, No. 4, 1996, 18.

used more effectively when it resides on one platform, HADS sought to consolidate audio and visual information in a format that would be easily accessible to anyone seeking to learn more about a building.[14] It appears that this program never caught on, or was perhaps impeded by technology that could not fully support this type of database.[15]

Another technology that is emerging and still in use is the Tablet PC Annotation System (TPAS). Primarily a tool for documenting existing conditions, TPAS is a tablet-based system that was created for digital conditions surveys in the field. It runs on AutoCAD and allows a surveyor to choose from a conditions list or create new conditions that are tagged to drawings during the survey. Later, the information can be exported to a database for categorization and analysis.[16] The intent is to reduce the number of transcription errors between field notes and drafting annotations in the office and to provide a common vocabulary across surveyors to create a more objective assessment. Using AutoCAD blocks with attributes allows a surveyor to tag a condition and list specific details in the same place. The tag can then be copied in the same drawing and across different drawings. The information in each tag is extracted to an Excel file for categorization.[17] The basic principles of this application are similar to the way

---

[14] Ibid., 18.

[15] Google searches rendered very little information, indicating that this idea never made it to the internet.

[16] Kelly Streeter. "Information Technology for Building Documentation." *APT Bulletin.* Vol. 41, No. 4, Special Issue on Documentation, 2010, 38.

[17] James V. Banta, Kent Diebolt, and Michael Gilbert. "The Development and Use of a Tablet PC Annotation System for Conditions Surveys." *APT Bulletin*. Vol. 37, No. 2-3, 2006, 39-40.

parametric families work in a BIM platform like Revit. Each unique family can hold information and specific details about its condition. Instead of exporting the information to Excel, a schedule of the information can be created in Revit. The goal is the same: integrate as much information about the building into the drawings as possible. BIM combines the single platform idea of HADS with the object tagging of TPAS to create a central database of information about a building.

Many preservation professionals acknowledge that BIM is quickly becoming standard practice in the architecture industry, but they seem reluctant to adopt it themselves. Since it is not specifically tailored to the needs of preservation, and likely never will be given the small market for preservation compared to the rest of the building industry, it may be best to adapt current tools to best suit the specific needs of preservation practice.[18] As with any adoption of new technology, it is important to remember that it is a tool, not a solution. A decision about a treatment for a building still requires critical thought and consideration of all known facts. Technology should be used thoughtfully and not just because it is there.[19]

---

[18] Ibid., 38.

[19] George C. Skarmeas. “From HABS to BIM: Personal Experiences, Thoughts, and Reflections.” *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 50.

Chapter 3: An Overview of BIM

3.1 From Drawing to Modeling

As stewards of historic buildings, historic preservation professionals must understand how to adapt to current technology and best use it to support their needs. The building industry continues to move in the direction of using 3-D modeling software as a replacement for 2-D drafting. The most striking difference between the CAD revolution over 20 years ago and the adoption of building information modeling (BIM) is that BIM involves more than the simple swap of a pencil for a mouse. It not only changes how building documentation comes together, but it also affects the way project teams are organized, how contracts are formed, and how the different phases of a project are scheduled.

BIM excels in creating a holistic model that functions as a database for elements within a building. This multifunctional 3-D tool makes the planning and design process more nimble and responsive, reducing the time it takes to test concepts, and expose the unseen. A dynamic 3-D model serves as a portal into all spaces, allowing for an easier understanding of scale and the relationships of volumes, functions, and systems.

3.2 Creating a Living Document

Beyond 3-D, BIM technology offers other compelling possibilities—a living, breathing virtual model that represents every element of a building: its enclosure, spaces, structure, mechanical systems, and materials. Models can be parametric; meaning, that as one variable is adjusted, the rest of the model immediately adjusts in response. This allows building stewards to test if-then scenarios when managing buildings. Parametric variables may include design options, material cost comparisons, and energy use impacts of various types. The case study discussed in Chapter 5 of this thesis will illustrate how BIM could have influenced the decision-making process during a building's renovation.

One of the best features of BIM is its afterlife; the model can be integrated into a building's long-term operational strategy. It can be expanded to catalogue and monitor elements within the space, or give operators information about a space's dimensions or light levels. Thinking even further in the future, the model could be linked to RFID (radio frequency identification) sensor tags on each artifact within the building, giving staff a dashboard display of everything in the building for monitoring purposes.[20]

3.3 Managing Data with BIM

A primary use for BIM models in preservation is for the management of data. A Finnish study presented at the 2007 Education and Research in Computer Aided Architectural Design in Europe (eCAADe) found that renovation projects benefit from using BIM models for inventory of existing data and not just for representing geometry within a building.[21] Emphasis on quality over quantity of information was a key observation of the study, and the researchers found that

---

[20] Claire Swedberg. "NYC's Metropolitan Museum of Art Adopts RFID." *RFID Journal*. July 26, 2011. http://www.rfidjournal.com/article/print/8630

[21] Hannu Penttilä, Marko Rajala, and Simo Freese. "Building Information Modelling of Modern Historic Buildings: Case Study of HUT/Architectural Department by Alvar Aalto." eCAADe 25, Session 13, 2007, 611.

BIM should be started early in the renovation process to allow time for data collection and verification.[22]

The major difference between BIM and traditional project structure is the shared database used by all project participants. Everyone works in the same model. Users see changes reflected in real time, which improves coordination. Consultants such as the MEP and structural engineers often work in separate models that are linked to form the final complete model. BIM does not only mean 3-D representation of a building. It includes all facts about the project such as cost estimates, technical specifications, quantities of building components, as well as a 3-D model of the building geometry itself. Unlike new buildings that begin with a blank sheet of paper, recording for preservation purposes works in reverse order. Existing building information is reconstructed in a BIM model.[23]

Not only is data collected and recorded, but it can also be manipulated to generate reports that account for spaces, objects within those spaces, or particular building components. Multiple views of a building are quickly generated to understand a building's scale and complexity or how an addition fits with the original design.[24] In addition to its use as a database of information, a model reflects the phasing of work from the original built conditions, to subsequent additions and renovations, to a building's present state.[25]

---

[22] Ibid., 612.

[23] Ibid., 51.

[24] David M. Foxe. "Building Information Modeling for Constructing the Past and Its Future." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 41.

[25] Ibid., 40.

BIM is an excellent tool to use for Life Cycle Analysis (LCA) because every element of a building can be modeled separately. Stewart Brand describes six distinct layers of buildings that have different rates of change. The site, structure, skin, services, space plan, and stuff are constantly changing at different speeds and have different service lives.[26] By breaking a model down into its separate shearing layers, professionals can better anticipate which parts of a building will fail first and what will need to be replaced more quickly. Proposed interventions can be studied as parts of the greater whole so that the consequences of a change in one place will be understood throughout the building.[27]

---

26 Stewart Brand. *How Buildings Learn: What Happens After They're Built.* New York: Penguin Books, 1994, 13.

27 Ana Rita Pereira, Jouke Post, and Peter Erkelens. "Innovating Built Heritage: Adapt the Past to the Future." http://www.irbnet.de/daten/iconda/CIB11946.pdf

Chapter 4: BIM for Historic Preservation

4.1 Introduction to Preservation Applications

Though much has been said about BIM for new buildings, its applications in existing buildings have not been fully explored. An example of an application in preservation comes from Robert Silman Associates and the firm's work assessing the cause of cracking in the concrete at the Solomon R. Guggenheim Museum in New York in 2007. In order to monitor the locations of the cracks to determine their cause, the engineers worked with a digital survey company to create a full model of the rotunda in a finite element modeling software. (Figure 4.1) Over the course of a year, they took field measurements of movements in the building that were calibrated with the model and analyzed to determine the best recommendations to fix the problem.[28]

Another example shows how a model's function as a database streamlines preservation work. EYP/Architecture and Engineering was hired to create a master plan for the interiors of the Massachusetts State House in 2008. A complex building with five major building campaigns and multiple interior levels inside an eight-story envelope, the client requested the use of BIM to document the interior space because of a model's ability to house textual and numerical information alongside graphic information. With interior offices changing frequently, the client was able to keep track of the changes and save time by making adjustments in one place and allowing the model to do the rest of the

[28] Nat Oppenheimer. "An Enthusiastic Sceptic." Architectural Design. 79 (2). London: John Wiley & Sons, 2009,104.

work automatically updating all associated views and schedules.[29] These are just two of many examples of the possible applications of BIM for preservation. As software continues to develop and technology improves, the possibilities for whole-building analysis become even more realistic.

4.2 Project Planning and Implementation with BIM

In new construction projects, designers model standard components and repeat them multiple times. Preservation projects require more up-front planning because particular components may need to be singled out for repair or modification. While it is possible to go back and change specific components later in the documentation process, it will save time if the designer can anticipate variations in components when the initial work begins.[30]

Data input comes from a variety of sources. Just as a designer may do field measurements by hand and then draft them later in CAD, the same method can be done with BIM software, such as Revit. Raster images may be linked into a model, then scaled and traced. (Figure 4.2) Vector-based CAD files can be imported and serve as the frame on which the model is built. (Figure 4.3) A highly accurate data collection tool uses a laser scanner to generate a point cloud of data on which a digital "mesh" is applied to begin filling out the actual structure of the building. (Figure 4.4) This method is particularly useful for intricate designs

---

[29] David M. Foxe. "Building Information Modeling for Constructing the Past and Its Future." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 39-41.

[30] Ibid., 42.

and hard-to-measure spaces that need to be documented to a fine degree of detail.[31]

4.3 Other Applications of BIM

There is also a strong case for sustainability and historic buildings. For buildings to remain in use, their environmental impact must be taken into account. However, it is often difficult to prove that many historic buildings are more energy efficient than their modern contemporaries. Energy modeling software that plugs into BIM software simulates conditions and assesses the energy impact of a building, which would inform the case for maintaining existing buildings rather than tearing them down to build something new. To determine the optimal efficiency of renovations and retrofits, a model can test different assemblies or systems by changing specific parameters and running the calculations for each scenario.

In addition to using a BIM model for stewardship of a building, it could be used to enhance interpretation of the building on-site and online. 3-D fly-throughs provide an interactive user experience that reveal unseen parts of a building and give virtual access to those who cannot visit in person. As a research tool, a model holds visual and textual data, providing an integrated, comprehensive way to study a building and its component parts. Representing a building three dimensionally brings greater understanding of a building's scale, massing, connections, and spaces.

---

[31] Ibid., 43-44.

4.4 BIM as Standard Practice

The U.S. General Services Administration (GSA) is a leader in the adoption of BIM throughout the building sector. It has led several pilot projects since 2003 that have tested new documentation techniques and project management programs as well as different software and technology platforms. The GSA is the country's largest public real estate organization, giving it a large stake in the search for technology that could increase its efficiency and cost-effectiveness.[32] While most new federal construction projects are required to use BIM, the GSA is leading the effort to incorporate BIM into major renovations of historic properties as well. It has developed a strategic approach to performance analysis - measuring performance using metrics such as timeliness, adherence to the budget, construction costs and schedules, and change orders. With historic buildings, studies may also include risk assessments associated with building complexity and unknown conditions.[33]

Those who adopt BIM may face challenges relating to project schedules and specialized knowledge of technology. BIM requires more front-end work to properly set up a project, but when used correctly, it saves time at the end during the construction phase. Project managers must be aware of this and budget time in project schedules accordingly. The GSA views the potential benefits, including better coordination among the project team, a higher level of data accuracy, and

---

[32] Caroline R. Alderson, Beth L. Savage, Charles Matta, Calvin Kam, and Anne E. Weber. "Government Policy and Practice: Digital Conservation and Landscape Renewal." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 11.

[33] Ibid., 12.

cost savings, as worth the investment in the new technology. The agency has also been a strong voice in advocating for universal standards across all BIM platforms, which will allow for future accessibility of information across multiple applications.[34]

Key aspects of BIM that the GSA applies to historic buildings include spatial program validation, 3-D imaging through laser scanning, 4D phasing, and master planning. The various pilot projects undertaken by the GSA revealed multiple benefits to using BIM instead of traditional documentation methods. On several projects, laser scanning proved to be a faster and more accurate method for data acquisition than traditional field measurement. Not only did it save time, it revealed discrepancies between as-built drawings and existing conditions such as floor deflection and roof heights. 3-D laser scanning has reduced field verification needs, although a few of the pilot projects showed that it is important to set priorities for scanning early. Some areas may need to be more accurate than others, and the general scanning conditions - availability of electrical power and setting up the scanner - may prevent the acquisition of a useful scan.[35]

One of the most promising aspects of BIM for historic buildings is its ability to detect clashes between old and new parts of the building and between building systems and structure. By showing buildings as three dimensional volumes

---

[34] Peggy Yee, Charles Matta, Calvin Kam, Stephen Hagan, and Oskar Valdimarsson. "The GSA BIM Story." http://www.fsr.is/lisalib/getfile.aspx?itemid=6995.

[35] Caroline R. Alderson, Beth L. Savage, Charles Matta, Calvin Kam, and Anne E. Weber. "Government Policy and Practice: Digital Conservation and Landscape Renewal." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 13-14.

instead of two dimensional representations of lines on paper, errors can be detected earlier in the design process. This helps protect historic building fabric by ensuring accuracy of the work before the construction phase. It can also incorporate a fourth dimension: time. Combining 3-D modeling with time allows for the creation of views that represent snapshots of the project at various points. This is key for sequencing construction activities and provides a better visual representation of a project's timeframe than a traditional Gantt chart or project schedule.[36]

A project at St. Elizabeths Hospital in Washington, DC, is testing ways to use BIM for master planning. A large campus with multiple buildings, St. Elizabeths is a National Historic Landmark and is set to be the new headquarters for the Department of Homeland Security (DHS), which includes a new headquarters for the U.S. Coast Guard. The project involves reuse of the historic structures on the site in addition to a large amount of new construction. Early in the process, it became clear that there was no central repository for the existing documentation of the site. The first step was to develop a database with all of the existing information. It was made available on site for all members of the project team. Laser scans of the buildings became 3-D models to be used for renovation purposes as well as context and scale markers for the new construction. The comprehensive model of the site was critical in explaining the design intent for each building and the campus-wide plan for rehabilitation. The model helped

---

[36] Ibid., 14-15.

reduce the overall effect of the new construction by easily showing the impact of different designs, and it has served as a living document for the evolution of the site as different buildings are redeveloped. The GSA acknowledges that it will take time for BIM to become mainstream in preservation, but it maintains that the investment in the technology has long-term benefits for historic properties as well as day-to-day advantages for overall maintenance and operations.[37]

The GSA has found that BIM has applications beyond simple documentation of buildings. Since it is a leader in the design and construction industry, as well as the preservation field, professionals who wish to do work with the agency must adopt their work methods. A model performs best when it functions as a living document that holds graphic, textual, and numerical information about a building. It should be used as a record and as a planning tool for maintenance and renovations. Preservation projects often have limited resources and funding. As BIM becomes more widely used, it will lead to greater efficiency, and therefore savings, on projects.

[37] Ibid., 16.

Chapter 5: Case Study - Inland Steel Headquarters

The purpose of this case study is to illustrate the following advantages of using BIM to create an HSR. First, it will consist of a 3-D set of drawings. Second, it will show how different building campaigns can be differentiated by phasing. Third, it will illustrate how different design and renovation options can be tested in a virtual environment. Fourth, it will serve as a platform for energy efficiency analysis.

5.1 A Brief History of Inland Steel

It was 1893, and the country was in the midst of an economic depression. Speculatory financing of the railroad began to falter, bringing the banks down with it. The US dollar was pegged to both gold and silver. The opening of new silver mines caused the value of the dollar to fall. Prices fell in agricultural markets and manufacturing slowed. It was into this market that Inland Steel was born.

During the depression, one of the companies that failed was the Chicago Steel Works, a manufacturer of farm machinery attachments.[38] Ross Buckingham, brother of the former company president, bought the aging manufacturing equipment and began looking for investors to contribute capital to a new business. Though he was able to generate interest from multiple people,

---

[38] Inland Steel Company. *50 Years of Inland Steel, 1893-1943.* Chicago: 1943, 5.

he was not able to raise enough money to put the equipment back to work.[39] He was still lacking investors and a concrete vision for the new business.

It was the events of the Chicago World's Fair and its steady stream of visitors that brought the final investors on board. Joseph Block, an iron merchant from Cincinnati, brought his family to see the sights of the Columbian Exposition. His firm, Block-Pollack Iron Company, had supplied the former Chicago Steel Works with the iron rails it used to deconstruct and turn into farm machinery. He met with George H. Jones, one of the other investors, and was convinced of the scheme. However, Block's partners in his firm were not interested and declined to put up the capital. Undaunted, Block decided to invest independently and brought his 22-year-old son, Philip, into the venture with him.[40]

With eight shareholders and $65,000 in cash, the Inland Steel Company was incorporated on October 30, 1893.[41] The shareholders then met to establish the board of directors and to begin operations for the new business. The first tasks were to build a new plant to house the old machinery and to secure enough orders to make a profit. George H. Jones, the vice president and sales agent for the company, had orders for 3,000 tons of equipment by the time the plant opened in mid-January, 1894. This was enough for six months of production if things went as planned. However, as soon as production started, the second-hand equipment began to show its age. The boilers that provided power to the

---

[39] Ibid., 6.

[40] Ibid., 6-7.

[41] Ibid., 7.

machines could not maintain the steam pressure needed to operate the mill, causing product to slow down or stop entirely. The backlog of orders dropped as the company struggled to keep up with demand. The officers did not draw salaries and they were forced to layoff employees. Still, the mill was able to produce 1,900 tons of finished products by June of the first year.[42]

Things continued to improve and the company was able to turn a profit by the end of 1894.[43] The business continued to grow as large portions of the profits were reinvested to buy new equipment and increase production levels. Innovation and streamlining of processes created a more efficient production line, which allowed the company to fulfill more orders in less time. By the turn of the century, annual payroll was more than $150,000 and Inland was on the verge of its biggest expansion project to date. Joseph Block's oldest son, Leopold Emanuel (L.E.), joined the company in 1901 to lend his skills in financing to the operation. The same year, the Lake Michigan Land Company offered 50 acres of land at the southern tip of Lake Michigan to any company willing to build an open-hearth steel plant on the large parcel. The condition was that the title of the land would not be transferred until one million dollars had been invested in equipment for the new plant.[44] The location at what became known as Indiana Harbor was situated near several railroad lines and its proximity to the lake meant that raw goods and finished products could be easily transported in and

---

[42] Ibid., 9.

[43] Ibid., 10.

[44] Ibid., 17.

out of the plant. The officers of Inland Steel raised enough capital to begin building, and the new mill in East Chicago, Indiana, was born.[45]

The manufacturing facilities at Indiana Harbor continued to grow throughout the first decade of the 1900s. Inland gained more control of its supply chain by acquiring mining properties, purchasing ore freighters, and building plants that processed everything from raw materials to finished goods. Throughout World War I, as businesses across the country slowed down, Inland continued to expand because of innovation and further streamlining of its processes. A major effort to electrify all of its plants was completed in 1926. This reduced operating costs, improved steel quality, and made the manufacturing floor a safer place to work.[46]

The company maintained offices in the First National Bank Building in downtown Chicago, but its main office building was located at Indiana Harbor with the rest of the plant. The noted Chicago firm Graham, Anderson, Probst and White, architects of the Wrigley Building, the Merchandise Mart, and the Field Museum, designed the building, which was completed in 1930. (Figure 5.1)

It was not until the early 1950s that Inland Steel decided to declare a more prominent presence in Chicago. The president, Clarence B. Randall, appointed Leigh B. Block to be the head of a planning committee tasked with identifying long-range goals for the new office space, including things like more square footage and air-conditioning. Leigh Block's brother, Joseph L. Block, took over

---

[45] Ibid., 25.

[46] Ibid., 47.

the presidency of the company in 1953. His desires for the new building reflected the pragmatic business sense that contributed to Inland Steel's steady growth:

> We could have modern offices designed to meet the exact needs of our organization; by spacing tenant leases we could be fortified for growth far into the future; and we could erect a structure which would be a credit to our company, our city, and our industry.[47]

Leigh Block put it more simply: "We wanted a building we'd be proud of, one that spelled steel."[48]

In 1954, Inland Steel purchased a site on the corner of South Dearborn Street and West Monroe Street. (Figure 5.2) The company hired Skidmore, Owings and Merrill (SOM) to design what was to be the first skyscraper built in the Chicago Loop since the completion of the Field Building in 1934.[49] The first lead designer for the project was Walter A. Netsch, who made the decision to organize the building into two separate towers: one for the offices and tenant amenity spaces; the other for the building services. He was also responsible for developing the aesthetic surface of the steel building and the lightness of the glass base, something that New York partner Gordon Bunshaft had partially achieved at Lever House on Park Avenue. When Netsch began work designing the Air Force Academy, Bruce J. Graham took over as the lead designer.[50]

---

47 Nicholas Adams. *Skidmore, Owings & Merrill: the experiment since 1936.* Milan: Electa, 2006, 102.

48 Ibid., 102.

49 Pauline A. Seliga (ed.). *The Sky's the Limit: A Century of Chicago Skyscrapers.* New York: Rizzoli International Publication, Inc., 1990, 181.

50 Nicholas Adams. *Skidmore, Owings & Merrill: the experiment since 1936.* Milan: Electa, 2006, 102.

Though Graham fiercely maintained sole authorship of the design, he kept most of Netsch's original ideas. (Figure 5.3) Inland Steel was Graham's first high-rise building, and he was keen to assert his presence as a design force in the city. He wrote of the design:

> Still driven by an innocent view of a society uncomplicated by traditions, we were in search of noble new materials. These materials had to fit into a city with a short history. The traditions of Mies were not as powerful as the honesty of structure exhibited by earlier Chicago architects such as Jenney, Sullivan, and others. However, the power of the grid and its hypnotic, endless quality permeated the building almost as an extension of smaller grids found within the huge American landscape. Awareness of fine materials began with this building not only in it exterior, but also in its furnishings and sculptures. Structure became even more religious, and as I look back now, more poetic.[51]

The office tower stands 19 stories tall and connects to the 25 story service tower on the east side of the site. The building totals 309,660 square feet. One of the key features of the design was to bring the support piers of the office tower to the perimeter of the building and to use 60'-0" clear-span girders to support the floors. This allowed for open space of 58'-0" x 178'-0" on every floor. A modular grid of 5'-2" x 5'-2" drove the layout of the ceiling, movable partitions, and floors. It also created flexibility for reorganization of offices between floors.[52] (Figure 5.4)

The building, which is set back from Dearborn Avenue and West Monroe Street on the northeast corner of the site, occupies 66% of the its zoned parcel.[53] The main entrance faces south, opening up to West Monroe Street. The first two

---

[51] *Bruce Graham of SOM.* New York: Rizzoli International Publications, Inc., 1989, 16.

[52] Ibid., 16.

[53] Ibid., 16.

floors of the building form a base that is set underneath the remaining floors. The overhang at the entrance is distinguished by large square light fixtures mounted flush to the ceiling of the overhang. (Figure 5.5) A pair of revolving doors marks the all-glass entrance to the lobby. Stainless steel lettering above the doors marks the building's name - Inland Steel Building. (Figure 5.6) The lobby floors are dark grey terrazzo, and the walls are covered in black granite. Richard Lippold's sculpture, *Radiant I*, is the focal point and is set apart by a lower ceiling and a shallow pool of water, which is made of the same terrazzo as the floors. (Figure 5.7) A white luminous ceiling adds diffuse light to the space. Moving northeast toward the elevators, a small reception desk made of the same black granite that covers the walls stands as a checkpoint for visitors entering the building. The granite walls and luminous ceiling continue into the elevator lobby, where six elevators, clad in stainless steel, take visitors and employees to the offices on the upper floors. (Figure 5.8)

The office floors vary depending on the tenant. Some of them are unfinished and await new tenants. (Figures 5.9 and 5.10) Others have been finished according to the specific needs of the tenants who have leased the space. A kit of parts that SOM designed during a recent renovation contains an updated version of the original E. F. Hauserman, now Clestra Hauserman, demountable partitions, perforated metal ceiling tiles, and open office furniture by Unifor. (Figures 5.11 and 5.12) It was intended to be part of the package that new tenants would buy into when moving into the building. Few tenants have chosen to use it. Common spaces such as the elevator lobbies and restrooms have been updated on the occupied floors. The elevators lobbies are carpeted, with black granite covering the walls. (Figure 5.13) Some of the restrooms have wooden stall partitions with white subway tile on the walls and black granite counters. Others have stainless steel stall partitions with the same white subway tile and black granite counters. (Figure 5.14)

The penthouse level service spaces house mechanical equipment and are inaccessible to visitors. The roofs on the office and service towers are also closed to visitors. The basement level of the service tower houses offices for the building engineers and maintenance staff. It also holds the entrance to the underground parking garage, which can hold about 70-80 cars.

The choice of materials was intended to reflect Inland Steel's presence in the industry. It was the first major building to be built on steel pilings instead of concrete caissons.[54] The curtain wall is composed of polished chromium-nickel-manganese stainless-steel and green-tinted dual glazed units. The support piers are also clad in the same polished stainless-steel. The service tower is sheathed in matte stainless-steel clad pre-cast concrete panels and houses the elevators, restrooms, service stairs, and HVAC equipment.[55] (Figures 5.15 and 5.16) Distribution of power, data and air is through a modularized floor system that served as a precursor to today's access flooring. The "Inland Celluflor" saved

---

[54] Pauline A. Seliga (ed.). *The Sky's the Limit: A Century of Chicago Skyscrapers.* New York: Rizzoli International Publication, Inc., 1990, 181.

[55] Nicholas Adams. *Skidmore, Owings & Merrill: the experiment since 1936.* Milan: Electa, 2006, 105.

1'-0" of space per floor, which allowed the architects to add an extra floor and still keep the envelope at the height dictated by the building code.[56]

The interiors of the building were coordinated by John C. Murphy of Watson and Boaler, although the majority of the design work was done by David Allen of SOM. A committee formed in 1956 and headed by Murphy included Leigh Block, his wife Mary, two other representatives from Inland Steel, Allen, Graham and William Hartmann, the partner-in-charge for SOM. The Blocks had recently traveled to Istanbul, where they had seen Allen's work at the Istanbul Hilton. They requested to work with Allen because of his track record as a modern, minimalist designer. He recounted that the Blocks instructed him "not to use any of that pseudo-Chippendale baloney."[57]

The Blocks requested that Allen use steel in the furnishings and asked that he integrate several specially-commissioned works of modern art into the interior. Most notable was Richard Lippold's steel sculpture, *Radiant I,* which occupied a significant portion of the lobby. Allen worked with furniture manufacturer Steelcase to design custom furniture for most of the building. His "tin desk," the first modern desk to be manufactured by the company, was a simple design of a teak butcher-block top and ebonized lacquer pedestals in a frame of polished stainless steel. (Figures 5.17 and 5.18) The parts and pieces were easily customizable and could be modified to suit the needs of the various

[56] Ibid., 105.

[57] Maeve Slavin. *Davis Allen: Forty Years of Interior Design at Skidmore, Owings & Merrill.* New York: Rizzoli International Publications, Inc., 1990, 26.

employees. He also designed seating, conference tables, and hardware. Other selections included chairs by Eero Saarinen and other furniture by Georg Jensen.[58]

Construction began in 1955 and was completed in 1958. (Figure 5.19) Inland Steel occupied the top eight floors, designating the 19th floor for executives and the 13th floor as a cafeteria, dining, and lounge space. The rest of the building was open for other tenants, including SOM, who located their offices there for a time. Inland Steel occupied the building until the steel industry began to suffer in the United States and the company was acquired by Ispat International, a subsidiary of ArcelorMittal, in 1998.[59] (See Appendix B for more images of Inland Steel.)

5.2 Recent History

The Inland Steel building was designated a Chicago Landmark on October 7, 1998.[60] It was previously owned by St. Paul Travelers Companies before being purchased by a partnership between investor Alfred D'Ancona, Harvey Camins, a real estate broker, and Frank Gehry, an architect, in 2005. The Camins group began a piecemeal renovation of the building, much to the dismay of Gehry. As the market began to falter, they put the building up for sale, and Gehry's friend,

---

[58] Ibid., 26-30.

[59] Northwest Indiana Steel Heritage Project. *The Modern History of Inland Steel.* 2009. http://www.nwisteelheritagemuseum.org/inland-history.htm

[60] City of Chicago. *Chicago Landmarks: Inland Steel Building.* *http://webapps.cityofchicago.org/landmarksweb/web/landmarkdetails.htm?lanId=1336&counter=163*

Manhattan developer Richard Cohen of Capital Properties, bought the building for around $57 million.[61]

The new partnership brought a much-desired change in the approach to renovating the building. Cohen hired SOM to design the renovation, with Stephen Apking as the partner in charge of the project. Rather than do small projects here and there, Apking and his team developed a whole-building renovation strategy that would bring the building back to Class A status and also make it a model of energy efficiency, seeking LEED Platinum certification for both Core and Shell and Commercial Interiors.[62] In order to take advantage of the historic preservation tax credit, Capital Properties nominated the building to the National Register of Historic Places. It was designated on February 18, 2009.[63]

As the economy continued to falter after the downturn in 2008, Capital Properties scaled back its plans for the renovation. Some of the more expensive upgrades were scrapped, and the quest for LEED certification stalled. SOM ran into other challenges with the Chicago Landmarks Commission, who rejected many of the proposed ideas to create a more sustainable building, citing that the changes would too greatly alter the original design.[64] Today, the building is about

---

[61] Fred A. Bernstein. "Frank Gehry (a Part Owner) Helps Develop a Landmark." *New York Times*. November 16, 2010.

[62] Ibid.

[63] National Register of Historic Places database. *Inland Steel Building.* *http://nrhp.focus.nps.gov/natregsearchresult.do?fullresult=true&recordid=0*

[64] Alexandra Lange. "Blue Sky Thinking." *Metropolis.* June 2010, 76-81.

half occupied, and the owner has implemented only a few of SOM's renovation ideas.[65]

5.3 Inland Steel as a Case Study

The choice to use Inland Steel as a case study was made for four reasons. First, there was ample documentation available, including a scanned copy of the entire set of original construction documents from 1957 and digital AutoCAD files from the time of the renovation work. Second, the modularity of the building meant that there would not be an overwhelming number of unique details to model. Given the time constraints of this thesis, a relatively simple design was necessary. Third, using BIM to document a historic building is best served when the building is still in use. Finally, a conflict between SOM and the Chicago Landmarks Commission during the proposed renovation provided a good example for testing multiple design scenarios with a BIM model.[66]

The BIM model of Inland Steel was created by the author to argue the merits of continuous documentation and monitoring in an HSR. Each documentation project of a historic property is different and comes with its own set of challenges. However, it is the intent of this case study to represent the general principles of BIM for existing buildings and to reveal lessons learned for future documentation of buildings using this method.

---

[65] Verification came on a site visit on March 22, 2012.

[66] The fifth, and more personal reason, was because I think more mid-century commercial office buildings deserve attention from the preservation community.

5.4 Modeling an Existing Building

Starting a model from scratch can be an overwhelming and daunting task. Since there are no universal BIM standards, many firms have developed their own in-house standards. This is the case at Skidmore, Owings and Merrill, who contracted with a BIM consultant to help develop their firm-wide standards.[67] While it is not impossible to start from nothing, having standard templates for title blocks, floor plans, reflected ceiling plans, and other drawings helps speed up the initial set up. Using CAD files also saves time because the backgrounds are not static objects in the drawing but provide a live framework on which to build the model. (Figures 5.20 and 5.21)

The key to a successful model is patience and a willingness to make mistakes. There are subtle differences between drawing in AutoCAD and modeling in a program like Revit. AutoCAD is essentially computerized drafting while modeling is 3-D data entry. For example, instead of the traditional hand or CAD drafting method using two lines set a certain distance apart to represent a wall, Revit has a menu of wall types, of which new types can be created and edited. When selected, Revit draws both wall lines at once and carries with it information about the thickness of the wall, its material properties, its height, assembly type, cost, manufacturer, and fire rating. (Figure 5.22) All of this information is documented in a schedule and filtered or customized in any

---

[67] As an employee at SOM, I was grateful to be able to use our templates to set up my project. BIM consultants such as Case (http://www.case-inc.com/) specialize in providing training and helping firms develop BIM standards specifically suited to their needs.

number of ways. In AutoCAD, blocks are elements that carry information with them that can be repeated multiple times. In Revit, the block becomes a 3-D "family" that also carries information with it. Families can be parametric and grow and change depending on the specific type of component. (Figure 5.23)

It became clear when cross-referencing the CAD files with pdf scans of the old drawings that they may not have the ideal level of clarity or detail to achieve absolute accuracy. Field verification would be the best way to ensure that the model is correct. A laser scan would also have provided accurate data, but it was unnecessary with such a simple, repetitive building. Another source of information for verifying the accuracy of certain assemblies could have been the shop drawings made during construction.[68]

5.5 A New Proposal for an Old Design

During the renovation process, SOM proposed to return to Walter Netsch's original design for the curtain wall, which consisted of a double layer of glass with the space between acting as ducting for the building's HVAC system. This would use natural convection as a way to pull return air back to the air handling units and be a source of heat capture that would keep the building cooler. (Figures 5.24 and 5.25) After Bruce Graham took over as lead designer, he changed the design to a tinted green glass curtain wall, similar in style to the curtain wall at Lever House. When SOM proposed the change, the Chicago Landmarks Commission rejected the request based on the grounds that it changed too much

---

[68] Time constraints prevented this from being part of the case study. In an actual project, this would be a good way to verify the accuracy of the data in the model.

from the original construction. Though it would have resulted in increased efficiency of the building and followed Netsch's original design, Chicago Landmarks responded that it would look too different from the outside and alter the character of the building.[69] Would the outcome have been different if a BIM model been available to provide data on the two different scenarios?

The first step was to build the two different curtain wall families based on the as-built drawings and the proposed double skin option. Then, by turning on one family at a time, an analysis of how each curtain wall connects to the rest of the building, the differences between the two types, and the energy performance of both could be generated. It was clear that the double skin option was more energy efficient, but it did significantly change the overall assembly. The exterior layer of glass matched the original glazing, but the internal layer, though unseen from the outside, increased the reflection of light from the unit overall. (Figures 5.26 and 5.27) The result confirmed the Landmarks Commission's fear that it would change the exterior appearance. Constructing multiple design options for the curtain wall could have helped the architects and the Landmarks Commission eventually arrive at a solution that would make both parties happy.

In keeping with the HSR's requirements to provide treatment options, this scenario illustrates two different solutions and their possible outcomes. As part of the BIM model, they are housed within that document and will be part of the

---

[69] Alexandra Lange. "Blue Sky Thinking." *Metropolis.* June 2010, 78-79.

record of treatment options for the building. Should another renovation occur in the future, those options will remain as part of the building's preservation story.

Chapter 6: Documenting Energy Performance

6.1 Sustainability and Historic Buildings

One of the main components of an HSR is the history of the site and structure being studied. Usually the history covers design intent, social importance, contextual relevance, significance, and various building campaigns or renovations. A missing piece of most HSRs is the building's operational history. In order to fully understand how a building works and to make recommendations for its maintenance and treatment, information about its energy and water usage, lighting, plumbing, and HVAC systems must be made available. Utility bills, construction specifications, and owners manuals are all examples of sources of information that should be consulted to provide a more comprehensive history of a building. A BIM model, in conjunction with other software, synthesizes the information for use in future management of a building.

As the green building movement has become mainstream in the last 5-10 years, preservationists have championed the cause by making the case for reusing existing buildings. Architect Carl Elefante coined the phrase "the greenest building...is one that is already built" and proffered the argument that historic buildings are important players in the fight to reduce waste, use less energy, and maintain diversity in the country's building stock.[70] He goes on to explain, "We cannot *build* our way to sustainability; we must *conserve* our way to

---

[70] Carl Elefante. "The Greenest Building Is... One That Is Already Built." *Forum Journal*. Vol. 21, No. 4, 2007, 26-38.

it."[71] With that in mind, existing buildings are key players in the effort to be a less consumptive and more sustainable society. It is neither feasible nor sustainable to replace all existing buildings with new, more efficient ones. Instead, it is imperative that designers, engineers, and building owners understand how to work with existing buildings to reduce their consumption.

Historic buildings, especially those that have been designated by local or national governing bodies, require greater sensitivity when performing retrofits and other upgrades. Until recently, environmental sensitivity was not a consideration in preservation plans. However, they are a natural fit together and share similar goals. Most preservation plans seek minimal change to an existing site and its fabric. Sustainability plans also seek minimal disturbance to a site and emphasize harmony with its surroundings. Treatments and cleaning methods for historic building materials are often safe for the environment because harsh, toxic chemicals are damaging to the delicate fabric being repaired. Many historic buildings use "green building" strategies as integral parts of their design.[72] Before air-conditioning, buildings employed passive heating and cooling strategies to maintain a comfortable indoor air temperature and proper ventilation. Climate could not be ignored because there were no artificial solutions for controlling the indoor environment. In the absence of electricity, windows were placed to take

---

[71] Ibid., 27.

[72] National Building Museum. "Balancing Historic Preservation and Sustainability in Federal Buildings: An Interview with Eleni Reed, Chief Greening Officer, Public Buildings Service, U.S. General Services Administration." February, 2011. http://www.nbm.org/about-us/national-building-museum-online/balancing-historic-preservation-and-sustainability.html

advantage of natural daylight. Assemblies were often composed of materials that could easily be broken down into reusable component parts. Limited transportation necessitated local sourcing. In many ways, the green building movement must look back at traditional building methods to move forward with better, more efficient buildings.[73]

6.2 Bringing Sustainability and Preservation Together

To address the gap between sustainability and preservation, the National Park Service recently released guidelines for the sustainable rehabilitation of historic buildings.[74] The illustrated guide provides recommendations for maintenance and superficial changes, but its primary focus is on the aesthetic impact of the changes instead of a holistic approach to keeping a building's historic character while reducing its environmental impact. To further examine the benefits of building reuse, the National Trust for Historic Preservation's Preservation Green Lab undertook a multi-year study of several buildings in different climates to evaluate the environmental savings of reusing and retrofitting existing buildings. The report used Life Cycle Analysis (LCA) methodology to compare the impact of reuse and renovation versus new construction over a 75 year life span. It concluded that, when comparing buildings of similar size and

---

[73] Carl Elefante. "The Greenest Building Is... One That Is Already Built." *Forum Journal*. Vol. 21, No. 4, 2007, 37.

[74] Anne E. Grimmer, Jo Ellen Hensley, Liz Petrella, and Audrey T. Tepper. "The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings." U.S. Department of the Interior, National Park Service. Washington, DC, 2011. http://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf

function, reuse almost always results in environmental savings.[75] Another key finding was that it can take anywhere from 10 to 80 years to offset the negative environmental effects caused by the construction of a new building that is designed to be 30% more efficient than an average existing building.[76] Given these results, the case for building reuse and informed, efficient operations and management becomes even stronger.

Just as preservationists use LCA to better understand how long materials and systems will last in a building, the same method is frequently applied to the sustainability analysis of a building. It is useful early in the design process when selecting materials and assemblies to understand how long a material is intended to last. For buildings to be sustainable, they must be energy efficient, but they must also be incredibly durable.[77] LCA often builds the case for keeping existing buildings in use. When embodied energy, demolition waste, new materials sourcing, and labor costs are considered, retrofitting an old building becomes a more attractive option.

As the National Trust's study shows, it is impossible to build our way to a more sustainable society. New and better technology cannot solve environmental problems on its own. It requires thoughtful application and consideration of the

---

75 National Trust for Historic Preservation. Preservation Green Lab. "The Greenest Building: Quantifying the Environmental Value of Building Reuse." 2011, VI. http://www.preservationnation.org/information-center/sustainable-communities/sustainability/green-lab/lca/The_Greenest_Building_lowres.pdf

76 Ibid., VIII.

77 Joseph Lstiburek. "Increasing the Durability of Building Constructions." *Building Science*. Digest 144, 2006, 4.

context of both the specific system within the building and the greater context of the building's surrounding area. Technology works best as a means to an end, and BIM is a tool that helps achieve the sustainability goals for a given project.[78]

Many of the misconceptions surrounding the efficiency of old buildings are due to a lack of information about the buildings in question. BIM bridges the information gap to give owners and designers a better understanding of how their buildings operate. It is a highly effective tool that works with other software to simulate energy performance and analyze the potential for energy and water savings in a particular building. The result is a more robust report that will inform the treatment recommendations and operations guidelines for historic properties.

6.3 Analyzing Inland Steel

Using the Revit model and Autodesk Green Building Studio for the sustainability analysis, the goal was to understand the building's current operational state and to assess its potential for greater efficiency and less waste. The Inland Steel building does not immediately appear to be a model of energy efficiency. As part of the post-WWII building boom, it possesses many of the characteristics of other buildings of the era: a significant amount of glass, inoperable windows, and an emphasis on air-conditioning. True to the International Style, it is a glass box that could be in any city, anywhere, and it does not take its local environmental context into account. However, despite the apparent inefficiencies of the systems in the building, it also displays sustainable

---

[78] Eddy Krygiel & Bradley Nies. Green BIM: Successful Sustainable Design with Building Information Modeling. Indianapolis: Wiley Publishing, Inc., 2008.

features that were new for their time and are used today in “green” buildings. The glass façade provides daylighting and views for the majority of the occupants. The Celluflor separates the HVAC, power, and data from the walls and allows for more control and multiple configurations. Since systems often need to be replaced before structural elements, this separation allows the systems to be upgraded without making significant alterations to the structure. The dropped ceiling and demountable partitions were designed with flexibility in mind. They also reduce the amount of demolition and construction waste during renovations because the modular parts and pieces can easily be refitted without significant impact to the interior structure.

To better understand Inland Steel’s operational history, the information provided in Revit, with the addition of information from regional databases and estimates of utility information, was input into Autodesk Green Building Studio and run through the program’s various points of analysis. Green Building Studio is an internet and subscription-based service that provides output relating to energy and carbon analysis, potential for achieving an EnergyStar rating, water efficiency, ability to achieve LEED glazing points, and possibilities for alternative energy sourcing from photovoltaics.[79] It also provides a place for testing design alternatives to understand how different designs or material choices would affect the building’s efficiency. While not as comprehensive as software like the Department of Energy’s EnergyPlus program, Green Building Studio excels in

---

[79] Autodesk. “Green Building Studio Questions & Answers.” June 2011. http://images.autodesk.com/adsk/files/GBS_FAQ_6_7_11.pdf

displaying information in an easy-to-use format (Figure 6.1), and it gives a general overview of the performance of several parts of the building with output options that can be integrated with EnergyPlus. It can run an analysis based on default information, or it can be detailed to the point of calling out the types of glazing, roof materials, cladding, specific room configurations, HVAC units, and plumbing fixtures. The more accurate the information going into it, the more accurate the report will be coming out of it.

Sample results include the following: the initial run of Inland Steel showed that the building could achieve a U.S. EPA Energy Star rating as-is. The LEED points for daylight and views would most likely be achieved. It is an expensive building to maintain, as annual energy costs are upwards of $400,000. If the building were to add photovoltaic panels, it would require almost 13,000 square feet of panels and take 45 years for the system to pay back the investment. All of this information comes from little extra effort on the part of the designer. The model provides most of the information, and Green Building Studio does all the computation. (Figures 6.2 and 6.3)

It is important to note that all energy simulations are imperfect because they take average climate data and occupancy into consideration. For a historic use, it would be possible to go back and track a specific year's performance based on the weather, utility bills, and other specific pieces of information from the time. It could serve as the record of the operational and environmental impacts of each year of its existence. However, for an HSR, the main function of this information is to aide in making better decisions about renovations and maintenance. Any suggested treatments should account for the environmental impact they will have. With access to this data, professionals will be able to make better choices about the treatments they propose and ultimately use.

Chapter 7: Recommendations for Using BIM for Preservation

BIM is an appropriate platform for a wide variety of preservation applications, but it is not a universal solution to be used on every preservation project. Like any new technology, consideration of the preferred outcome should drive decisions about the best means to use to reach the desired end product. The following recommendations address some of the possible barriers to BIM implementation and provide guidelines for appropriate application of BIM on preservation projects.

The initial process of adopting BIM requires patience and support from all levels of staff in a firm. A significant up-front investment is required to begin using BIM in place of other documentation methods, and although senior leadership may not directly use the software programs, the project managers and decision makers in the firm must support the change. Since BIM is about more than just a different way of drawing, managers must learn how to alter contracts, fee proposals, and schedules to accommodate the differences in the way a project runs. Especially with preservation projects, it is important to build in more time at the beginning of the project for data collection and input into the model. Time savings is achieved later in the project during construction documents because many of the details have already been modeled. Schedules should reflect those changes.

It is costly to move from CAD to BIM. Software licenses are expensive and must be upgraded every few years. Most of the large companies that make CAD software also have a BIM product. To streamline the conversion process and to ensure compatibility between programs, it is best to choose the program in the same family of products. The largest companies, Autodesk and Bentley, have robust BIM software that comes with large online help and training communities.[80] Training is another added cost, but it is also an investment that will pay off once staff know the program and are able to use it efficiently.[81] It is also recommended to set up office-wide standards for use on every project. Most offices already have CAD standards and specific ways of producing drawing sets. It is worth the time spent to set up BIM standards. Until there are national standards for BIM, individual firms will have to set up standards based on best practices and the specific needs of their clients.[82]

After switching to BIM, the most important decisions come in choosing when to use it. It will not immediately replace CAD and other documentation methods, but it will serve as another option for documenting projects that would benefit from a high level of data output. Considerations include the size of the project, the type of building, the project's scope, the intended use of the building, and the project's sustainability goals. Once professionals see how much data is

---

[80] Autodesk: http://usa.autodesk.com/revit/
Bentley: http://www.bentley.com/en-US/Products/Building+Analysis+and+Design/

[81] It is not yet the norm, but it is becoming more common for students to come out of school knowing how to use BIM software such as Revit. Where CAD proficiency is expected now, it will not be long before proficiency with Revit or Bentley is a requirement.

[82] BIM consultants provide training and BIM implementation for firms looking to transition from CAD. It is often worth the cost to have experts set everything up so that projects start out under the best possible conditions.

generated and how processes are streamlined, they will be more enthusiastic about using BIM on every project.

The size of a project is not the most important factor in deciding to use BIM, but it plays a role. In general, the larger a project, the more it will benefit from using BIM. A model's function as an automatically updated database is especially useful on big projects with a large number of spaces to document. Economies of scale come into play, and time savings will increase as many of the operations that would normally be repeated from space to space become automatic.[83] It also decreases the chances for human error throughout a project because the model performs certain actions the same way every time. This does not exclude small projects from using BIM. If the goal is to produce a highly accurate record of a site, BIM is the best choice, regardless of size.

Any type of building, from a single-family residence to a large commercial office building to the most ornate cathedral, is a candidate for BIM documentation. Some buildings are easier to document than others, but that has less to do with the method of documentation and more to do with details and type of construction. The method of data entry may vary depending on the type of building. Field measurements may be enough for a residence, while existing CAD drawings could be used for an office building. An ornate cathedral would

---

[83] For example, doing area take-offs for the spaces in a project becomes much faster because the areas automatically update when walls move. In CAD, this operation would have to be redone each time the spaces change. On a small project, it may not be an issue, but on a large project there will be significant time savings.

benefit from laser scanning to ensure accuracy and the capture of an appropriate level of detail.

Laser scanning is becoming more widely used in preservation due to its high level of accuracy and its ability to correctly capture hard-to-draw shapes. Though it is an expensive method of documentation, the costs are becoming more competitive as labor costs continue to rise. Professionals must weigh the amount of time and personnel it would take to field measure against the time, cost, and personnel needed for laser scanning before making a decision.[84] Computing power is also a consideration. The point clouds generated from laser scans create huge data files that a firm's computing hardware may not be able to support. In the case of Inland Steel, it was a building with simple, repetitive geometry that could be easily modeled and verified. It would not have been cost effective to scan it. However, for a project with several unique details, laser scanning is the best option.

Ultimately, a project's scope and intended purpose are the primary drivers for using BIM over an alternate documentation method. The extent of the work and the end use of the building are important considerations. If the purpose of the documentation is to have it as a record for history's sake, the full capabilities of BIM would not be realized, and the traditional HABS method of documentation would be the best solution. If the purpose of the documentation is to have it as a

---

84 Caroline R. Alderson, Beth L. Savage, Charles Matta, Calvin Kam, and Anne E. Weber. "Government Policy and Practice: Digital Conservation and Landscape Renewal." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 13-14.

record for treatment and to use it as a planning tool for renovations, BIM is an excellent program for the job. BIM models are especially useful with additions of new construction because they hold both the record of the existing building and provide a place for the new construction documents. Since models are 3-D volumes, the scale and massing of any new work can easily be visualized next to the existing work. If a project is looking to meet specific sustainability goals, BIM provides most of the information needed to perform energy and water efficiency calculations and also informs any Life Cycle Analysis efforts.

The more familiar people become with using BIM software, the less people will question when and where to use it. It will become a standard of practice like using CAD today. As more projects are done with BIM, reworking project schedules, sharing the model with consultants, and restructuring contracts will become more common. As with anything new, it takes practice to get something right. The capabilities are there. It is up to preservation professionals to take advantage of them.

Chapter 8: Conclusion

It has been the intent of this thesis to explore ways in which building information modeling can be used in preservation practice and to update the current method of creating historic structure reports. As a tool that is quickly becoming the standard method of documenting projects in the architecture and design industry, preservation professionals must become familiar with BIM and learn how to harness its power for their own means. In creating a living model that responds to changes and maintains an updated record of events in a building's life, professionals will have access to more accurate information and be able to make better designs about proposed treatments for buildings. When tasked with creating a historic structure report, the choice of making it “living” is now a viable option.

On its own, a program like Revit does not provide a fully packaged, one-size-fits-all solution to the current drawbacks related to the historic structure report. Though it is moving into the market of facilities maintenance and operations, it remains largely a designers’ tool. BIM software like Revit functions as a database for a large amount of information about a building, but it does not fully function the same way as a relational database such as Microsoft Access does. It does not have a good platform for including image or text files that can be referenced in the drawings themselves. However, it is possible to set up a link between the model and a database in a program like Access. In so doing, Access would house the images and text not specifically associated with discreet parts of the building. The model would then feed up-to-date information via tables into the database that would link with the associated images and text descriptions. For example, a conditions glossary could be generated based on the different families in the model. Brief descriptions of the types of conditions, their locations, and affected assemblies could be exported from Revit to Access where sample images could be linked to illustrate each condition.[85]

The purpose of the HSR is to collect pertinent information to make good decisions about managing change over time. BIM contains a large of amount of information about a building that can be organized graphically, numerically, or textually. It incorporates the dimension of time to provide a visual chronology of a site and a record of past work. It contributes to the argument for reuse by housing cost and service life information within the model and by contributing information for energy models. Finally, BIM provides an integrated platform from which a more detailed and more informed historic structure report may be created. As preservation professionals look for ways to better understand the buildings they seek to protect, building information models provide a promising step forward in the search for “living” historic documents.

---

[85] An example of this in a new construction project relates to the creation of a furniture package. Quantities, types, and locations of furniture can be linked from Revit to Access, where images of each piece of furniture is included in the reports that are generated to include in the bid package. As the furniture moves and quantities are updated in Revit, the Access database adjusts accordingly.

Bibliography

Adams, Nicholas. *Skidmore, Owings & Merrill: the experiment since 1936.* Milan: Electa, 2006.

Alderson, Caroline R., Beth L. Savage, Charles Matta, Calvin Kam, and Anne E. Weber. "Government Policy and Practice: Digital Conservation and Landscape Renewal." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 11-17.

Autodesk. "Green Building Studio Questions & Answers." June 2011. http://images.autodesk.com/adsk/files/GBS_FAQ_6_7_11.pdf

Banta, James V., Kent Diebolt, and Michael Gilbert. "The Development and Use of a Tablet PC Annotation System for Conditions Surveys." *APT Bulletin*. Vol. 37, No. 2-3, 2006, 39-45.

Bernstein, Fred A. "Frank Gehry (a Part Owner) Helps Develop a Landmark." *New York Times*. November 16, 2010.

Brand, Stewart. *How Buildings Learn: What Happens After They're Built.* New York: Penguin Books, 1994.

Bruce Graham of SOM. New York: Rizzoli International Publications, Inc., 1989.

Bryan, Paul. "Metric Survey for Preservation Uses: Past, Present, and Future." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 25-29.

Carroon, Jean. *Sustainable Preservation: Greening Existing Buildings*. Hoboken: Wiley, 2010.

City of Chicago. *Chicago Landmarks: Inland Steel Building.* http://webapps.cityofchicago.org/landmarksweb/web/landmarkdetails.htm?lanId=1336&counter=163

Clark, Kate. "Informed Conservation: The Place of Research and Documentation in Preservation." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 5-10.

Cliver, E. Blaine, John A. Burns, Paul D. Dolinsky, and Eric Delony. "HABS/HAER at the Millennium: Advancing Architectural and Engineering Documentation." *APT Bulletin*. Vol. 29, No. 3/4, Thirtieth-Anniversary Issue, 1998, 31-35.

Crotty, Ray. The Impact of Building Information Modelling: Transforming Construction. London: Spoon Press, 2012.

Eastman, C., Liston, K., Sacks, R., Teicholz, P. BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors. Hoboken: John Wiley & Sons, Inc., 2008.

Elefante, Carl. "The Greenest Building Is... One That Is Already Built." *Forum Journal*. Vol. 21, No. 4, 2007, 26-38.

Foxe, David M. "Building Information Modeling for Constructing the Past and Its Future." *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 39-45.

"From Blueprint to Database." *The Economist*. June 5, 2008.

Garrett, Billy G. "Historic Structure Reports: A Redefinition." *CRM Bulletin*. Vol. 13, No. 4, 1990.

Garrett, Billy G. "Revision of the National Park Service Guideline for Historic Structure Reports." *Standards for Preservation and Rehabilitation, ASTM STP 1258*. Stephen J. Kelley (ed.). 1996, 109-118.

Geva, Anat. "A Multimedia System for Organizing Architectural Documentation of Historic Buildings." *APT Bulletin*. Vol. 27, No. 4, 1996, 18-23.

Grimmer, Anne E., Jo Ellen Hensley, Liz Petrella, and Audrey T. Tepper. "The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings." U.S. Department of the Interior, National Park Service. Washington, DC, 2011. http://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf

Inland Steel Building website. Accessed December 10, 2011. http://www.inlandsteelbuilding.com/index.html

Inland Steel Company. *50 Years of Inland Steel, 1893-1943.* Chicago: 1943.

Jernigan, F. BIG BIM little bim: The practical approach to building information modeling. Salisbury: 4Site Press, 2008.

Krygiel, Eddy & Bradley Nies. *Green BIM: Successful Sustainable Design with Building Information Modeling.* Indianapolis: Wiley Publishing, Inc., 2008.

Krygiel, Eddy, Phil Read, and James Vandezande. *Mastering Autodesk Revit Architecture 2011.* Indianapolis: Wiley Publishing, Inc., 2010.

Lange, Alexandra. "Blue Sky Thinking." *Metropolis.* June 2010, 76-81.

Lavoie, Catherine C. "The Role of HABS in the Field of Architectural Documentation." *APT Bulletin*. Vol, 41, No. 4, Special Issue on Documentation, 2010, 19-24.

LeBlanc, François and Rand Eppich. "Documenting Our Past for the Future." *The Getty Conservation Newsletter* 20, no. 3 (Fall 2005): 5-9. http://www.getty.edu/conservation/publications_resources/newsletters/pdf/v20n3.pdf

Lstiburek, Joseph. "Increasing the Durability of Building Constructions." *Building Science*. Digest 144, 2006.

Miri, Ali A. "Philosophy and Principles of Preservation in Practice." *CRM*. No. 7, 2001, 11-14.

Murphy, M., E. McGovern, S. Pavia. "Historic Building Information Modelling - Adding Intelligence to Laser and Image Based Surveys." International Society for Photogrammetry and Remote Sensing Workshop '3-D-ARCH 2011' "3-D Virtual Reconstruction and Visualization of Complex Architectures" March 2-4, 2011.http://www.isprs.org/proceedings/XXXVIII/5-W16/pdf/murphy_etal.pdf

National Building Museum. "Balancing Historic Preservation and Sustainability in Federal Buildings: An Interview with Eleni Reed, Chief Greening Officer, Public Buildings Service, U.S. General Services Administration." February, 2011. http://www.nbm.org/about-us/national-building-museum-online/balancing-historic-preservation-and-sustainability.html

National Register of Historic Places database. *Inland Steel Building.* *http://nrhp.focus.nps.gov/natregsearchresult.do?fullresult=true&recordid=0*

National Trust for Historic Preservation. Preservation Green Lab. "The Greenest Building: Quantifying the Environmental Value of Building Reuse." 2011. http://www.preservationnation.org/information-center/sustainable-communities/sustainability/green-lab/lca/The_Greenest_Building_lowres.pdf

Northwest Indiana Steel Heritage Project. The Modern History of Inland Steel. 2009. http://www.nwisteelheritagemuseum.org/inland-history.htm

Oppenheimer, Nat. “An Enthusiastic Sceptic.” *Architectural Design.* 79 (2). London: John Wiley & Sons, 2009,100-105.

Penttilä, Hannu, Marko Rajala, and Simo Freese. “Building Information Modelling of Modern Historic Buildings: Case Study of HUT/Architectural Department by Alvar Aalto.” eCAADe 25, Session 13, 2007, 607-613.

Pereira, Ana Rita, Jouke Post, and Peter Erkelens. “Innovating Built Heritage: Adapt the Past to the Future.” http://www.irbnet.de/daten/iconda/CIB11946.pdf

Saliga, Pauline A. (ed.). *The Sky’s the Limit: A Century of Chicago Skyscrapers.* New York: Rizzoli International Publication, Inc., 1990.

Schmitt, Megan Cross. “The Evolution of the Historic Structure Report: A Review of Its Past and a Look at Its Future.” A Thesis in Historic Preservation, University of Pennsylvania, 2007.

Skarmeas, George C. “From HABS to BIM: Personal Experiences, Thoughts, and Reflections.” *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 47-53.

Slavin, Maeve. *Davis Allen: Forty Years of Interior Design at Skidmore, Owings & Merrill.* New York: Rizzoli International Publications, Inc., 1990.

Streeter, Kelly. “Information Technology for Building Documentation.” *APT Bulletin.* Vol. 41, No. 4, Special Issue on Documentation, 2010, 33-38.

Swedberg, Claire. “NYC’s Metropolitan Museum of Art Adopts RFID.” *RFID Journal*. July 26, 2011. http://www.rfidjournal.com/article/print/8630

U.S. Department of the Interior, National Park Service. *Preservation Brief 43: The Preparation and Use of Historic Structure Reports.* http://www.nps.gov/hps/tps/briefs/brief43.htm

U.S. Department of the Interior, National Park Service. *NPS-28: Cultural Resource Management Guideline*. http://www.cr.nps.gov/history/online_books/nps28/28chap8.htm

U.S. General Services Administration. *BIM Guide Series 03 - Laser Scanning.* http://www.gsa.gov/graphics/pbs/GSA_BIM_Guide_Series_03.pdf

U. S. General Services Administration. *BIM Guide Series 04 - 4D Phasing.*

http://www.gsa.gov/graphics/pbs/BIM_Guide_Series_04_v1.pdf

Woodcock, David G. “Guest Editor’s Note.” *APT Bulletin*. Vol. 41, No. 4, Special Issue on Documentation, 2010, 3.

Yee, Peggy, Charles Matta, Calvin Kam, Stephen Hagan, and Oskar Valdimarsson. “The GSA BIM Story.” Accessed October 23, 2011. http://www.fsr.is/lisalib/getfile.aspx?itemid=6995

Archival Collections

Skidmore, Owings and Merrill, LLP: Inland Steel Archives
14 Wall Street
New York, NY 10005
and
224 South Michigan Avenue
Suite 1000
Chicago, IL 60604

Appendix A: Figures

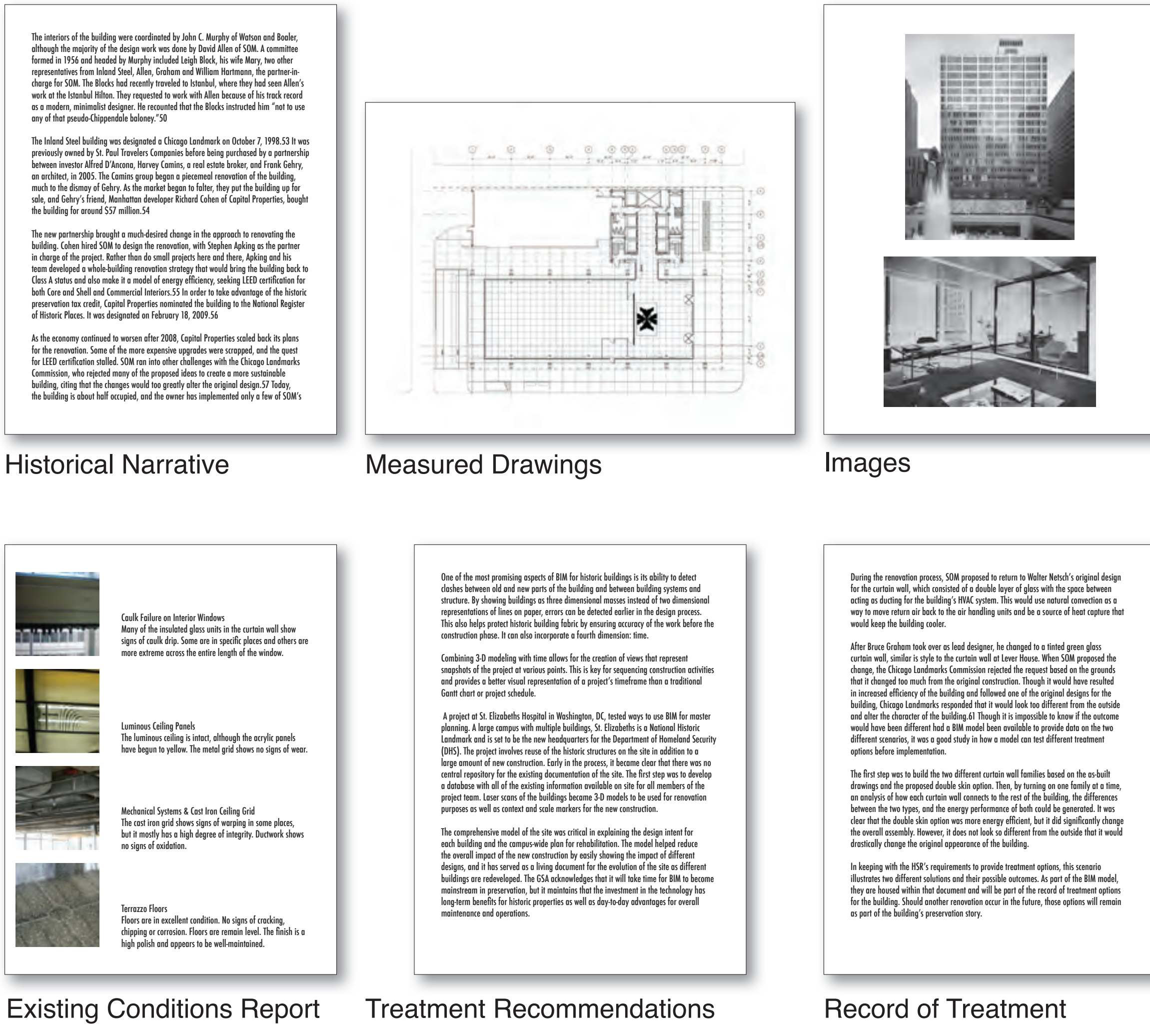


Figure 2.1: Sample Pages in an HSR. Source: the author, 2012.

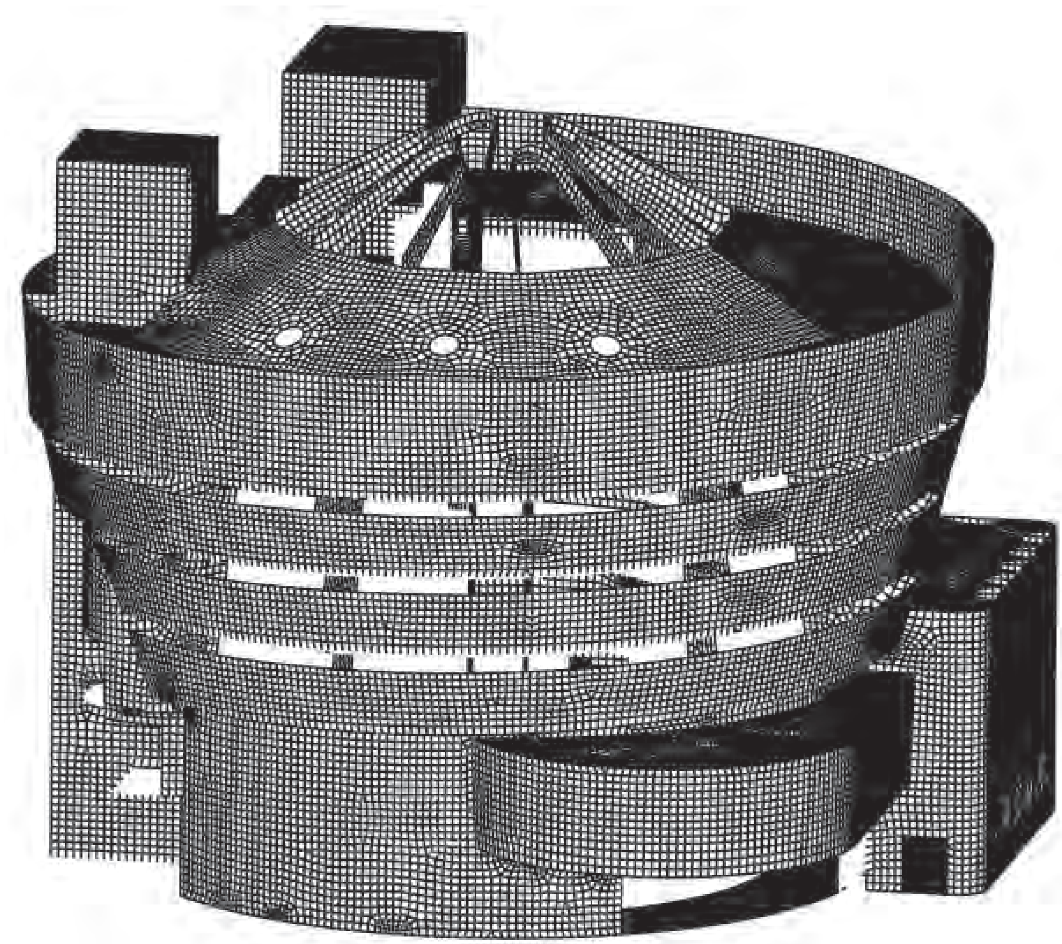


Figure 4.1: Finite Element Analysis Model of the Solomon R. Guggenheim Museum, New York. Source: Architectural Design March/April 2009, 103.

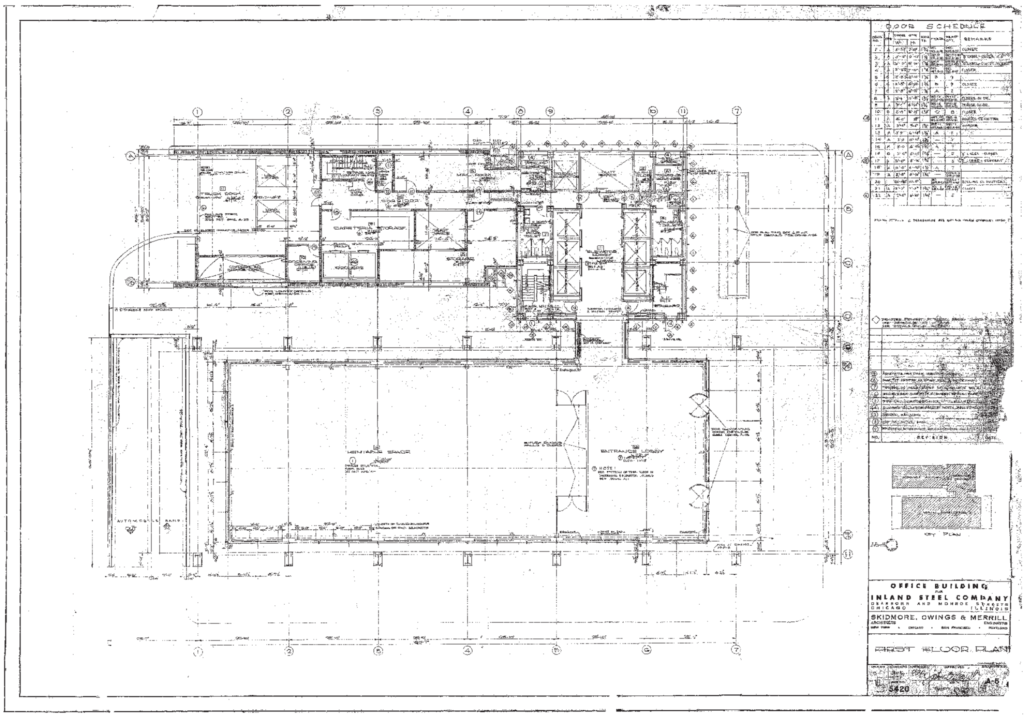


Figure 4.2: Original Construction Drawing of Inland Steel. Source: SOM Archives, 1957.

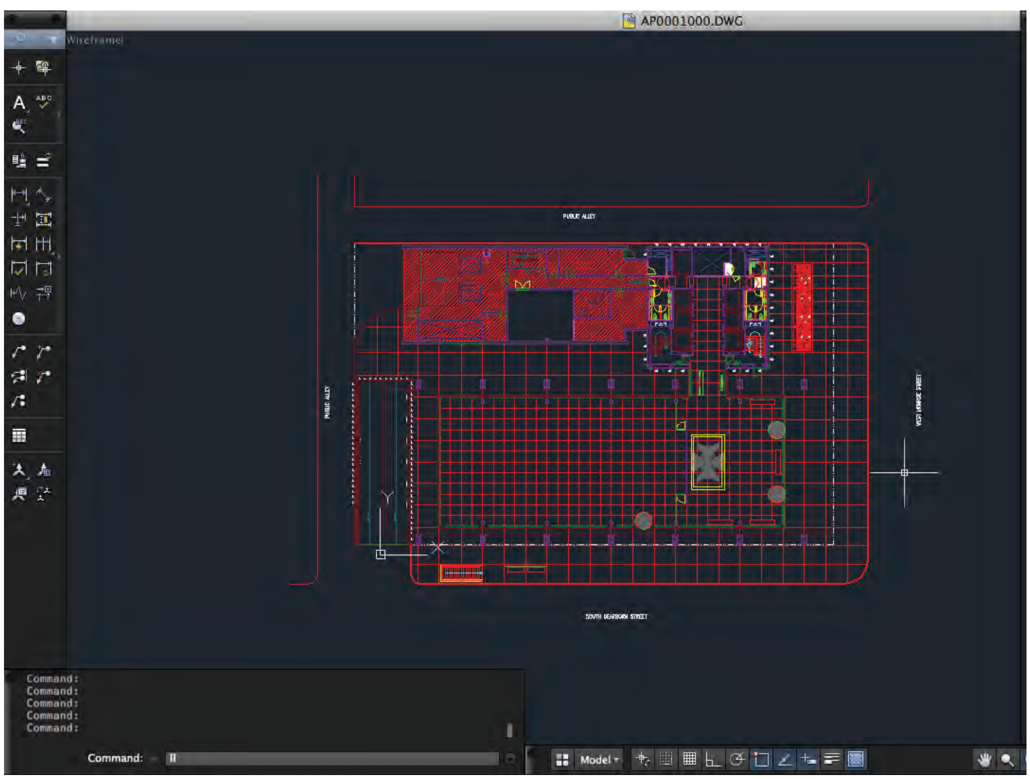


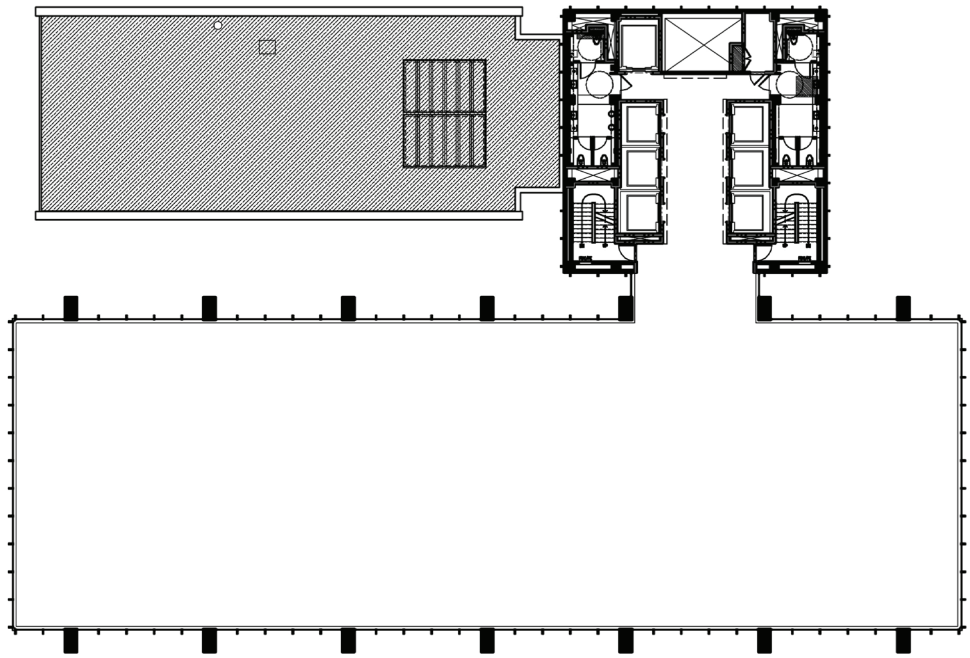
Figure 4.3: CAD Drawing of Inland Steel. Source: SOM Archives, 2007.

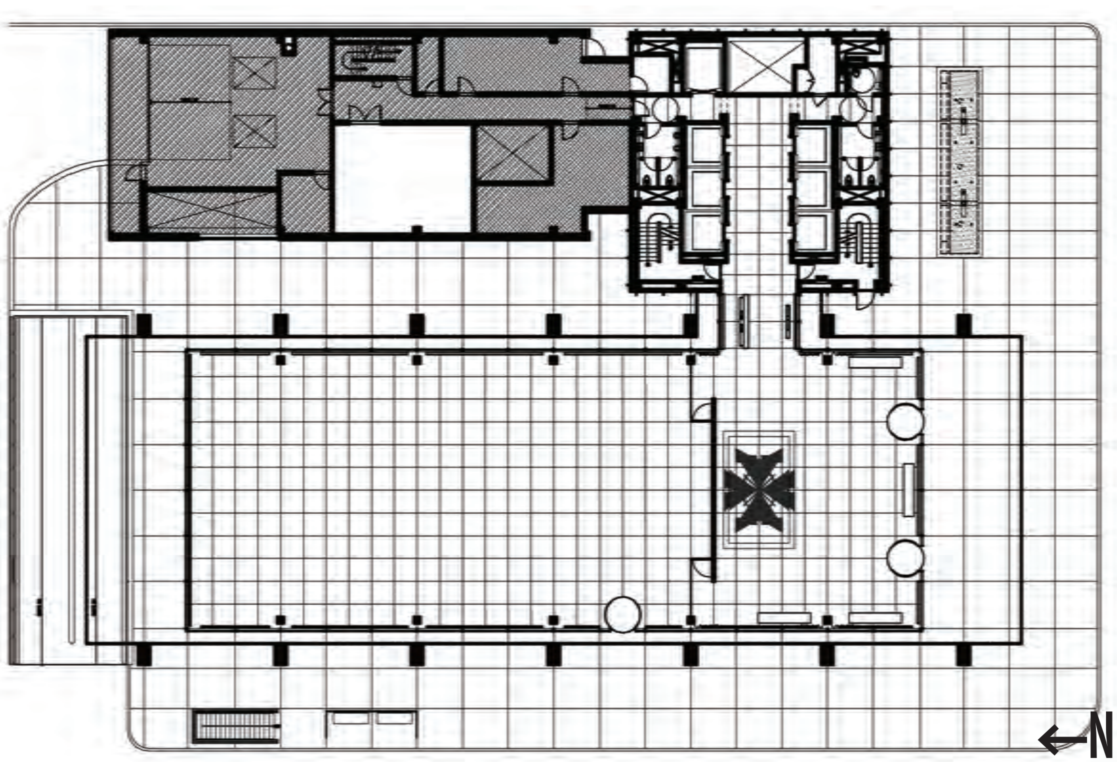
Figure 4.4: Laser Scan of St. Patrick's Cathedral, New York. Source: Langan Engineering & Environmental Services. http://www.langan.com/web/services/34/220

Figure 5.1: Main Offices of Inland Steel; Indiana Harbor; Graham, Anderson, Probst & White; 1930. Source: http://en.wikipedia.org/wiki/File:InlandSteelOffice.JPG

Figure 5.2: Location of Inland Steel Headquarters; Chicago. Source: Bing Maps, 2011.

Figure 5.3: Model of the Inland Steel Headquarters; Art Institute of Chicago. Source: the author, March 2012.


Typical Floor Plan



Ground Floor Plan

Figure 5.4: Floor Plans. Source: SOM Archives, 2008.

Figure 5.5: Entrance to Inland Steel. Source: Ezra Stoller, SOM Archives, 1958.

Figure 5.6: Entrance to Inland Steel Today. Source: the author, 2012.

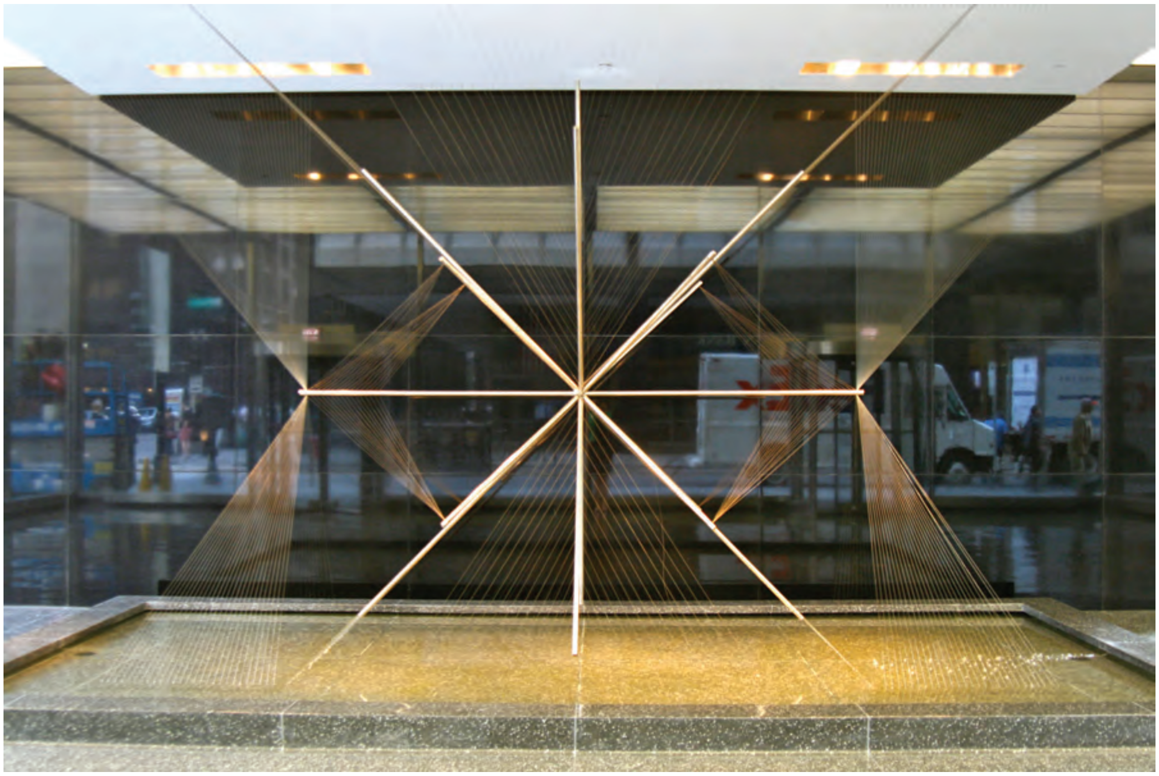


Figure 5.7: Lobby Showing Richard Lippold's Radiant I. Source: the author, 2012.

Figure 5.8: Ground Floor Elevator Lobby. Source: the author, 2012.

Figure 5.9: Unfinished Tenant Floor. Source: the author, 2012.

Figure 5.10: Venetian Blinds Shading the Windows on an Unfinished Tenant Floor. Source: the author, 2012.

Figure 5.11: Proposed Open Office Kit of Parts. Source: Jeong Hee Kim, SOM Archives, 2007.

Figure 5.12: Proposed Enclosed Office Kit of Parts. Source: Jeong Hee Kim, SOM Archives, 2007.

Figure 5.13: Upper Floor Elevator Lobby. Source: the author, 2012.

Figure 5.14: Typical Restroom. Source: the author, 2012.

Figure 5.15: Stainless Steel Cladding and Green-tinted Curtain Wall Glazing. Source: the author, 2012.

Figure 5.16: Corner Detail of Office Tower. Source: the author, 2012.

Figure 5.17: Private Office. Source: Ezra Stoller, SOM Archives, 1958.

Figure 5.18: Open Office Area. Source: Hedrich Blessing, SOM Archives, 1958.

Figure 5.19: Inland Steel Headquarters. Source: Hedrich Blessing, SOM Archives, 1958.

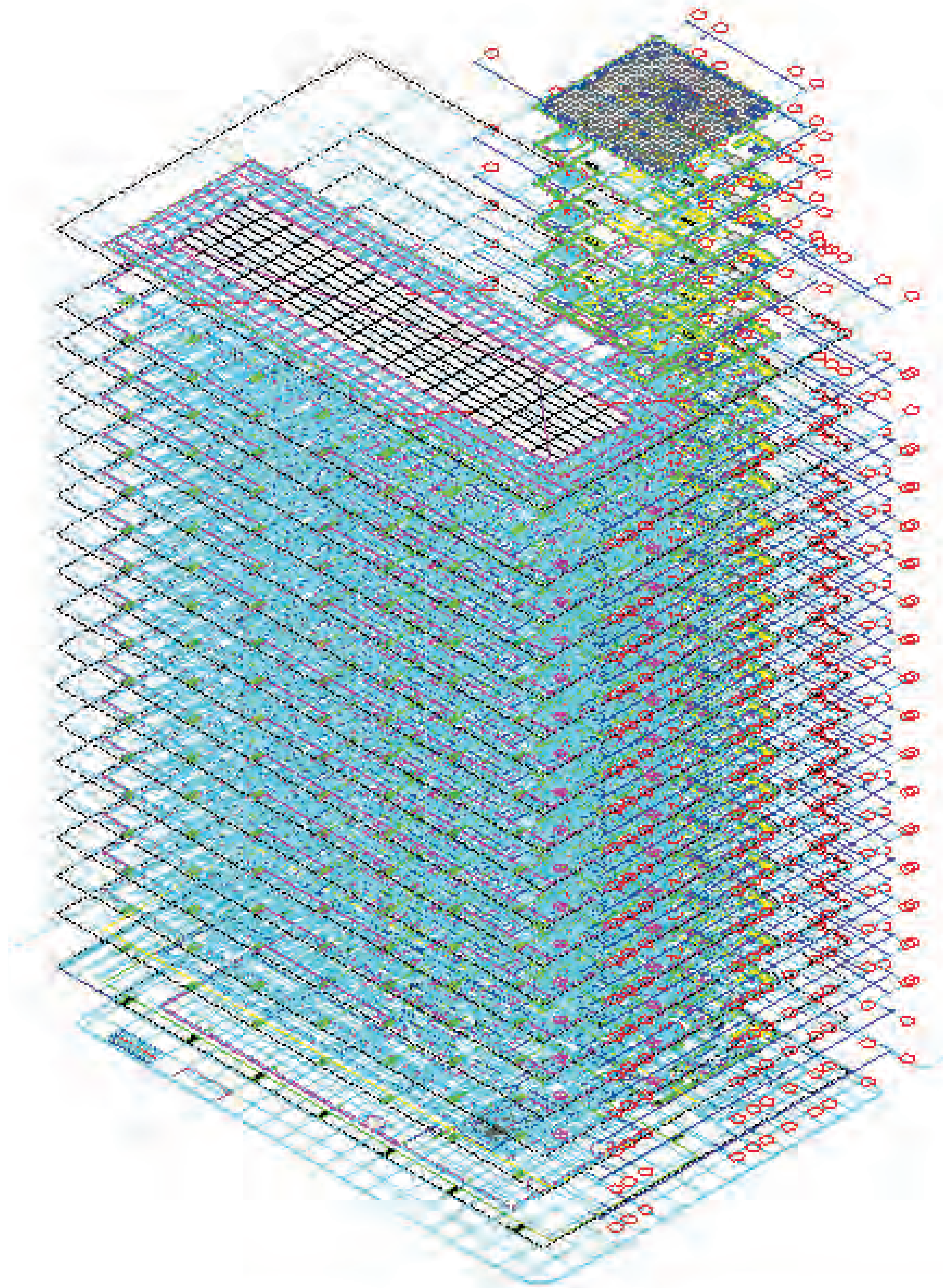


Figure 5.20: CAD Files Linked into Revit. Source: Autodesk Revit, the author, 2011.

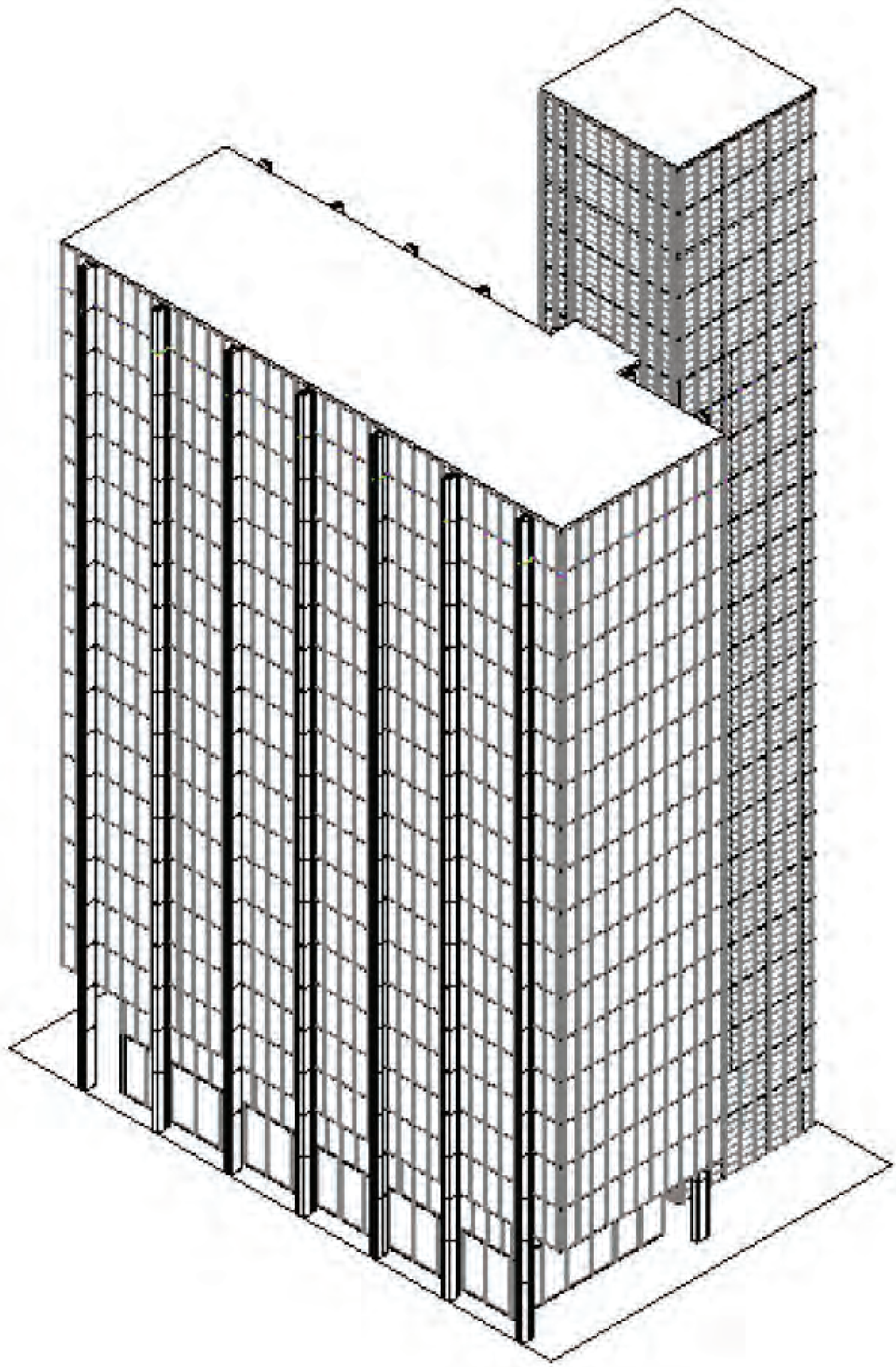


Figure 5.21: BIM Model. Source: Autodesk Revit, the author, 2011.

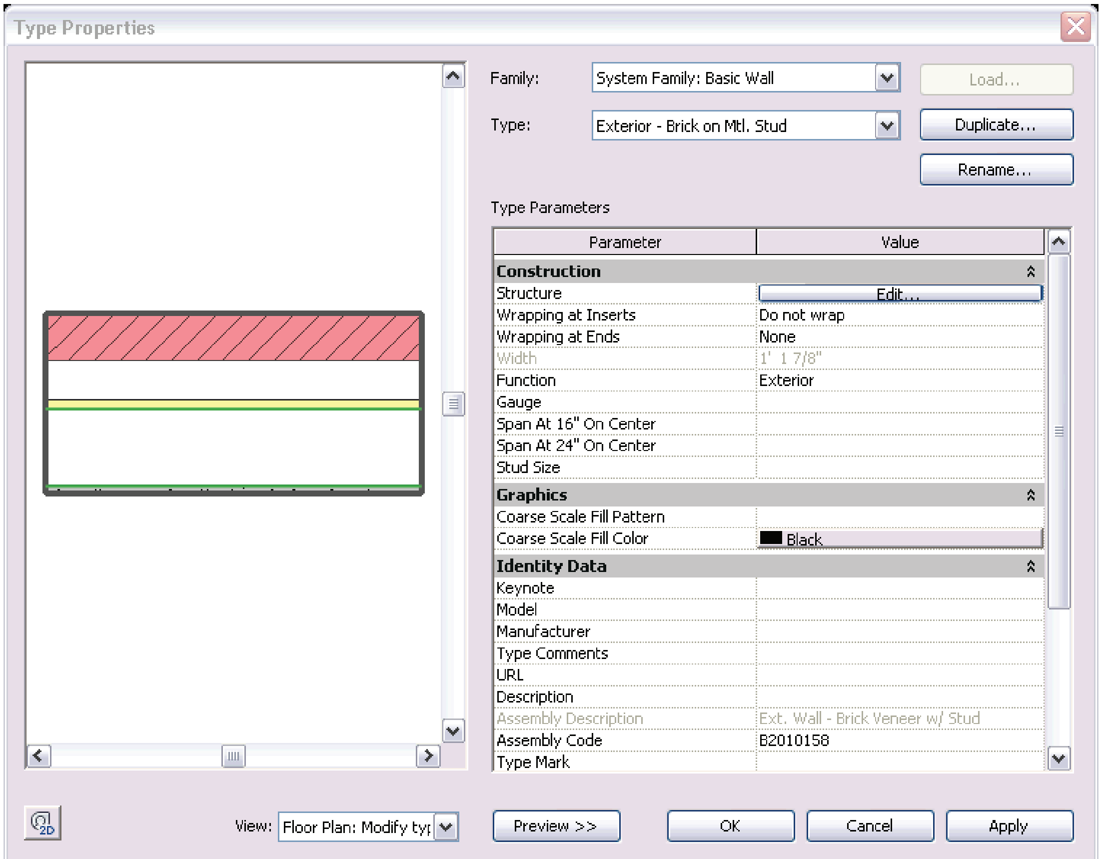


Figure 5.22: Properties Box Showing Information Parameters for a Wall Type. Source: Autodesk Revit, 2012.

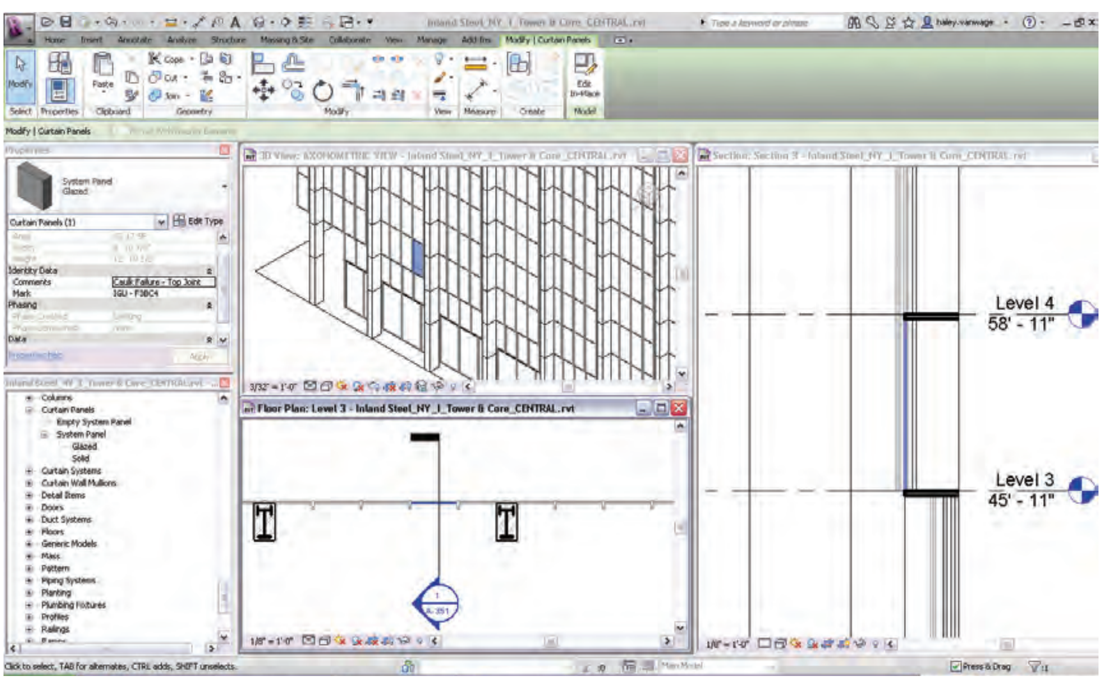
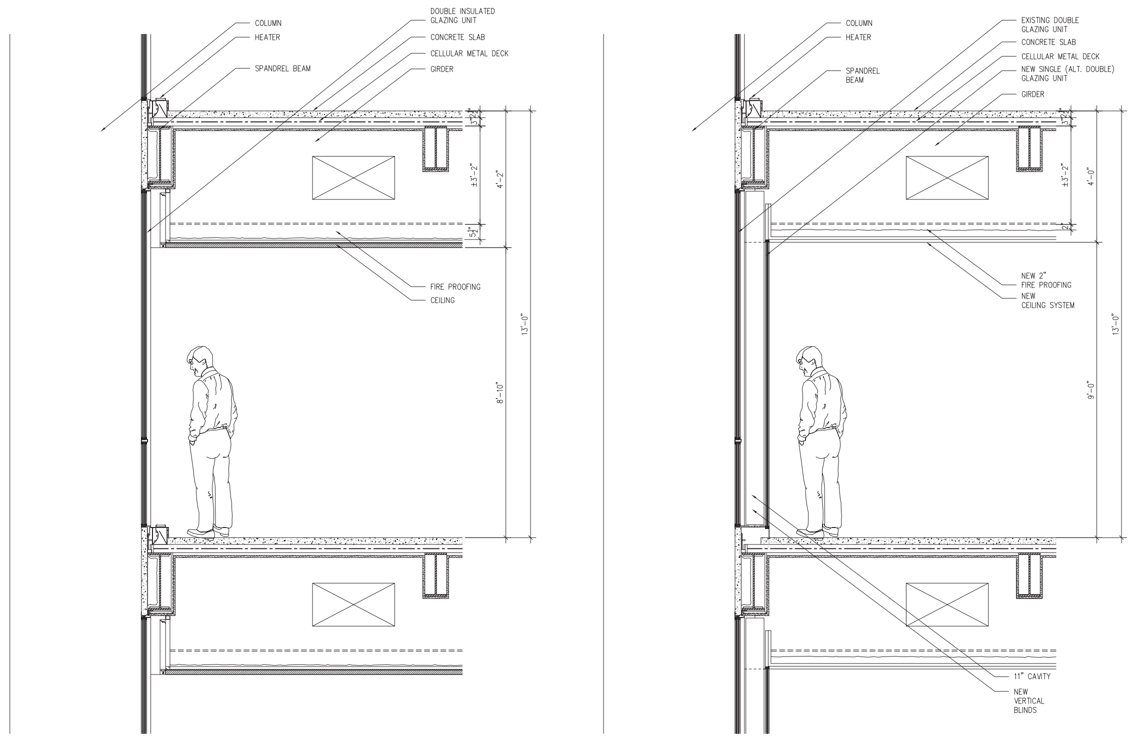


Figure 5.23: Selection of a Window Panel in Multiple Views. Source: Autodesk Revit, 2012.



Existing Curtain Wall

Proposed Curtain Wall

Figure 5.24: Existing and Proposed Curtain Wall Designs. Source: SOM Archives, 2008.

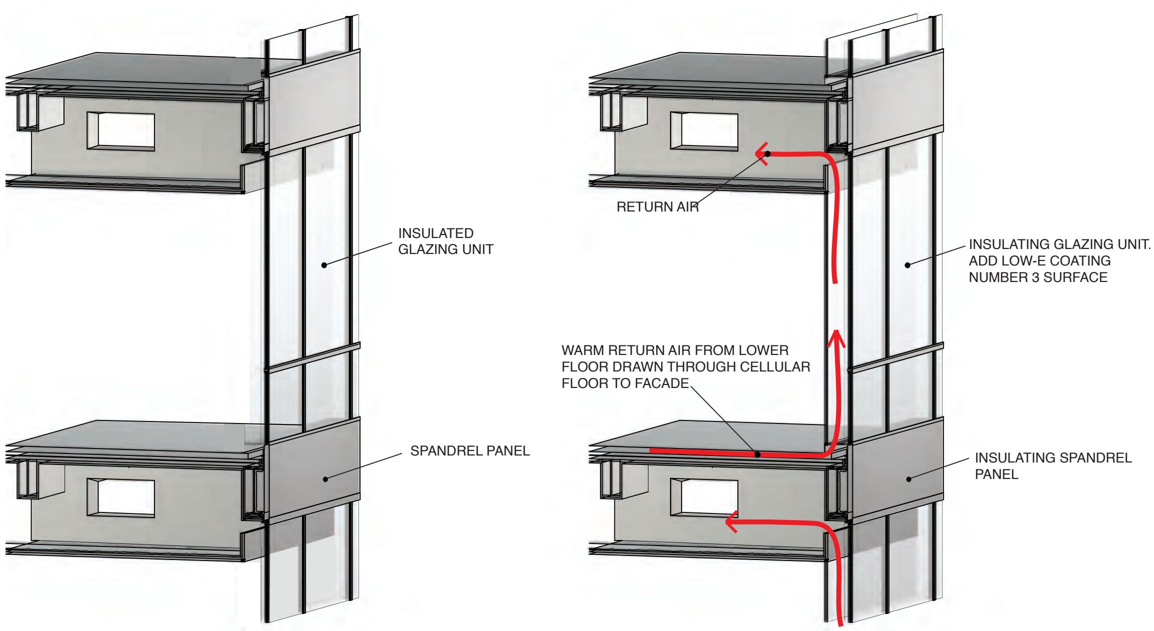


Figure 5.25: Existing and Proposed Curtain Wall Designs Showing Difference in Appearance. Source: SOM Archives, 2008.

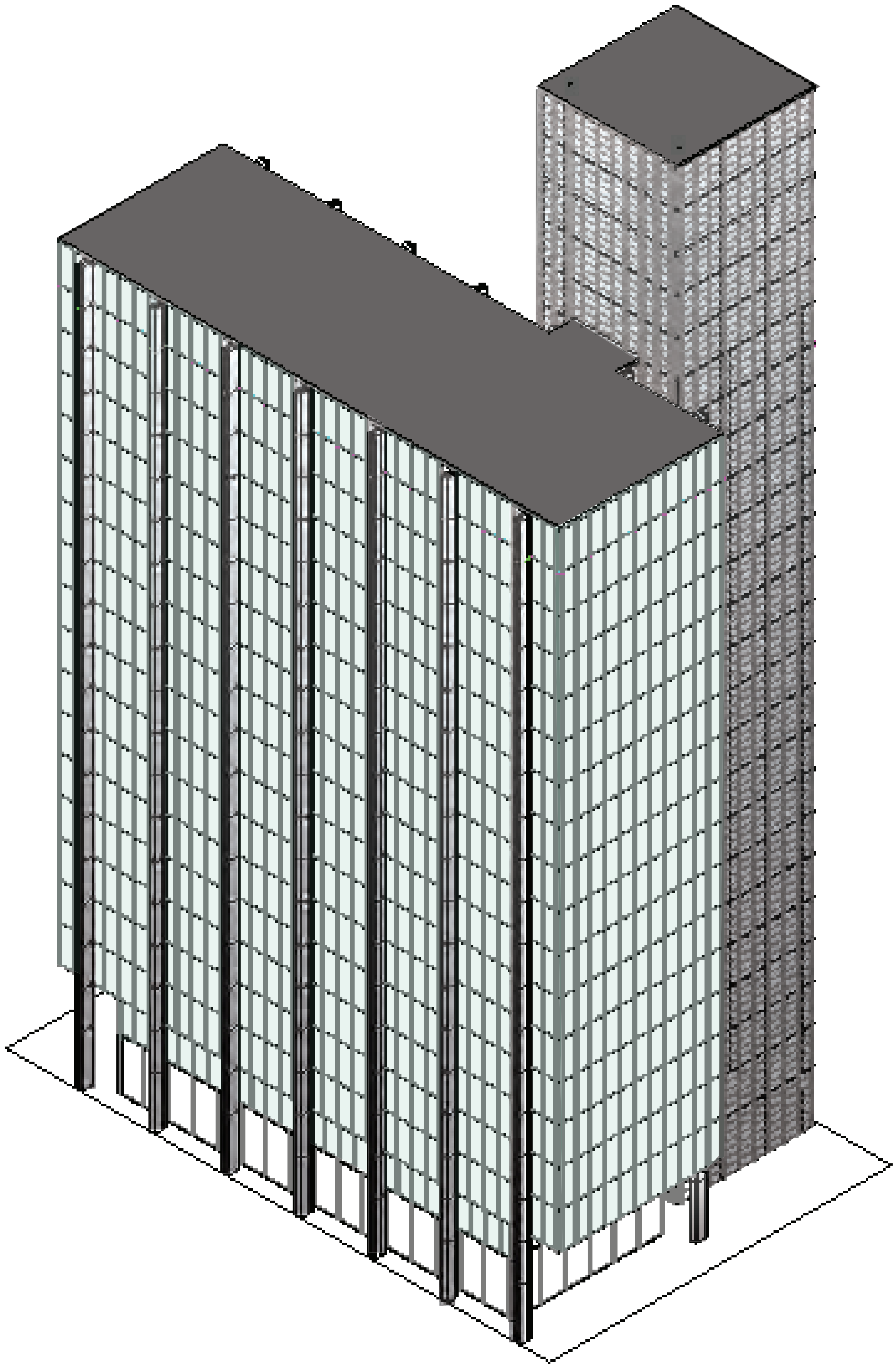


Figure 5.26: Existing Curtain Wall. Source: Autodesk Revit, the author, 2012.

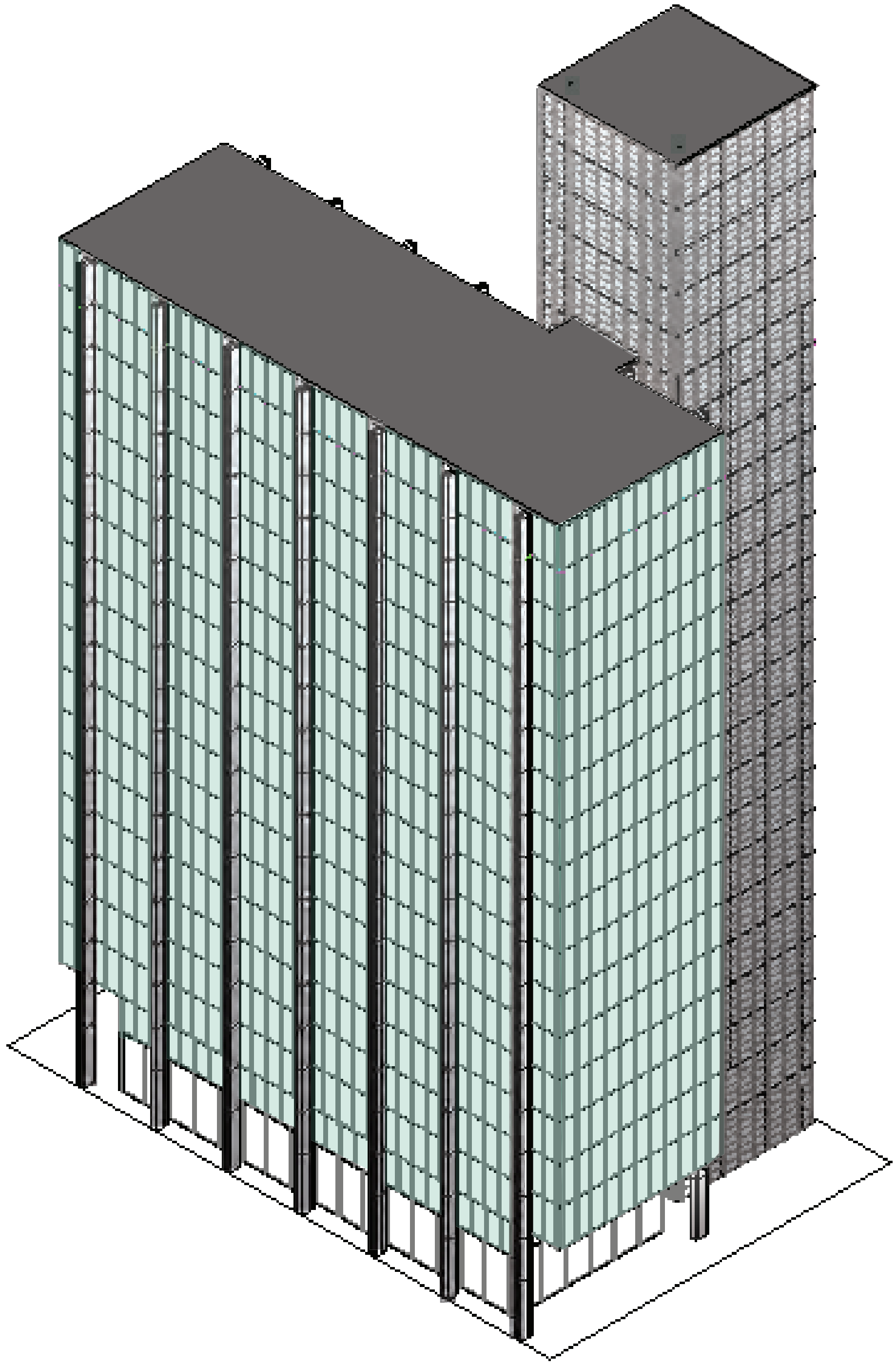


Figure 5.27: Proposed Curtain Wall. Source: Autodesk Revit, the author, 2012.

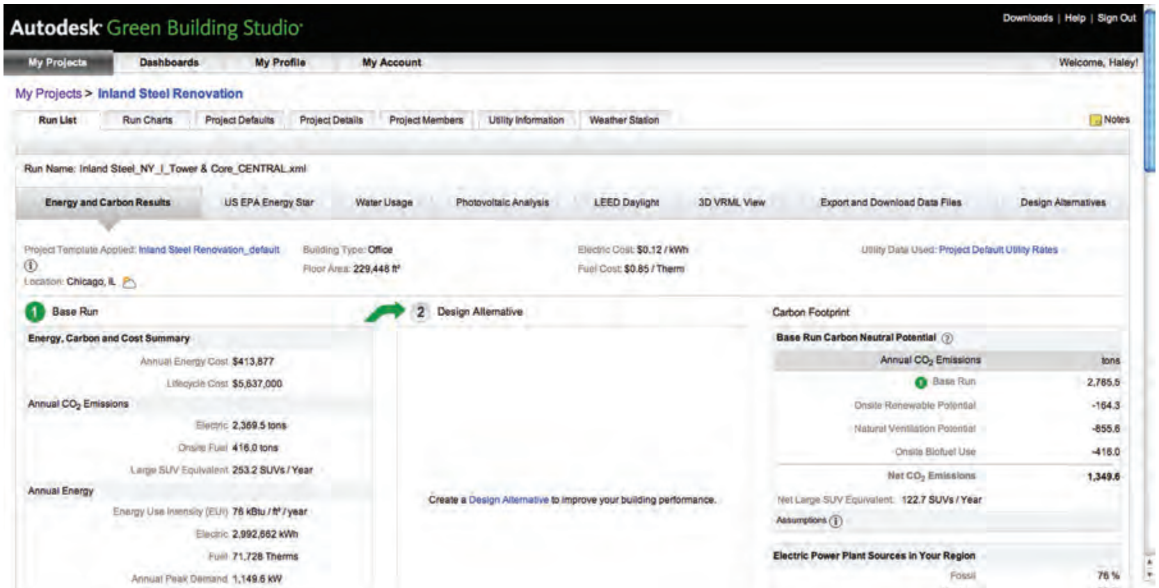


Figure 6.1: Green Building Studio Interface. Source: the author at https://gbs.autodesk.com/, 2012.

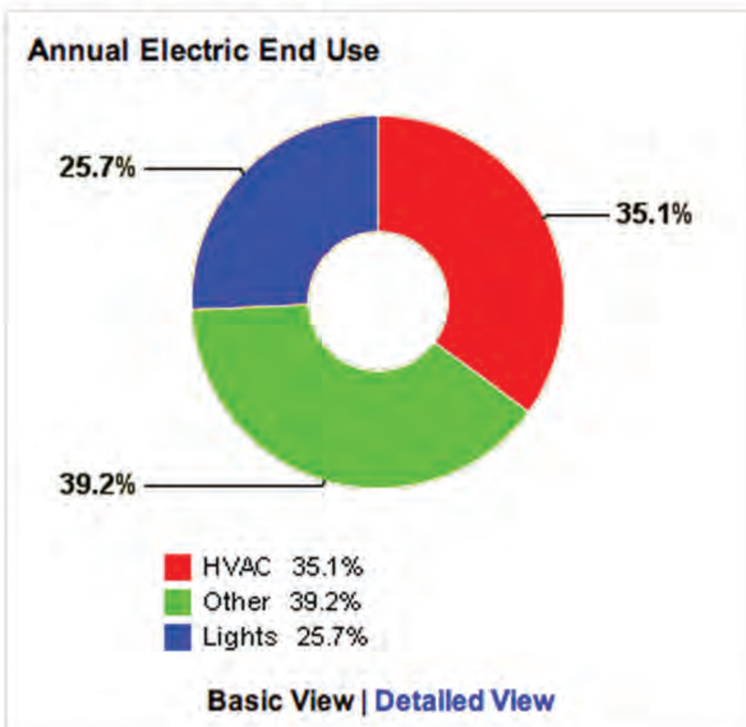


Figure 6.2: Sample Output from Green Building Studio. Source: the author at https://gbs.autodesk.com/, 2012.

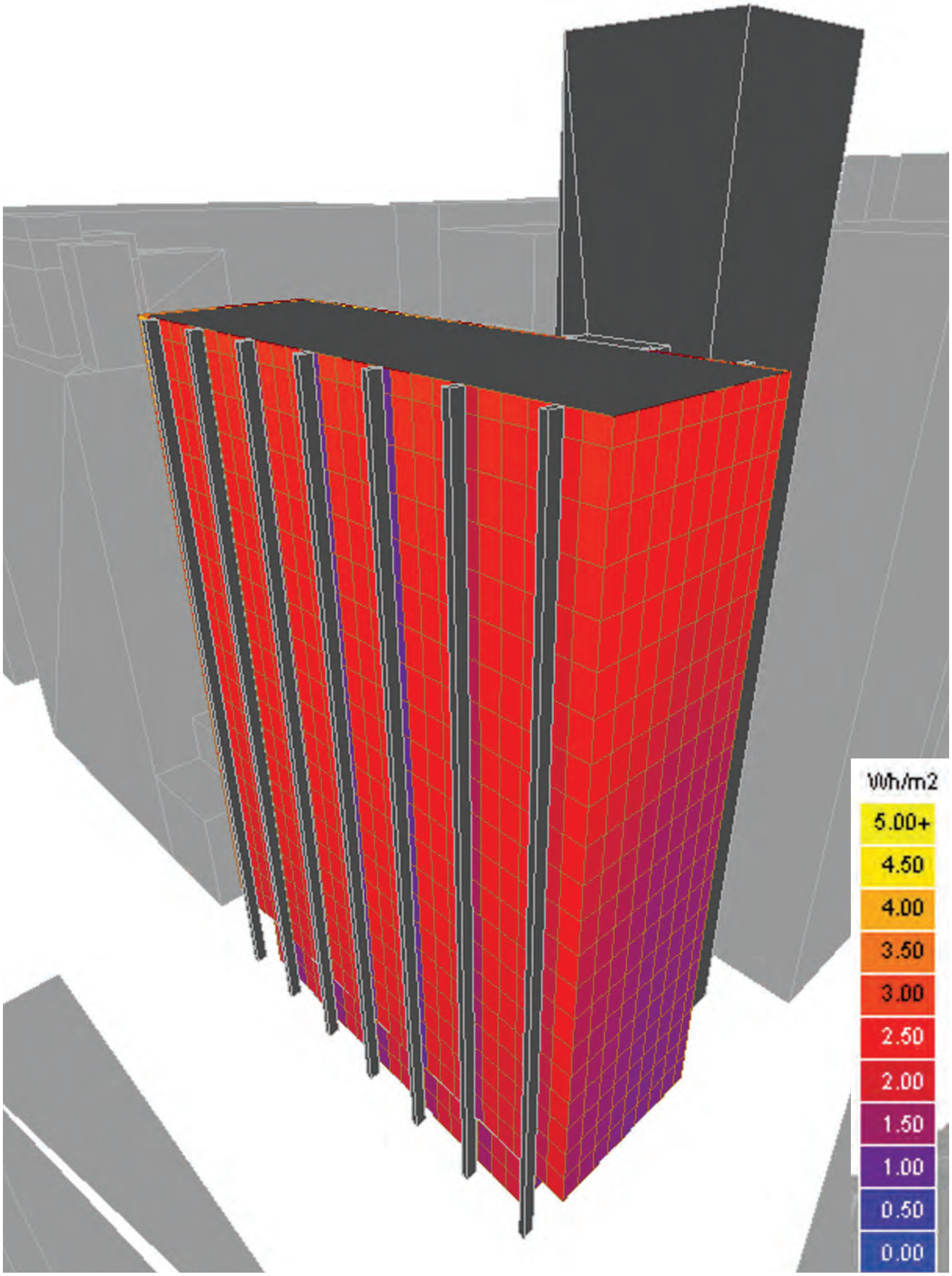


Figure 6.3: Solar Incident Heat Gain in Winter. Source: SOM Archives, 2008.

Appendix B: Additional Images of Inland Steel

Figure B.1: Signing lease for occupancy in new Inland building. L-R: Fred Kramer (of Draper & Kramer, realtors), Leigh B. Block, Inland VP, Charles J. Merriam and George H. Lorch. Merriam & Lorch are patent attorney firm with office presently in Board of Trade Bldg, Chicago. The last named two men are firm partners. Source: Kaufmann and Fabry Co., SOM Archives, 9/4/1956.

Figure B.2: Architectural View No. 13 Looking NE at Building Site. Source: Bill Mick for Kaufmann and Fabry Co., SOM Archives, 7/25/1956.

Figure B.3: Architectural View No. 25 Looking NE at Building Site. Source: Bill Mick for Kaufmann and Fabry Co., SOM Archives, 8/15/1956.

Figure B.4: Completed excavation and steel columns of the new Inland Steel Company building are inspected by a group from Inland and Skidmore, Owings and Merrill, architects of the building, who yesterday signed a lease for occupancy of its sixth floor. L-R: Bruce Graham, architect of Skidmore, Owings and Merrill; John O. Merrill, senior partner of the architectural firm; Joseph L. Block, president of Inland Steel company; William E. Hartmann, partner of the architectural firm; Neele E. Stearns, vice president of planning of Inland, and Fred Kramer, of Draper and Kramer, Inc., rental agents for the Inland building. Source: SOM Archives, 1957.

Figure B.5: View Looking Upward - East Wall of Main Building, Showing Stainless Steel Column Covers and Spandrel Panels. Source: Kaufmann and Fabry Co., SOM Archives, 3/20/1957.

Figure B.6: Stainless Steel Covered Panel (5'-1"x13'-0"x5"; 3500 lb.) Being Turned on End, Without Touching Ground, Preparing to Hoist to Upper Floor Level of Service Tower. Source: Kaufmann and Fabry Co., SOM Archives, 5/16/1957.

Figure B.7: Architectural View No. 43 Looking N at Building. Source: Kaufmann and Fabry Co., SOM Archives, 2/21/1957.

Figure B.8: Architectural View No. 47 Looking N at Building. Source: Kaufmann and Fabry Co., SOM Archives, 6/21/1957.

Figure B.9: Architectural View No. 51 Looking N at Building. Source: Kaufmann and Fabry Co., SOM Archives, 10/30/1957.

Figure B.10: Get ready to run up "No Vacancy" sign on Inland Steel building, new stainless steel and glass structure at Dearborn and Monroe. Trying panel for size is Graydon Megan, Inland Secretary, on top of sign. Clarence Holmberg, who has been in charge of building planning, steadies Ferd Kramer, of rental agents, as he hands up board to Megan. Source: Kaufmann and Fabry Co., SOM Archives, 10/9/1957.

Figure B.11: View Looking Down between Office and Service Towers. Source: Ezra Stoller, SOM Archives, 1958.

Figure B.12: View Looking East of Inland Steel Building. Source: SOM Archives, 1958.

Figure B.13: NE View of Inland Steel Building. Source: Ezra Stoller, SOM Archives, 1958.

Figure B.14: Detail of Inland Steel Building. Source: Ezra Stoller, SOM Archives, 1958.

Figure B.15: Lobby with Richard Lippold's Radiant 1. Source: Ezra Stoller, SOM Archives, 1958.


Figure B.16: Typical Enclosed Office. Source: Hedrich Blessing, SOM Archives, 1958.


Figure B.17: Typical Corner Office. Source: Ezra Stoller, SOM Archives, 1958.

Figure B.18: Entrance to SOM. Source: Ezra Stoller, SOM Archives, 1958.


Figure B.19: Conference Room at SOM with Model and Renderings of U.S. Air Force Academy. Source: Ezra Stoller, SOM Archives, 1958.

Figure B.20: Open Office Area of SOM. Source: Ezra Stoller, SOM Archives, 1958.

Figure B.21: Partner Reception Area with Model of Chicago. Source: Ezra Stoller, SOM Archives, 1958.

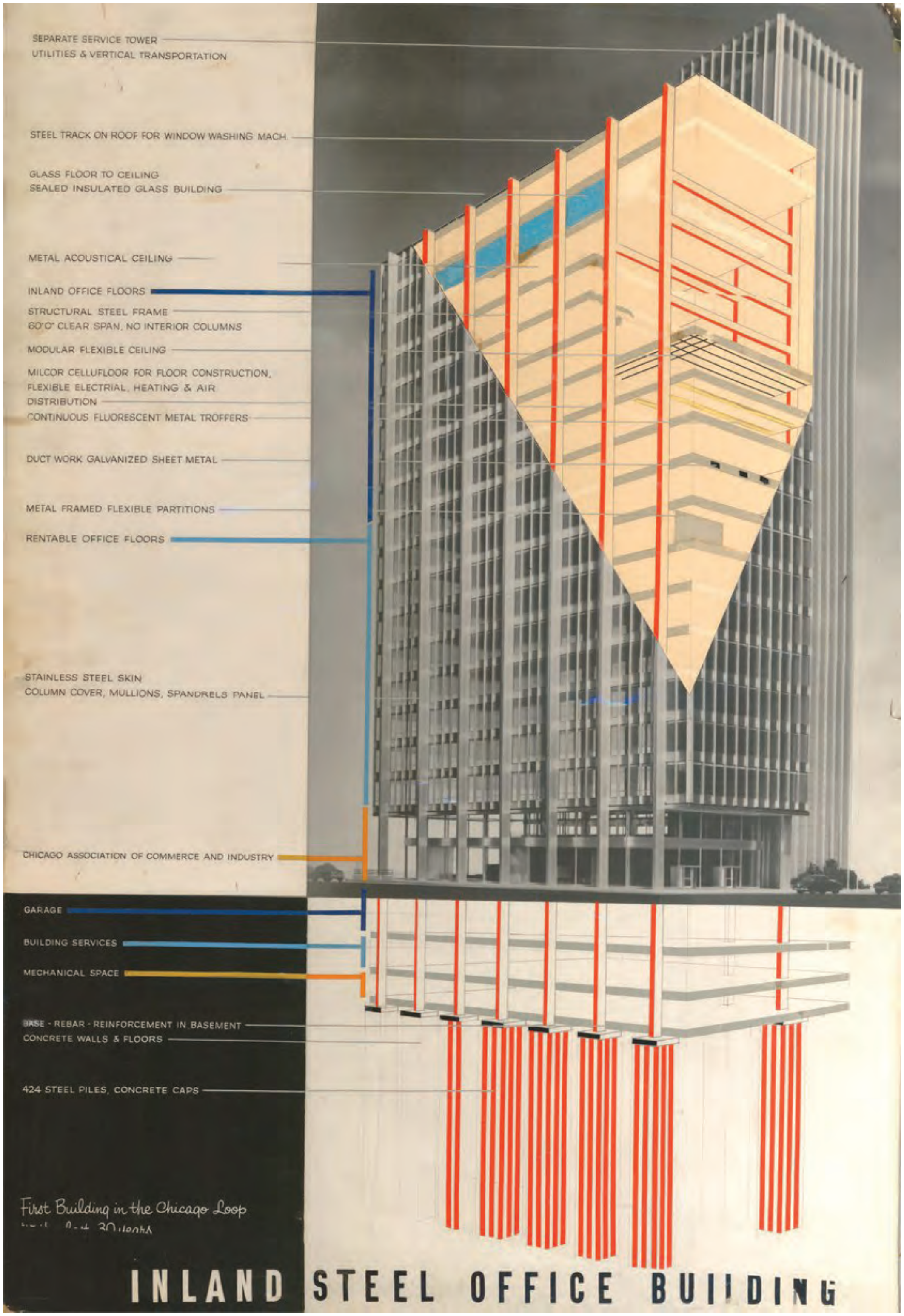


Figure B.22: Advertisement for Inland Steel Office Building. Source: SOM Archives, 1958.

Index