



H.A.B.S. - Historic American Buildings Survey and the integration of new technology

H.A.B.S. La aplicación de nuevas tecnologías para el levantamiento de edificios históricos

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ABSTRACT: This advanced drawing and research course covers the documentation guidelines for the Historic American Buildings Survey (HABS) set forth by the U.S. National Park Service. Students acquire the ability to analyze and assess historic sites for documentation, create detailed field notes, and produce measured drawings that follow national Standards for submission to the Library of Congress. They gain a fundamental knowledge of how to record historic sites that may require further study, preservation, alteration, or addition. Most recently the course has integrated digital methods of documentation in conjunction with the Center for Computational Studies, using aerial and frontal drone photography, photogrammetry, and 3D point clouds with control points and GPS referencing to expand the amount of data that can be expediently collected while on site. By overlaying the techniques they are able to assess the usefulness and complementary nature of the analog and the digital.

KEYWORDS: Historic Buildings, Measured Drawings, Point Clouds, Documentation, University of Miami, H.A.B.S

RESUMEN: Este curso avanzado de dibujo e investigación, abarca las pautas de documentación para HABS (El Levantamiento de Edificios Histórica Norteamericanos) establecida por el Servicio de Parques Nacionales de los Estados Unidos. Los estudiantes adquieren la habilidad de analizar y evaluar sitios históricos para su documentación, crear notas de campo detalladas, y producir dibujos con medidas siguiendo las normas nacionales para posteriormente ser presentados a la Biblioteca del Congreso. Obtienen un conocimiento fundamental de cómo registrar los sitios históricos que puede requerir algún estudio adicional, preservación, alteración o adición. Recientemente, el curso ha integrado métodos digitales de documentación en conjunto con el Centro de Estudios Computacionales, utilizando fotografías de drones aéreos y frontales, fotogrametría y nubes de puntos 3D con puntos de control y referencias GPS para ampliar la cantidad de datos que se pueden obtener en el terreno. Superponiendo diferentes técnicas los estudiantes serán capaces de evaluar su utilidad y la naturaleza complementaria entre lo analógico y lo digital.

PALABRAS CLAVE: Edificios Históricos, Dibujos Medidos, Nubes de Puntos, Levantamiento, Universidad de Miami, H.A.B.S

Introduction

The Historic American Buildings Survey was created in 1933 under President Franklin D. Roosevelt’s New Deal to provide much-needed work for architects, photographers, and historians, who documented America’s built environment at a key moment in modernization and nationalization. The effort provided an invaluable historical record of sociological, technological, and design development as well as art, information, and inspiration for Americans of that time and ours.

HABS was the first significant boon to historic preservation at the national level. The program field-tested many of the preservation strategies still in use today, such as surveying contextual information and the establishment of national standards for documentation. Still growing after 75 years, HABS and its affiliated engineering and landscape surveys record more than 500,000 drawings, photographs and histories for more than 41,000 historic structures and sites dating from Pre-Columbian times to the 21st-century.

At the University of Miami, the School of Architecture offers students to earn a certificate in Historic Preservation. Alongside theory and design courses devoted to the subject, the “Documentation of Historic Structures” is an advanced drawing and research course that has been offered for many years. Students acquire the ability to analyze and assess historic sites for documentation, create detailed field notes, and produce measured drawings that follow National Park Service Standards for submission to the Library of Congress. They gain a fundamental knowledge of how to record historic sites or any existing built or natural conditions that may require further study, preservation, alteration, or addition. They also acquire an understanding of urban and architectural design concepts relevant to tropical urban sites including: block structure, building typology, structural systems, spatial relationships, circulation, ventilation, massing, arrangement, composition, and assembly of building materials. (Figure 1)

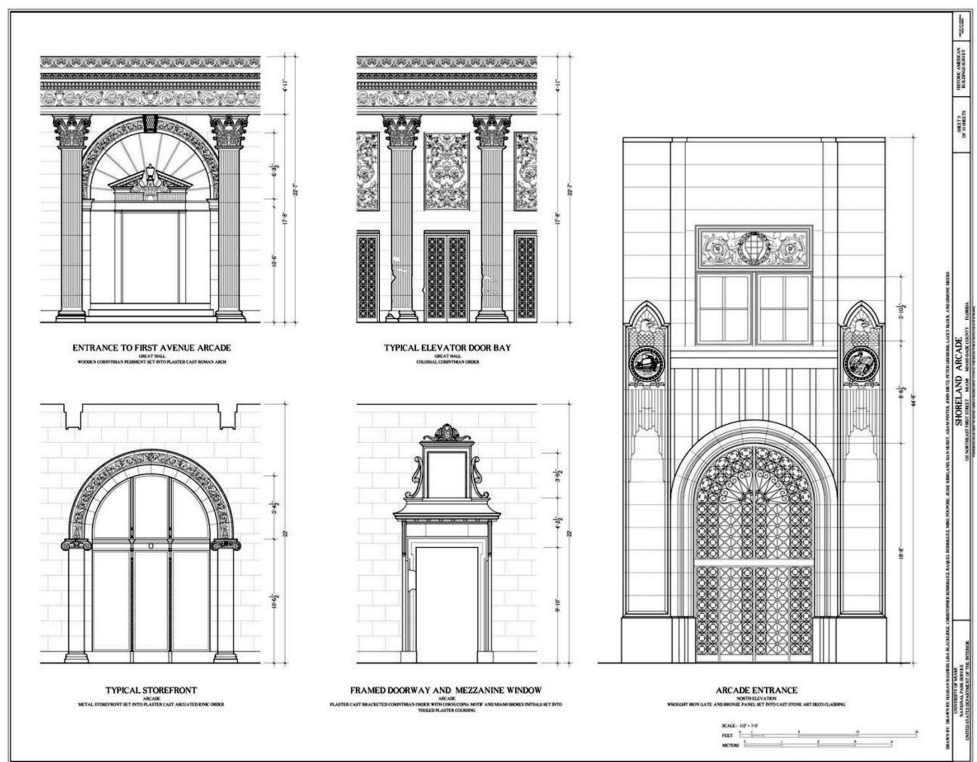


Figure 1: Shoreland Arcade, Comparison of Architectural Orders

Historic building subjects in Miami

"Priority has always been given to recording structures threatened with destruction. HABS/HAER/HALS documentation can mitigate the loss by providing permanent graphic and written records." [1] The documentation of the following buildings constitutes a portion of the work produced by students of the School of Architecture. The school has produced HABS documentation Drawings and Historical Reports for buildings that were threatened by demolition, such as St. Stephens Episcopal Church in Coconut Grove, which has already been demolished and replaced. However, these were selected as subjects for the course for a variety of other substantial reasons including: the quality of their architectural character, their historic significance to the local national building culture, and the accessibility provided by each site and its caretaker.

Shoreland Arcade

Built during the 1920's building boom in Downtown Miami, the Shoreland Arcade [2] (Fig. 1) was to be the home of the Shoreland Building Company, developer of the highly successful Venetian Islands in Biscayne Bay and Miami Shores, the garden suburb just north of Miami along the Florida East Coast Railway. The vision for the building was for a gothic inspired office tower over an eclectic pedestal which would front three sides of a block in the heart of the city. Without the corner properties, the building design cleverly yielded more valuable store frontage by integrating internal arcades through the block. This extension of the pedestrian realm extended the opportunity to shoppers to step out of the tropical sun and rain and into tall airy shaded passages, decorated with classically inspired plaster wall decorations, terrazzo floors and bronze embellishments.

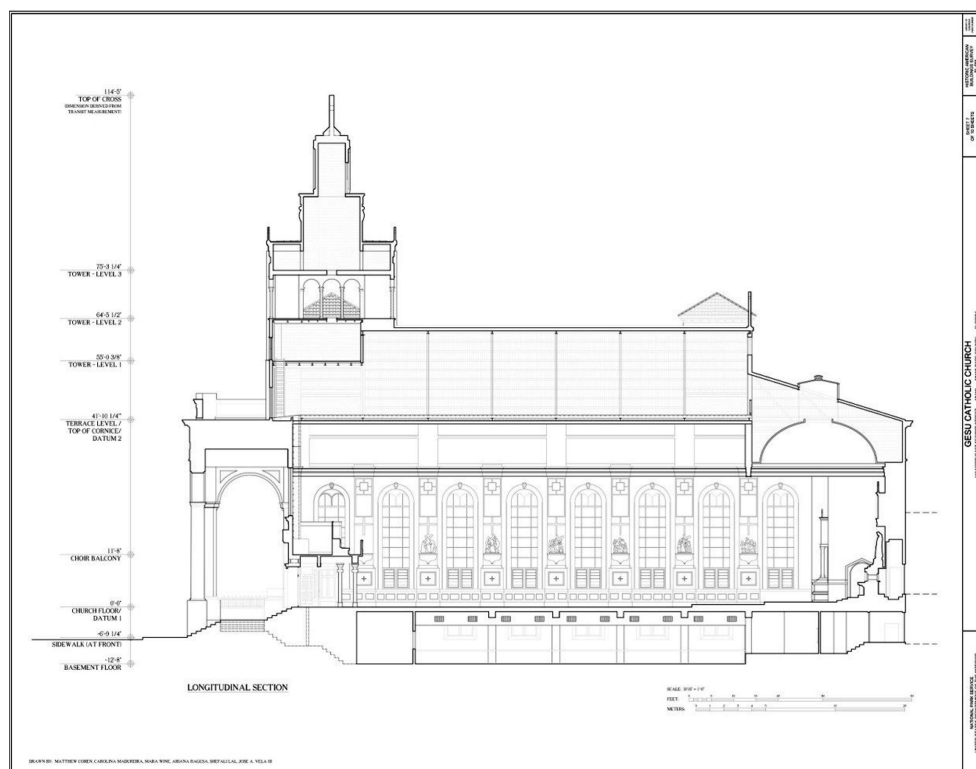
The hurricane of 1926 derailed the dreams of many Miamians. The tower of the Shoreland Arcade would never be realized leaving only the 2 story pedestal to stand. The 30,000 sf area of the upper floor was illuminated by light wells and originally generous office spaces along the double loaded corridor were subdivided into a labyrinth of small dark spaces, before being abandoned nearly 30 years ago. The grand passages and storefronts of the ground floor would be filled with only enough low-rent retail spaces to front the streets, abandoning the great interior. Only in recent years has the rebirth of the city center brought inspired some hope for the eventual renovation and completion of the building.

Gesu Catholic Church

The first Catholic Church in Miami [3] was founded in 1896, only months before the incorporation of the City itself. The first structure, a wooden building erected on a piece of property donated by Henry Flagler in Miami, was not able to accommodate the growing Catholic parish of the bustling town and by the 1920's a new larger church was built in its place. The new Gesu Church was accompanied by a palazzo style rectory and a 5-story courtyard building to house a school. The design of the church reflected the urban character of its site: pressed up to the corner of the block, setback from its neighboring building just enough to illuminate the large German-made stained glass windows, and raised half a floor to accommodate a basement. It also accommodated the growing community with a tall and wide front portico and perhaps most notably provided a large steel frame truss system to carry the roof while maintaining an interior free of columns, allowing parishners to be in full view of all five Italian marble altars.

1. Burns JA, editor. Recording Historic Structures. Second. National Park Service; 2004.
2. Historic American Buildings Survey. Shoreland Arcade, 120 Northeast First Street, Miami, Miami-Dade County, FL [Internet]. Door Details - Shoreland Arcade, 120 Northeast First Street, Miami, Miami-Dade County, FL p. 9-. Available from: <http://www.loc.gov/pictures/item/fl0738/>
Library of Congress Call Number: HABS FL-573
3. Historic American Buildings Survey. Gesu Catholic Church, 118 Northeast Second Street, Miami, Miami-Dade County, FL [Internet]. Gesu Catholic Church, 118 Northeast Second Street, Miami, Miami-Dade County, FL 2013 p. 7-. Available from: <http://www.loc.gov/pictures/item/fl0778/>
Library of Congress Call Number: HABS FL-584

The Jesuit community in Miami surged with the arrival of Cuban exiles and rejuvenated the parish although the neighborhood as a whole deteriorated as the city's suburbs expanded westward. While the school was eventually demolished, the church has been very well maintained with strong leadership at its helm, and today it serves a growing community of urban residents. (Figure 2)



4. Historic American Buildings Survey. HABS GUIDELINES - RECORDING HISTORIC STRUCTURES AND SITES WITH HABS MEASURED DRAWINGS [Internet]. HABS GUIDELINES - RECORDING HISTORIC STRUCTURES AND SITES WITH HABS MEASURED DRAWINGS 2008 p. 1-22. Available from: <https://www.nps.gov/hdp/standards/HABS/HABSDrawings.pdf>

Figure 2: Gesu Catholic Church, Building Section

Producing measured drawings – the Residency, Harbor Island, Bahamas

“HABS drawings are considered “as-built” drawings. As such, they illustrate the existing condition of a building at the time of documentation, including additions, alterations, and demolitions which have occurred since the building was first constructed. Where sufficient knowledge exists concerning the sequence of changes to a building over time, it may be useful to provide appropriate notation on the drawings. Alternatively, delineators may wish to produce additional interpretive drawings illustrating the building at an earlier date, in order to more fully explain its historic significance.” [4]

The United States Secretary of the Interior sets forth a series of Standards and Guidelines for the documentation of historic buildings to be acceptable for inclusion in the HABS Collection in the Library of Congress. The documentations may be in the form of measured drawings, large format black and white photographs, large format color transparencies, written histories, and field records. The Standards specify:

“1) Documentation shall adequately explicate and illustrate what is significant or valuable about the historic building, site, structure, or object being documented;

2) Documentation shall be prepared accurately from reliable sources with limitations clearly stated to permit independent verification of the information;

3) Documentation shall be prepared on materials that are readily reproducible, durable, and in standard sizes;

4) Documentation shall be clearly and concisely produced.” [5]

Site Assessment and Planning

Considerations have to be made for transportation whether the site is down the street, in the next town over, or in another country all together. Each building site presents unique challenges in access. If the building is in use at the time of the field work, coordination with user's schedule is essential. Our ARC 518 class took a small caravan of aircraft to North Eleuthra. From the airport, we had ground transportation provided by Mr. Finethreads, who delivered us to the nearby dock where we met Captain Duke for a water taxi east to Dunmore Town on Harbor Island where a golf cart was waiting for us.

Typical of British colonial towns in the Bahamas, the Bay Street runs parallel to the coast and perpendicular roads stretch uphill from Bay streets to a King or a High Street. In the case of the Residency, it was located on Dunmore Street overlooking the Government Dock and the Harbor. As the coast bends so does the grid of streets, resulting in wedge conditions, referred to as “jibs,” like the one just north of the site. This verandah house was built on the site of Lord Dunmore's original home in the early 1900's after standing for centuries. The former Governor of Virginia and loyalist to the Crown, Dunmore was commissioned to the Bahamas. The current building served the same function of state residence and place of government business until just a decade ago. Mr. Flowers recounted what it was like to live there when he toured the faculty and students through the property.

A focused initial assessment of the architectural elements of the building subject is a crucial step in the documentation process. “The quality of architectural documentation cannot be easily prescribed or quantified, but it derives from a process in which thoroughness of research and factual accuracy play a large part, and it acts, for better or worse, as a measure of the integrity and reliability of the information” [5]. Based on thorough on-site observations one can formulate a list of drawings that collectively describe the building in detail. These typically include a location map, site plan, floor plans, exterior elevations, building sections, doors and windows, building details, and interpretive drawings. Gathering existing documentation of the building subject may result in the discovery of a useful drawing or photograph to reference in the planning of the documentation process. Based on the amount of time allotted to the site documentation – and whether that time is compressed into a few days or stretched out over a year – one can devise a strategy to be most effective and efficient in conducting field work. The number of team members and their experience is a factor as well. In Harbor Island, we had only two full working days. The ten students had already had a brief introductory documentation exercise so they were able to be very efficient with their time and produce 20 field notes.

Field Drawings

The first drawings produced are actually loose proportional studies in sketchbook. One then lays out a larger “field note” sketch on large gridded

5. Heritage Documentation Programs.

6. HABS Standards: Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation, Federal Register [Internet]. 6. HABS Standards: Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation, Federal Register Washington DC; 2013 p. 43159–62. (139; vol. 68). Available from: https://www.nps.gov/hdp/standards/standards_regs.pdf

paper with the drawing as large as possible –to an easily referenced scale related to the grid- while leaving space around drawings for dimensions and title block (Figure 3). The subject must be legible and include enough information to draft it once off site. Identify primary dimension strings that capture the most information along accessible locations for a measuring tape to be stretched. Draw the strings, identify the measurable points on the building, and mark them on the strings. Using running dimensions, record the dimensions legibly.

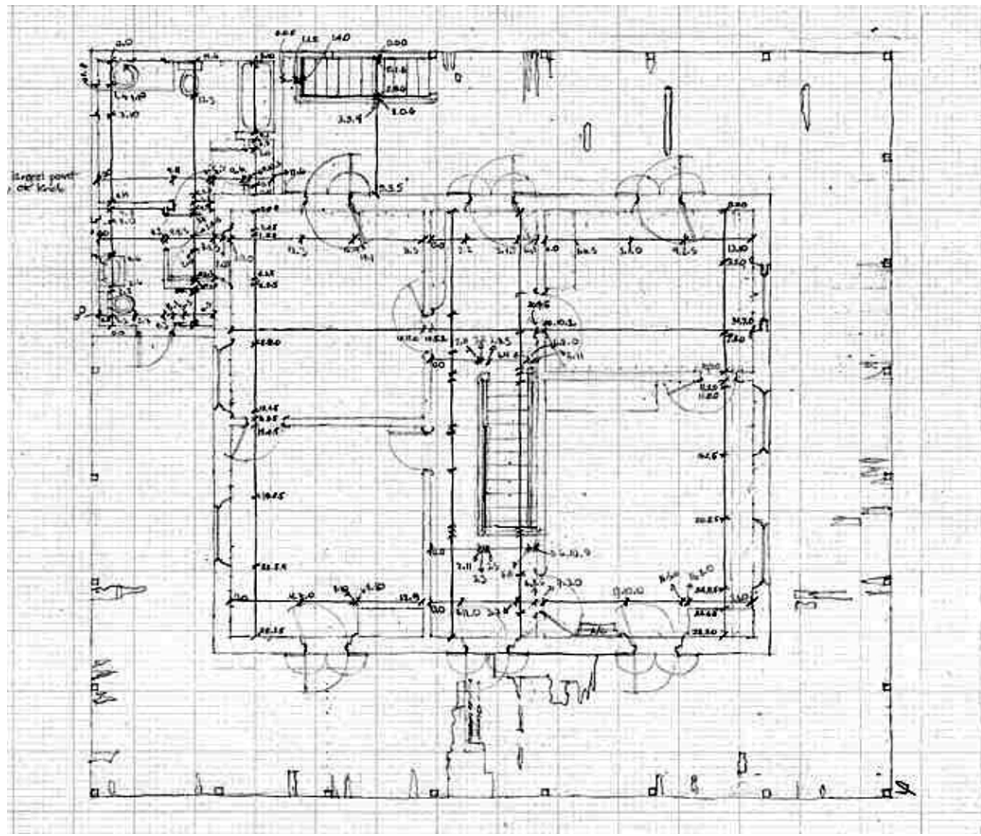


Figure 3: The Residency, Field Note of Second Floor Plan

After walking the perimeter of the site and understanding its extents one can produce a loose sketch of the site plan with approximate dimensions. Then in a field note, a more proportional sketch can be produced and major site elements can be identified and labeled, particularly for edge conditions such as fences, gates, hardscape elements, as well as the locations of major trees. Wherever possible these site elements can be dimensioned back to the corners of the primary structures and also to datum points that bay be established within the site using wooden stakes. Larger sketches may be produced as needed to better document architectural elements as required.

The floor plan of the building must also be understood generally with overall dimensions so as to lay out a field note properly. In this case a separate field note was produced to document the verandah because its dimensions would all be measured on the exterior. Another delineator worked simultaneously to document the building from the masonry walls inward through the interior. Care must be taken to properly record wall thicknesses at door and window jambs in order to ensure the alignment of one room to another. Another critical set of dimensions requiring a separate field note is the stair. It has a more intricate assembly of wood components

that are best depicted at a larger scale in plan and in section. The stair section is then expanded to include the interior elevation of the stair hall which later can be used to assemble a building section. A section through the readily accessible first floor verandah was produced to link the building interior to the exterior grade including the crawl space and foundations under the house.

Having been uninhabited for many years, and having been beaten by tropical storms and hurricanes, the building was partially inaccessible due to structural damage on the upper verandah. Extension ladders were used at each of the four corners of the house in order to access vertical dimensions at two locations for each building elevation. A datum line was established by running a level string around the perimeter of the building and marking it onto main masonry structure and wooden verandah posts. From the datum line vertical dimensions were recorded down to grade and up to the eave allowing for the irregularities in the grade elevation and in the wood structure to be recorded. (Figure 4)

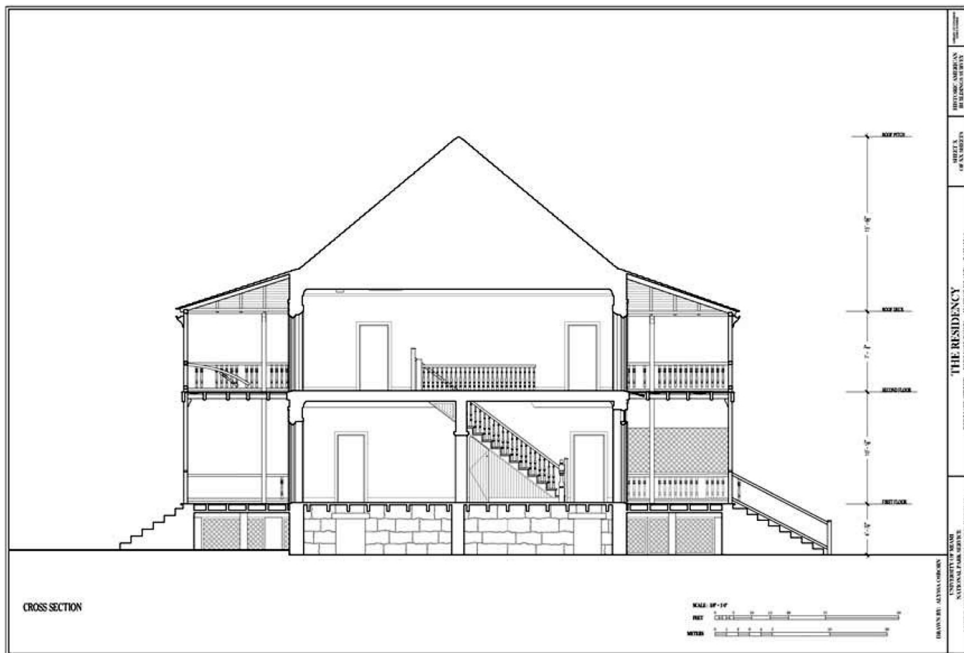


Figure 4: The Residency, Building Section Draft

Drafting, Verification, and Layout

In the process of producing the field work there are several instances where an error may occur and it is in the drafting that those errors or omission of information will become apparent. Revisiting the site or reviewing site photos may help clarify questions that arise while drafting. Especially in an Autocad environment which has an unforgiving level of precision, one must be conscious of the scale at which the drafts are to be printed and maintain an appropriate level of tolerance (Fig. 4). All the Floor Plan field notes must be drafted, joined, and reconciled before proceeding with other drawings. In model space, Elevations and Sections are to be aligned horizontally and linked by common guidelines to ensure consistency from one drawing to the other. Above and/or below each elevation and section should be a block or x-ref of the associated plans so that vertical guidelines can confirm major building components.

The HABS Guidelines [4] describe a system for laying out the sheets of drawings and organizing them sequentially. A set may begin with a cover sheet, which would be the place for a title, a brief written introduction, and an illustrative drawing. The rest of the sheets should be arranged from smallest scale to largest, beginning with the Site Plan. All Floor Plans are then arranged from the lowest floor to the highest. Elevations begin with the primary entrance of the building then either clockwise or counter-clockwise. Sections and details fill out the remaining sheets.

Integrating new technology – the Residency, continued

Over the years, the HABS standards have been adjusted to accommodate new technology. The production of digital drawings using AutoCAD is now widespread, while the printing of ink on mylar drawings continues to meet the standard for archival stability. Now with digital techniques for recording measurements becoming more widely available, the Historic Documentations Program (HDP) - which is the umbrella program containing HABS, HALS, and HAER - is building an online database of images produced using LIDAR and point clouds. In documenting the Residency on Harbor Island, this course aimed to collect data both manually and digitally, and compare the results graphically for level of accuracy. The hypothesis was that digital techniques are viable as a complement to traditional ones. (Figure 5)

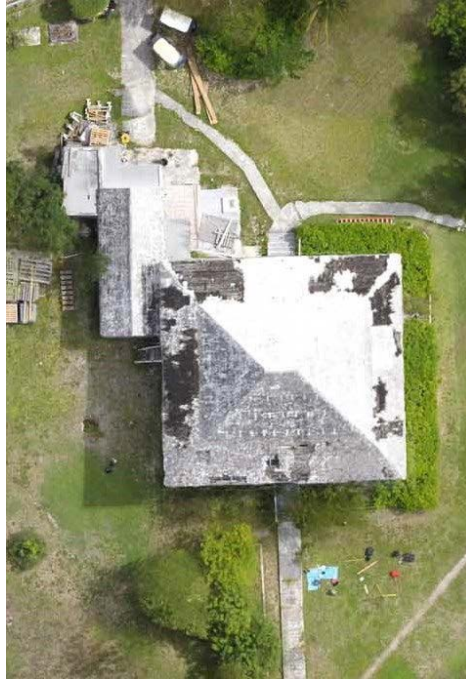


Figure 5: The Residency – Aerial photo of field work in progress

From the University of Miami Center for Computational Science, Chris Mader and Amin Sarafranz conducted the digital components of the field documentation. There were three principle objectives as part of the field work at The Residency: 1) Construct a georeferenced orthorectified photo of The Residency grounds that could be used to assist in development of the site plan; 2) Conduct a topographic survey using standard ground surveying methods (using a total station and GPS), to support the site plan, but also help in quantifying the precision and accuracy of our techniques for georeferencing the orthophoto; and 3) Creation of a high density point cloud (3d model) of The Residency (building) that could be used as drawing aid off-site (after the trip), and also to explore other possible uses of this 3d model in the context of the broader course objectives. (Figure 6)



Figure 6: Dunmore Town and the Residency, Ortho-rectified photographs at varying scales



Orthophoto

To create the orthophoto, we overflowed the site (Figures 5, 6) using a drone and gopro hero4 camera at an altitude of approximately 35 meters (above the base site elevation). The site is inclined roughly West to East and increases in elevation by about 6 meters, so the actual relative altitude varies. Upon returning to Miami, we processed the images to create an unscaled composite ortho-rectified image (orthophoto) that includes all of the site, as well as some of the surrounding structures (in order to provide context). While onsite, we also collected control points to use in georeferencing the orthophoto. The process of georeferencing the orthophoto both scales and orients the photo correctly with respect to a geospatial coordinate system (in this case WGS84). The control points were collected using a highly accurate GPS (within several centimeters of true position). (Figure 7)



Figure 7: The Residency – Site Plan with Topographic Survey Data

Topographic Survey

We conducted the topographic survey (Figure 7) using a Leica total station. ~200 survey points were collected covering the grounds and as much of the boundary (wall/fence) as was accessible. Some survey points were also selected to overlap with GPS control points and later used for quantifying the accuracy of the georeferenced photo (above).

Point Cloud

The (unscaled) dense point cloud of the building (Figure 8) was built from photos taken of the sides and top of the building using the drone. The point cloud was constructed using a computational approach called Structure from Motion. Once constructed the point cloud can be represented in standard LIDAR file formats, further exploration of its potential applications is possible. A few point cloud processing software were tested while ReCap, a software from Autodesk company, yielded the optimized result. The LIDAR data is loaded and displayed in a high quality with the full color range preserved on each point.

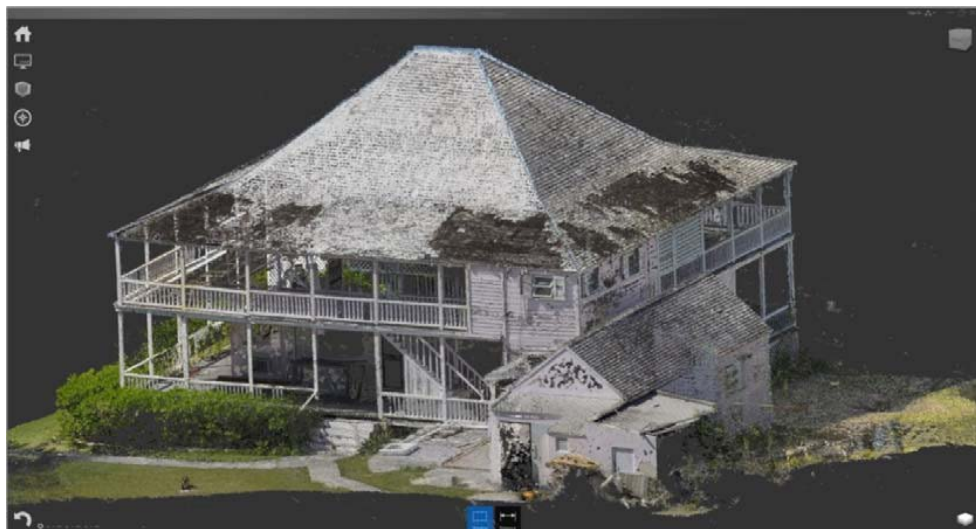


Figure 8: The Residency– Point Cloud Sample.

In an effort led by Li Yi, the point cloud was then edited using ReCap, by eliminating unnecessary elements that were not related to or even obstructing the building documentation. Elements such as trees, lawns, shrubs, clouds, sky, etc. were manually selected and deleted in order to obtain a “CLEAN” 3D model that only contained building components. Then we focused on how to rectify all four building facades according to the reference points that were collected during the on-site survey as an elevation image, with the goal of overlaying the rectified point cloud of each façade with student drawings in order to compare the survey and drawing accuracy. For this step, the point cloud, which was generated from ReCap software, was imported into AutoCAD software, rectified and exported as high-resolution raster images. (Figures 9, 10)



Figure 9: Rectified View of Point Cloud, Parallel to the Plane of Façade.

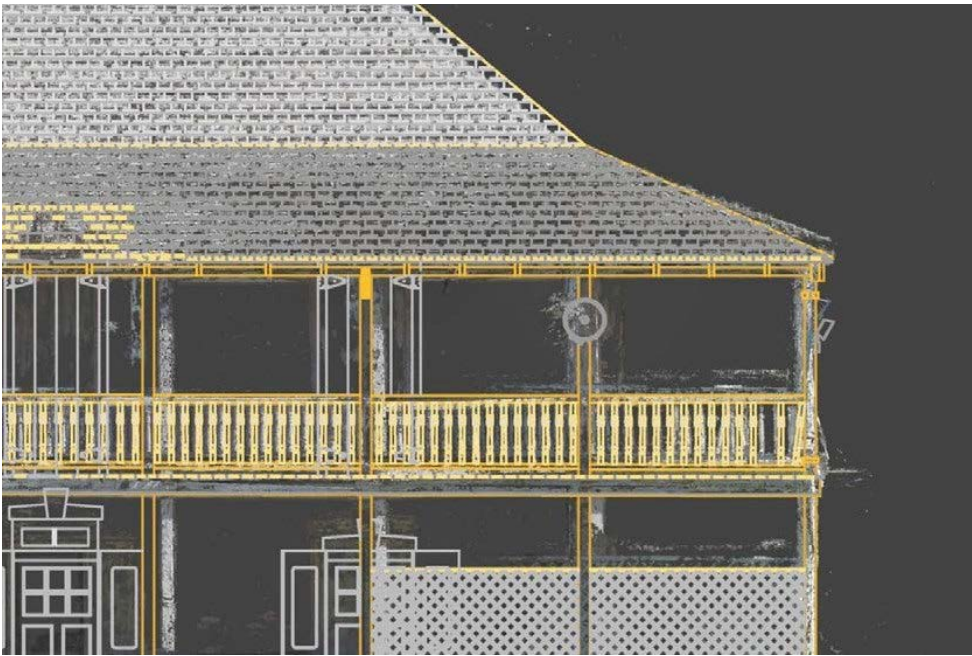


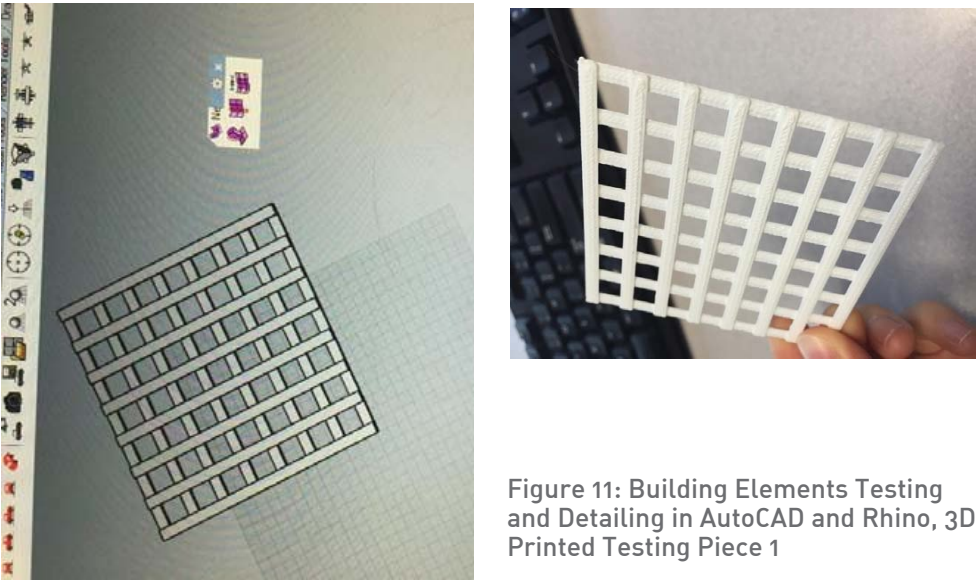
Figure 10: Overlay of Student Progress Drawing with Point Cloud.

Then, we decided to take a step forward, exploring if the point cloud can be computed in an automated algorithm to generate the 2D drawings. By utilizing another Autodesk product “Civil 3D”, we were able to reconstruct the triangular mesh surface with the point cloud via “Point Cloud to Surface” tool.

However, the above computational method requires extremely high performance from computer hardware and is very unstable. Mainly, the 3D mesh that was converted requires tremendous efforts of clean-up in order to be a workable model in the AutoCAD to be projected into a 2D surface. It is an issue that is still under resolving. As an alternative, we tested if the point cloud can be converted into mesh surfaces and printed in a 3D printer, under consideration that 3D physical model could have become another important

aspect of historic building documentation. In this stage, we investigated into a professional point cloud processing software called “MeshLab”, with its strength of various mesh creation computational algorithms in compares to only one in Civil 3D. The transforming certainly achieved better results by reconstructing the surface from point cloud with less time and lower computer hardware requirement.

While we were managed to produce the main structure of building directly from the point cloud, the details such as columns and roof textures still required manually intervention for the accuracy of the 3D printing task. As a result, we decided to adopt a hybrid method which utilized MeshLab to construct the main 3D surface while integrating AutoCAD and Rhino 3D modeling software to manually refine details. With this method, we were able to deliver 3D printed building models with high-quality. (Figure 11)



Conclusion

New technologies can substantially facilitate the documentation of historic building and places. 2D and 3D imagery can be produced more quickly and more economically than ever before. With access to global positioning systems, with powerful processing software, and with readily available hardware a tremendous amount of data can be captured and formatted into usable applications.

However, these new technologies do not replace the traditional methods of recording historic structures. Not only is the archival stability of digital data uncertain, it does not come close to the expected 500-year stability of physical drawings produced with ink on mylar. They also are limited by the inability to understand or process the architectural composition of the building subject the way the human mind can. While a drone mounted camera can collect millions of pixels in high resolution, it does not extract a floor plan or a ceiling plan, nor cut a section. It may approximate an elevation with frontal photography but it does not provide large-scale detail drawings or any of the two dimensional drawings used in construction –or used in the documentation of existing buildings. The documentation process

still requires that a person observe, analyze, and compose drawings that accurately and thoroughly capture the architectural characteristics of a building. Furthermore, it becomes apparent that the process must continue to involve architects, the very people who use 2d drawings to design buildings, in order to adequately document a building in plan, section, and elevation.

The conclusion, therefore, is that working with new technology, the architect is able to integrate new tools into a traditional process. Certainly, high resolution ortho-photos, topographic surveys, and point clouds complement the set of information to be captured manually. And if that data can be archived in a reliably stable format, perhaps those tools can be deployed more broadly. Like Nolli's plan of Rome, which documents the city's form at both an urban and an architectural scale, perhaps these new tools will facilitate the documentation of entire streets, neighborhoods, or cities. Perhaps it is the proper management of data and a proper interface that will allow access to multiple scales of drawings and multiple types of media in a regularly updated structure that will be most valuable to the management, to the preservation, and continuous renewal of our cities.

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Este artículo fue presentado en el evento Medioambiente Construido y Desarrollo Sustentable, MACDES, que tuvo lugar en noviembre de 2016 en el Palacio de Convenciones de La Habana, como parte de la 18 Convención Científica de Ingeniería y Arquitectura, de la Universidad Tecnológica de La Habana José Antonio Echeverría, Cujae. Teniendo en cuenta que el tema abordado en el artículo sirve como complemento de los problemas que se tratan en este número, el equipo editorial, previa aprobación de sus autores, decidió incluirlo.



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