INDIANA ARCHITECTURE X 3D: ARCHIVAL ENCOUNTERS OF THE 3-D KIND

BY CAROL STREET

The original architectural drawing (1891) for the Wysor Grand Opera House appears on the left, and the 3-D model (2014) on the right. Drawings + Documents Archive.

ABSTRACT: 3-D modeling and printing within the archives setting offer new tools for archivists to interpret collections and provide innovative avenues of outreach to many types of audiences. This article explores the recent initiative to invigorate architectural records collections at Ball State University's Drawings + Documents Archive using rapid prototyping skills already employed by students in the College of Architecture and Planning. Transforming the information on nineteenth-century drawings using twenty-first-century technology creates a new level of interest and engagement in the archival collections among students, faculty, researchers, and casual visitors.

Introduction

While the substantial hurdles of 3-D printing are difficult to overcome—such as the equipment costs for high-quality printers and printing materials, as well as the time and technological skills required—it is possible for many archives to approach 3-D printing on a modest budget and garner big results. Such is the case at the Drawings + Documents Archive at Ball State University, where staff recently completed a pilot project to reproduce a three-dimensional model of a building and many of its details from original architectural drawings from the late nineteenth century. The project is called Indiana Architecture X 3D (IAX3D), and it was made possible through key

partners at the University Libraries, the College of Architecture and Planning, and the Department of Architecture who graciously allowed access to expensive printers, graduate assistants with the knowledge to produce 3-D models, and an online platform to make the information available worldwide.[3] These partnerships allowed the archives staff to pursue this project on a budget of less than $300.

While the 3-D prints based on the collections are compelling products and contemporary artifacts in their own right, it should be made clear that the main emphasis throughout the project has been on the original archival drawings. The intention of the project was never to supplant the drawings, but to support them and generate a new level of interest among patrons. The prints serve as outreach tools to enhance and add value to the original drawings largely because they engage and inspire our students and other researchers to learn more about the buildings and the ideas they represent. In addition to the physical 3-D prints available in the archives, the University Libraries' Digital Media Repository hosts an online collection of 3-D renderings of each piece that are easy to manipulate with a computer mouse, as well as 3-D print files available for download for patrons to print on their own printers.[4]

The Drawings + Documents Archive

The Drawings + Documents Archive, physically located in the Ball State University College of Architecture and Planning, collects records documenting architecture, landscape architecture, historic preservation, and urban planning from sites and structures throughout the state of Indiana. These records include architectural working drawings, presentation drawings, landscape plans, project files, photographs, specification books, trade catalogs, and models. The primary patrons within the university community are undergraduate and graduate students in architecture, landscape architecture, historic preservation, and urban planning, as well as faculty and alumni. The collection also draws many patrons from outside the university, including architects, landscape architects, home owners, historians, and historic preservationists in the state of Indiana.

Both general introductory sessions and specific embedded classroom projects facilitate use of the archives' resources by College of Architecture and Planning undergraduate- and graduate-level students. In the introductory sessions, students are shown a rotating selection of the archives' "greatest hits." These are beautiful, full-color presentation boards and construction drawings skillfully hand drawn on paper or linen drafting cloth by some of the greatest Indiana architects of the nineteenth and twentieth centuries. For a few moments, museum-quality drawings lie before the students, ready and waiting for close examination and discussion. However, it became obvious during these introductory sessions that some students had difficulty connecting with the drawings and often appeared indifferent to them, despite their obviously keen interest in the built environment.

Certainly not every student seemed disconnected during archives sessions, but the number of uninterested students was significant enough to notice. These students lingered at the back of the group and had a difficult time tearing themselves away from their smart phones. One student even brazenly left her earbuds in with the music loud

enough for others to hear, and another sent text messages a few feet from the archivist leading the session. These students clearly belonged to a section of the student population that couldn't be reached by further explanation about the importance of the drawings or by pointing out examples of skillful line drawing. As with many students in the college, these students generally tended to be creative, visual learners comfortable with technology. They may have little to no experience in drawing by hand or reading construction drawings at the time they come to the archives. For students whose creativity is largely expressed in a digital format, perhaps the drawings seemed to them to be what many archivists fear–old, quaint, and irrelevant. With each introductory session, it became increasingly apparent that we needed to find a better way for these students to connect with the drawings in the collection.

All undergraduate students in the College of Architecture and Planning begin their education with a shared first-year program before they choose whether to go into architecture, landscape architecture, or planning.[5] During this first year, they are exposed to all the disciplines in the college and taught how to draw and perceive space. It is their only year dedicated to the fundamentals of drawing and sketching.[6] Computer-aided design and drafting (CAD) comes later, in their discipline-specific courses, and then drawing quickly figures less prominently in their coursework. Some students discontinue drawing altogether at this point, while others who enjoy it and have honed their skills continue to add some hand drawings into their presentations. However, most student work at this point is digital. Students are required to become proficient in CAD programs such as Rhino, Revit, and Illustrator, and also in using the fabrication lab equipment, such as the 3-D printer, the router, and now even robots, to create rapid prototypes of their CAD designs. The computer programs and technological tools are clearly vital to their academic success, as well as their future careers, so it is fairly easy to construe how students without an inherent interest in history might not see the value in visiting the archives.

"Meet Them Where They Are"

The teaching philosophy of "meet them where they are" applies to a wide range of issues outside of the archives, but it also resonates when working with many different kinds of archives patrons.[7] For those unfamiliar with this philosophy, it simply means what it says: discover the patron's abilities and knowledge as it relates to the topic and work from his or her current base of knowledge. Some patrons may be familiar with archival research and embrace the process; others may have just walked into their first archives and have no idea where to begin. Just as a French language teacher can't expect her students to speak fluently without first learning vocabulary words and sentence construction, archivists can't expect patrons to be literate in primary sources without learning the basics. The reference interview is the opportunity for an archivist to assess the research inquiry and the patron's comfort level with archival research. Once that has been ascertained, the archivist decides whether to send the patron off to begin the search for records or to educate him or her through each step of the process. It's

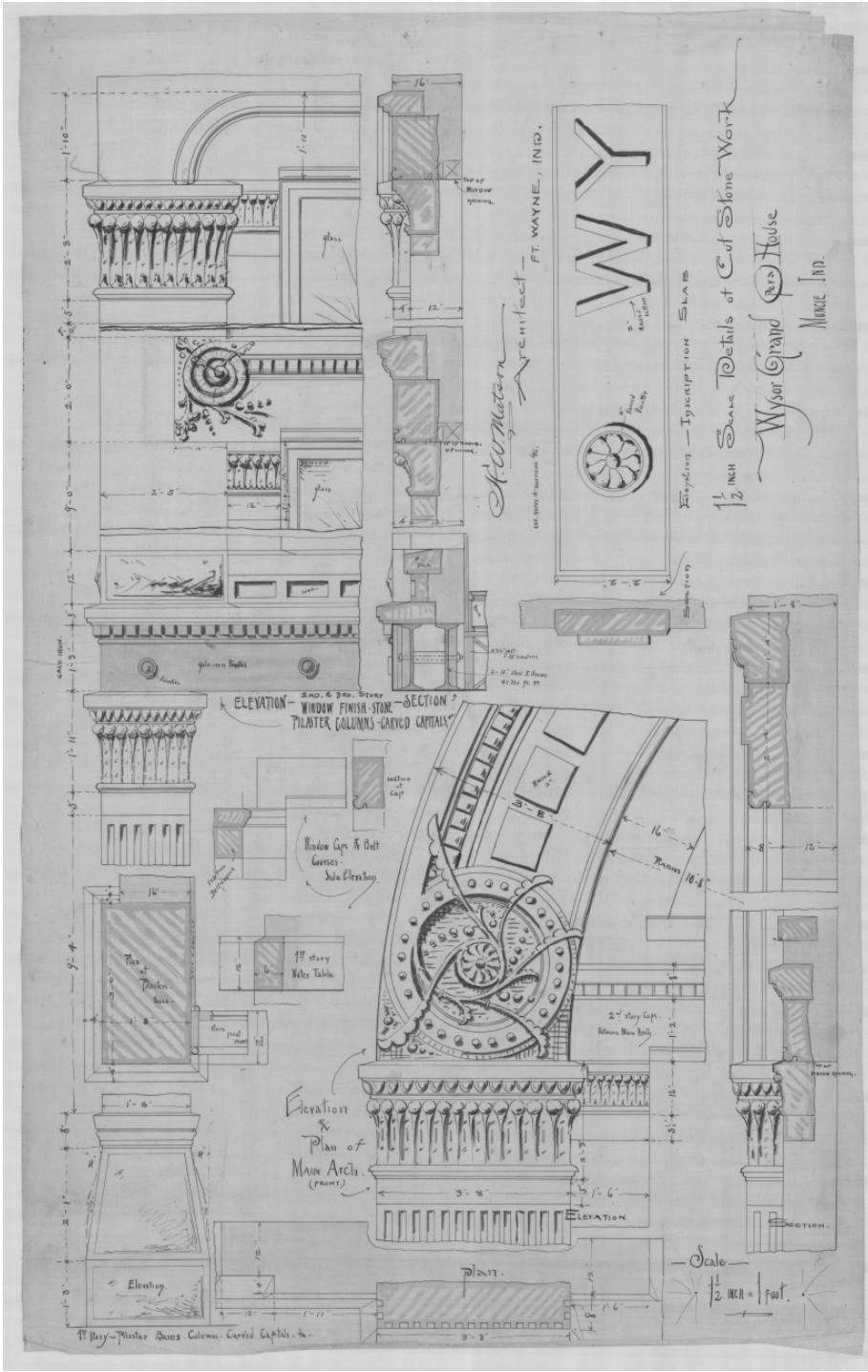
certainly not a new philosophy or one limited to the fields of archives or librarianship, but it is an effective way to provide reference.

Applying the same philosophy of "meet them where they are" to undergraduate and graduate students in the design fields involved taking a closer look at their course curricula, attending class juries and presentations, and talking with the faculty across the disciplines. To help make the archives' collections more relevant to a larger percentage of these students, it became clear we should use the same technologies they currently use or aspire to use. With all of the capabilities and buzz surrounding 3-D printing, it seemed like a natural tool to use to interpret historical drawings. The only barriers in the way were not having the requisite technological skills, time, or a large budget.

The barriers seemed insurmountable until the archives received its first graduate assistant from the Architecture Department. Austin Pontius, a first-year graduate student in architecture who had just earned his bachelor's degree in architecture at Ball State University, received his assignment to work in the archives in the fall of 2013. He brought with him the technological skills necessary to do the work and, at an assignment of 20 hours per week of work in the archives, he also had the time to do it. Pontius was scheduled to leave for an internship in the spring semester, but another architecture graduate assistant, Chris Hinders, would take his place. The budget, while important, became a minor issue because the college owned a 3-D printer and planned to charge the archives only for the cost of materials used to make each print. While the archives was able to use the college's $30,000 printer, the 3-D prints ultimately cost the archives a mere $13 to $25 each. We then had two semesters worth of skills, time, and funds to begin our first project. Now staff needed to choose the first set of drawings to prototype out of the thousands of drawings in the collection.

Selection turned out to be the easiest part of this endeavor. One set of drawings that often finds its way into class sessions is the beautiful collection of Wysor Grand Opera House drawings. Built in 1891, this impressive Romanesque Revival theater exemplified the architectural exuberance of gas boom–era Muncie, Indiana, where Ball State University is located. The city grew dramatically after the Ball Brothers Company, responsible for the iconic glass canning jars still used today, was lured to Muncie in 1887 to take advantage of an abundance of natural gas in the area. Other manufacturers followed, and Muncie quickly became a prosperous, fashionable city in the middle of a building boom.

Facing page: This Wysor Grand Opera House detail sheet, 1891, displays an artistry rarely seen in modern drawings. Kibele and Garrard Architectural Drawings, Drawings + Documents Archive, Ball State University.


Wysor Grand Opera House
Muncie Ind.
1½ Inch Scale Details of Cut Stone Work
Hartman Architect Ft. Wayne, Ind.
Elevation — Inscription Slab
Section
ELEVATION — 2nd. & 3rd. Story Window Finish-Stone — SECTION
Pilaster Columns-Carved Capitals
Window Caps & Belt Courses-Side Elevation
1st story Water Table
Elevation & Plan of Main Arch (front)
Elevation
Plan
Section
Scale 1½ Inch = 1 Foot.
1st Story-Pilaster Bases. Column-Carved Capitals-&c.

Of all the extraordinary buildings built in the city during this time, the Wysor Grand Opera House was considered one of the finest.[8] Located in the heart of downtown, this stately, three-story opera house featured a prominent limestone arch and columns along the front brick façade and intricate wrought iron details throughout the interior and along the exterior porticos. Commercial store spaces flanked each side of the impressive entrance to the theater.

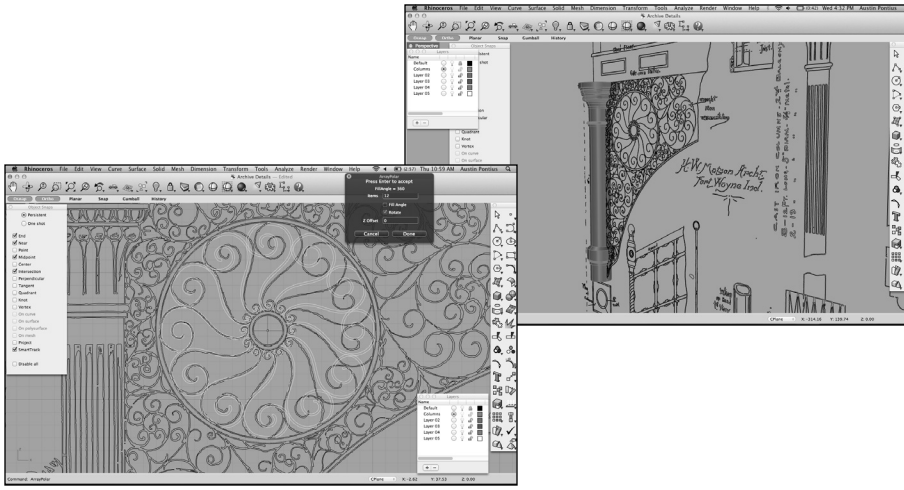
The Wysor Grand Opera House provided an extraordinary venue that attracted a wide variety of entertainment to Muncie from its dedication in 1892, when it opened with Shakespeare's *Richard III.* Harry Houdini, Pavlova, Al Jolson, Sophie Tucker, and John Philip Sousa all graced the Wysor's stage at some point.[9] Owners of the Wysor Grand Opera House adapted to the twentieth century by converting it to a motion picture theater in the 1920s.[10] However, the later popularity of the multiplex theater on the outskirts of town and the demand for convenient downtown parking led to the building's demolition in 1963 to create a parking lot.[11] Its fortunes and ultimate fall parallel the boom-and-bust periods of the city, a former factory town in the Rust Belt. Given the building's interesting history and the opportunities it affords to discuss numerous architectural, cultural, and social issues related to the disciplines in the college, it seemed like the ideal candidate for the inaugural 3-D printing project.

The drawings themselves are extraordinary examples of architectural drawings from the late nineteenth century. Drawn by architect Harry W. Matson, who was well known for his many hours spent working at the drafting table, the drawings display an artistry rarely seen in modern architectural renderings.[12] Matson was based in Fort Wayne, Indiana, and designed numerous opera houses across Indiana, but the Wysor Grand Opera House was his last and likely greatest creation.[13]

Building the 3-D Models

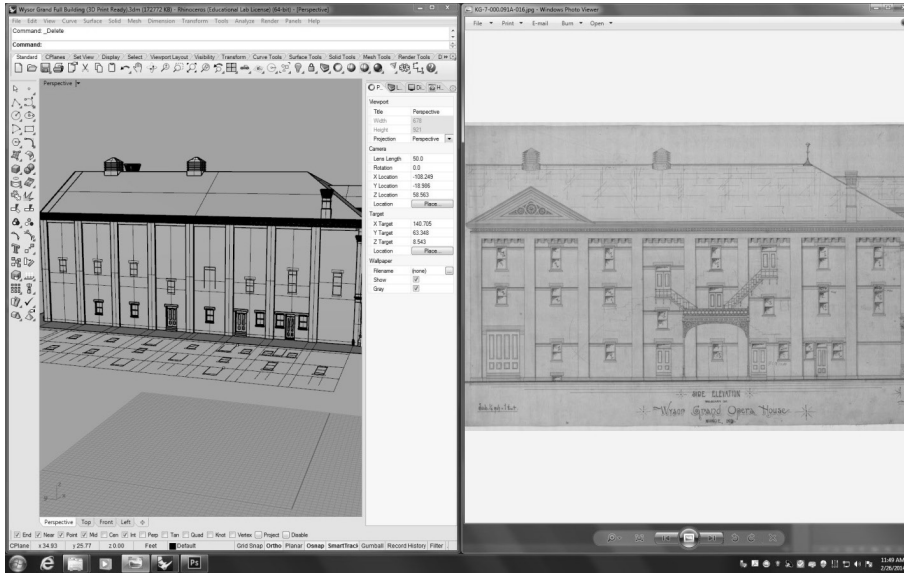
To begin the process of making 3-D prints, the original drawings were first scanned as TIFF files with a resolution of 300 pixels per inch in 24-bit color. The University Libraries uses the Colortrac SmartLF Gx+ T56, which is a roll scanner that physically moves an item through the scanner. It can accommodate drawings up to 42 inches wide of virtually endless length. The size makes this type of scanner desirable for scanning construction plans, but the drawings must be shielded from the friction caused by their movement through the scanner. A long sheet of six mil polyester can be folded in half to create an envelope that effectively surrounds a drawing as it moves through the process, thereby ensuring its safety.[14]

The scans were then imported into the design program Rhino and used to create an image underlay and baseline.[15] Rhino is a computer program well known to architecture students, including the graduate assistants working on the project, so their only learning curve was in perfecting their techniques for some of the complicated shapes and intricate details of the Wysor Grand Opera House. [16]



These screen captures were taken during the process of creating the 3-D models in Rhino. Images by Austin Pontius.

In Rhino, the image in the underlay was traced, which created vector lines needed to create volumes and surfaces to give it three dimensions.[17] The online guides *Preparing Rhino Files for 3D Printing* and *ZCorp Architecture Design Guide,* the latter written specifically for the printer used, were particularly helpful when troubleshooting unexpected glitches with the files.[18]



This screenshot shows the west façade being built in Rhino, with original drawing on the right for comparison. Image by Chris Hinders.

After completion, the working file (3DM) created in Rhino was converted to a stereolithography file (STL), a standard file format for rapid prototyping. This file format creates a mesh layer over the object, which must be solid with no open or unconnected seams. If any raw edges are present, they must be fixed before the object can be printed. In essence, the model must be considered "watertight."[19]

Different types of 3-D printers and kinds of materials are used to create 3-D prints. Some printers extrude plastic or resin to create shapes, and others build the print layer by layer.[20] Still others print metal, acrylic, and glass; not to mention the important work being done in the medical fields with biocompatible materials.[21] The College of Architecture and Planning's ProJet 450 printer by Z Corporation builds an object by layering a proprietary composite powder called VisiJet®PXL, which is approximately 85 percent calcium sulfate hemihydrate (commonly referred to as gypsum or plaster of Paris), at a vertical build speed of .9 inch per hour.[22] This powder can have color added to it via a color toner cartridge, but we chose to print in white to highlight the form of each object without the distraction of color. The print bed volume is 8 x 10 x 8 inches, which means no single print can be larger than that size. Numerous smaller projects can be printed at the same time, up to the volume of the build bed. The printing process is fairly lengthy, depending on the size of the object and whether other objects are being printed at the same time. Our typical workflow allows us to run the prints overnight, and they are ready for excavation the next day.

The finished build bed appears to be a smooth tray of powder, much like fresh snow on an empty field. Excavating the objects from the build bed involves using large brushes and a suction tube to remove unused powder from the solid objects. The base platform for the build bed can be raised and lowered to accommodate powder removal from around the objects so that they can be safely moved. At this stage, the goal is to remove large sections of powder in the negative space created by the use of the powder. The unused powder is recycled back into the printer for future use.

The final traces of powder are removed during the postprocessing phase. Photo by Austin Pontius.

Within the printer, but separate from the build chamber where the print is made, is the postprocessing unit for final and complete powder removal. Once the majority of powder has been removed from the surface of the print in the build bed, it is moved to the postprocessing unit.[23] This area has a perforated floor and a small air hose to gently blast away the final lingering traces of powder. In addition to the compressed air, smaller brushes are also used to dislodge stubborn powder. For safety, a glass hood over the work area protects the operator against breathing fine powder particles; one manipulates the piece via arm holes in the glass. Throughout this process, the print is rather delicate until the final step to harden it.

The lab uses two methods for hardening, although there are others.[24] One choice is to use a hot wax–dipping process that works well on simple designs but tends to obscure some of the fine details, and the other is a propriety resin called StrengthMax produced by Z Corporation, the maker of the printer.[25] Students typically use the hot wax method because it is more economical; however, the archives staff prefer StrengthMax for its durability and unobtrusive finish.[26] While the wax tends to remain on the surface of the print, StrengthMax penetrates the print more effectively. The print is fully dipped into the resin and removed after a few seconds. Goggles and gloves are worn for safety during this stage of the process. The print is then placed on parchment paper to dry for a few hours. After it dries completely, it can be handled normally.

At this stage, the 3-D prints are treated nearly like any other item in the collection. They are cataloged, secured in appropriate archival housing, and utilized in class sessions. The prints are stored much like small models or other objects in the collection, in oversize archival boxes with sheets of foam padding underneath and individually cut foam padding for each print to prevent contact with the other prints in the box. However, they have the distinct difference of being replicable, unlike anything else in the collection. While touching the 1891 ink-on-linen drawings is not encouraged in the class session, handling of the 3-D prints is absolutely encouraged. The prints can also be taken outside of the archives for presentations. These particular prints traveled to Kansas City for a presentation at the 2014 Midwest Archives Conference (MAC), a trip they would not have taken if they were irreplaceable objects.

Creating a Web Portal

The leader in providing 3-D file content is the Smithsonian Museum and its Smithsonian X 3D (SIx3D) initiative that supports all 19 museums, 9 research centers, and the National Zoo.[27] The project is still in its beta phase, but it has already produced downloadable 3-D print files of Abraham Lincoln's life mask from the National Portrait Gallery as well as a graceful *Embreea* orchid from the Smithsonian Gardens. For scans that are too large to print, such as the Liang Bua Cave laser scans, the site offers high resolution, 3-D model image downloads. Staff at the Drawings + Documents Archive became aware of SIx3D after the Wysor Grand Opera House modeling project was well underway and decided to model elements of the project after it, including the name.

Smithsonian X 3D has its own separate website with tours, downloads, and pages for educators to utilize in conjunction with the 3-D prints. The project also has a

$350,000 annual budget and corporate sponsors, and it intends to raise $15 million to build a new innovation center on the National Mall.[28] Clearly this is well above the average archives' budget and dramatically surpasses the Drawings + Documents Archive's minimal budget for this project. Using SIx3D as a model, we still needed to use workflows already in place without buying additional equipment or programs.

Ball State University Libraries uses CONTENTdm management software for all of the online collections in the institution's Digital Media Repository. To streamline access to content in a platform already familiar to our patrons, we needed to use CONTENTdm for IAX3D too. The scope of the collection and working with 3DM and OBJ file types were unfamiliar territory for most in the University Libraries' Metadata and Digital Initiatives and Library Information Technology Services Departments; however, everyone's enthusiasm for the project soon led to results.

The three main components of the online IAX3D collection items are the print-ready files that can be downloaded directly from the site, the 3-D image that can be manipulated with the click of the mouse, and the still image of the original Wysor Grand Opera House drawing for comparison. The latter is a straight-forward JPG file, already available in the Kibele and Garrard Architectural Records online collection. The downloadable print-ready files are 3DM files stored in an online share designated for the project. They appear as a link within the metadata field titled "3-D Print-Ready File (.3dm)" at the top of the metadata fields. These 3DM files are useful for people who are planning to print the file on a 3-D printer, but the average user will not have the correct software needed to view these files. Therefore, it was vital to include a file type accessible enough for most people to view the 3-D object. Under the guidance of Robert Seaton, the University Libraries' emerging technologies analyst, we saved the 3DM files as OBJ files and embedded them in the viewing area using a Javascript called three.js. This file format supports 3-D graphics and can be opened with updated versions of Internet Explorer, Chrome, and Firefox, making it accessible to most users. For performance and security purposes, OBJ files are hosted on a separate server and only include the viewer as an iframe in the CONTENTdm page.[29] These files allow the viewer to enlarge the graphic, rotate it 360 degrees, and move it to best fit the screen, all with the click of the computer mouse. The end result is a new type of content in a digital collection format already utilized by our audience and staff.

Archival Preservation

Archiving the 3-D model file formats brings up issues common to archivists managing other born-digital materials, but particularly architectural collections of the late twentieth and early twenty-first centuries. Currently, the archives' print-ready files are being stored as 3DM files on the Digital Media Repository server and the archives' server, but we are exploring the idea of converting files to an interchangeable and easily preserved format for future storage. At this stage, there are options, such as PDF/e, U3D, STEP, and E57, although there is no clear answer or published standard for architectural archives, and digital preservation archivists continue to search for solutions.[30]

Outreach

The heart of this project lies in the interest it generates from students, faculty, and other researchers. From the dean of the college to a first-year undergraduate, the physical re-creation of a long-lost building combined with the novelty of 3-D printing elicit an enthusiasm not typically seen for archival materials. The fact that these drawings and subsequent prints are more detailed than anything the students tend to produce also adds to their allure.

And what about the students who have a difficult time connecting with the drawings? The ones who lingered in the back of the class and didn't think the archivist noticed they were on their phones are the same ones who now put their phones in their pockets and sidle up to the table as soon as the archivist brings out the 3-D prints. They understand and value the work involved in creating the 3-D models and that appreciation then tends to extend to the drawings themselves. Students pick up the models, marvel at details such as the thin arc of the gas lamp on the staircase or the intricacies of the wrought iron decoration on the column. Then they match the 3-D prints to their 2-D counterparts to check on the accuracy of the print compared to the drawings.

They also ask questions and pass the prints among themselves, generating discussions ranging from how they were made to bigger issues of architectural design, preservation, and urban planning. The students quickly want to learn more about the building. They become invested in the structure, which is important when bringing up issues of historic preservation and adaptive reuse, and they are saddened to discover that the building has been torn down to create, of all things, a parking lot. The discussion often organically turns to issues of urban renewal, changes in building trades over the centuries, and the development of the city of Muncie. The conversations often end with laments over the loss of a beautiful structure and a better understanding of historic preservation. Their engagement with the objects and participation in the discussion help cement in their minds the archives as a place for ideas, research, and discoveries.

This is certainly not meant to espouse 3-D printing as a panacea that will inspire all students to immediately and enthusiastically embrace working with archival materials. It is still merely a tool for interpretation and participation meant to engage our users, much like any other outreach tool we currently use. In the end, the drawings are still the truest connection to our lost architecture. Throughout this process, staff has never wavered from the conviction that "it's all about the drawings," because the prints and online collection cannot stand on their own. Without the original drawings, the prints themselves are little more than nifty paperweights.

However, in our experience working with these same drawings, the 3-D prints prompt far more interesting and engaging conversations among the students than ever before. The students are perhaps more comfortable interacting with technology they can touch and relate to their sphere of knowledge. It's also a relatively new innovation that is still exciting and fresh to a generation grown accustomed to technological advances throughout their lives.

The IAX3D project also appeals to the archives' patron groups. The faculty, alumni, and working architects, landscape architects, and preservationists are often equally as enchanted as the freshman students when they pick up one of the prints. This group

tends to appreciate the drawings already because they spent countless hours at the drafting table learning to draw and often still carry on the tradition in their own practices. Their interest in the models has more to do with marveling at the innovations and how much model-making has changed through the years.

IAX3D continues to evolve. Current projects underway involve modeling a Baltimore through-truss bridge built by the Indiana Bridge Company in 1891, the Indiana State Library built by architects Pierre and Wright, and the former Negro League baseball stadium, also built by Pierre and Wright, that was recently converted into condos. All of these diverse projects create challenges and opportunities for interpretation via 3-D modeling. The bridge was specifically chosen for its steel pin–connected construction that allows for printing it in individual pieces. Students have the opportunity to piece together elements of the bridge by reading the original 1891 engineering drawings. It is, essentially, a puzzle activity that helps them learn to read engineering drawings and understand historic bridge construction.

As it changes through gained experience and use, it is worth noting how the project affects the archives. Once an overlooked aspect of the college tour given to prospective high school students, as well as younger elementary and middle school groups, the archives now features prominently on the tours. Student groups typically visit the archives after the fabrication lab, where they see the 3-D printer, routers, robot, and other prototyping equipment, and before they go into the class studios. For most of these visitors, this is their first foray into an archives, and the staff wants them to have a great experience.

Fifth graders assemble a 3-D printed bridge truss pin construction modeled after an 1891 drawing from the Indiana Bridge Company. Drawings collection at the Drawings + Documents Archive. Photo by Carol Street.

Because these tours often arrive with little advance notice, having the 3-D prints enables staff to quickly assemble a few objects that will immediately capture interest and provide a launching pad for a wide range of discovery, depending on the age of the group. A small group of fifth graders was the first class to engage the bridge prints. The students quickly grasped the concept and immediately began working collaboratively to put the bridge together. Discussions ranged from the practical "I think this piece goes there" to why that piece would go there—for strength or connection. From an architecture graduate student leading the group, the young students learned about engineering and weight loads necessary for bridges to support trains, cars, and people over a length of space.

For a recent class of 25 second graders, the 3-D prints were the basis of a matching game in which students linked the prints to the objects in the drawings. The prints supported a discussion of the featured architectural elements. Staff held the objects so the entire class could see them, and the children enthusiastically talked about what they recognized in the prints and learned architectural terms such as *column, window casing, rosette,* and *façade*. But, perhaps even more important, they learned to feel comfortable in the archives space. Positive, early introductions to archives create a strong foundation on which students can build research experience as they grow in their educational careers.

While the collections at the Drawings + Documents Archive pertain to specialized areas of study that already utilize 3-D technologies for rapid prototyping, the possibilities exist for other institutions with very different types of archival collections to leverage this utility. Using photogrammetry or 3-D scanners to replicate 3-D objects, such as those that are particularly fragile, sculptures, or manufactured objects that played an important role in the development of an area, is certainly a good choice.[31] Re-creating 3-D objects on a printer can engage patrons in the design process of making the objects. For example, students re-creating the relative simplicity of the Ball canning jar, a Muncie icon manufactured by the Ball Brothers Company from 1880 to 1996, using computer design programs would learn the geometry of design choices that led to its enduring success.[32] We can effectively not only show patrons objects, but help them understand the process of their design.

Another possibility for 3-D printing in archives lies in transforming 2-D designs into three dimensions, just as we are doing with architectural plans. Drawings, marginalia doodles, and other illustrations can be transformed into 3-D objects using current print technology. Companies are cropping up to convert children's hand drawings to 3-D–printed characters, resulting in charming objects for parents to treasure.[33] Using a similar process, but with historically significant materials such as Kurt Vonnegut's doodles or the Kelmscott Chaucer illustrations, could enable different audiences to see or feel archival 2-D materials in another dimension. A 3-D printed page from the Kelmscott Chaucer would never replace the beauty of the book in its original form, but it could enable sight-impaired patrons the opportunity to relate to its design. These are just a few examples of how 3-D printing can be extended to special collections, and archivists will undoubtedly find far more creative and meaningful ideas within their own collections.

In conclusion, the value of the positive outreach response has vastly outweighed the technological glitches, considerable investment of time, and steep learning curve staff encountered in initializing the Indiana Architecture X 3D project. As the barriers to 3-D printing—namely, high cost and technological knowledge required—decrease, archivists will likely discover a wide array of uses for the technology to benefit their collections. Partnering with those who already have the technology at their disposal, as well as the knowledge to use it, is a viable strategy to bring currency to archival collections, attract new audiences, and engage patrons now.

ABOUT THE AUTHOR: Carol Street is the archivist for architectural records at Ball State University Libraries' Drawings + Documents Archive, located within the College of Architecture and Planning. She manages the archives' extensive collection of architectural drawings, photographs, documents, and building remnants documenting the history of Indiana's built environment, and actively engages students in the use of these materials. Street received her BA, MLS, and graduate certificate in museum studies from Indiana University and has previously worked at the Museum of Modern Art, Indiana Historical Society, Eiteljorg Museum of American Indians and Western Art, and as a consultant to the Columbus Indiana Architectural Archives.

NOTES

1. George E. Hamilton, *Oliver Wendell Holmes—His Pioneer Stereoscope and the Later Industry* (New York: Newcomen Society in North America, 1949), Central Pacific Railroad Photographic History Museum, 2005, accessed January 22, 2015, http://cprr.org/Museum/Holmes_Hamilton.pdf.
2. Those key partners are John Straw; Brad Faust; Arthur Hafner, PhD; Philip Repp (University Libraries and Information Technology); Guillermo Vasquez de Velasco, PhD; Michel Mounayar (College of Architecture and Planning); and Mahesh Daas, PhD (Department of Architecture).
3. Ball State University Libraries Digital Media Repository, "Indiana Architecture X 3D," accessed January 15, 2015, http://libx.bsu.edu/cdm/landingpage/collection/IndArch3D.
4. Ball State University College of Architecture and Planning, "First-Year Program," accessed January 15, 2015, http://cms.bsu.edu/academics/collegesanddepartments/cap/bachelors/firstyearprogram.
5. Ball State University College of Architecture and Planning, "Course Curriculum," accessed January 15, 2015, http://cms.bsu.edu/academics/collegesanddepartments/cap/bachelors/firstyearprogram/curriculum.
6. A search for journal articles using the philosophy of "meet them where they are" resulted in a wide range of articles on a broad series of topics, such as teaching pedagogy in K–12 and college classrooms, evangelism, yoga instruction, nursing, marketing, and business.
7. "Jacob Henry Wysor Claimed by Death," *The Muncie Morning Star*, January 18, 1905, accessed January 20, 2015, http://www.ingenweb.org/indelaware/News/munciemornstar1905.html.
8. Dick Greene,"Seen and Heard in Our Neighborhood, 11 May 1963," Ball State University Libraries Digital Media Repository, accessed January 21, 2015, http://libx.bsu.edu/cdm/singleitem/collection/GrnRchOrNgh/id/5532/rec/3.
9. Wysor Grand Opera House drawings for alterations, 1929. Kibele and Garrard Architectural Records, Drawings + Documents Archive, Ball State University.

10. Dick Greene, "Seen and Heard in Our Neighborhood, 1 March 1973," Ball State University Libraries Digital Media Repository, Dick Greene Collection, accessed January 22, 2015, http://libx.bsu.edu/cdm/singleitem/collection/GrnRchOrNgh/id/4486/rec/32.
11. "Architect Matson Dead," *The Fort Wayne Daily Gazette*, May 11, 1892.
12. Harry W. Matson died in 1892, the same year the Wysor Grand Opera House was erected. Other examples of his work can be found in the Harry W. Matson biographical file at the Drawings + Documents Archive.
13. Waverly Lowell and Tawny Ryan Nelb, *Architectural Records: Managing Design and Construction Records* (Chicago: Society of American Archivists, 2006), 121–23.
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15. These talented master of architecture graduate assistants are (in order of working on the project) Austin Pontius, Chris Hinders, Matt Jennings, Patrick Gerhart, and Ashley Urbanowich.
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19. The selection of a 3-D printer is essentially a Venn diagram where the level of expertise available, budget, and expectation of results collide. It will vary by institution. An inexpensive MakerBot, which uses PLA filament resin in an extrusion process, could be perfect for one institution but not have adequate detail for a different institution. Given the rapid changes in technology for 3-D printing, I'm hesitant to recommend specific products or types of machines because they are likely to be outdated in short order. When you're ready to purchase equipment, reviews are easily available online. As library maker spaces evolve, colleagues will increasingly become good resources for information on what works in this sphere.
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30. Much appreciation to Brandon Pieczko, digital archivist for manuscript collections at Ball State University, for brainstorming ideas with me regarding uses for 3-D printing in local history collections.
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