THE JAMES B. HUNT JR. LIBRARY AT NORTH CAROLINA STATE UNIVERSITY:
THE LIBRARY BUILDING AS RESEARCH PLATFORM

Application for the 2014 Stanford Prize for Innovation in Research Libraries

The North Carolina State University Libraries

January 15, 2014
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NCSU LIBRARIES
The James B. Hunt Jr. Library At North Carolina State University: The Library Building As Research Platform

NOMINATOR'S STATEMENT

“Our vision was to give NC State a signature library that would help us recruit the very best students and the very best faculty and to serve the community as an inspiring place of excellence and passion and ideas and vision. You cannot be in this building without realizing that something very important is happening at this university.” Susan K. Nutter, Vice Provost and Director of Libraries, North Carolina State University

North Carolina State University’s James B. Hunt Jr. Library, an iconic building for the university, embodies the institution’s entrepreneurial aspirations with a forward-looking and ambitious approach to supporting research and learning through a diverse array of advanced technologies. The building, which opened on January 2, 2013, is located on Centennial Campus, NC State’s home for the College of Engineering, the College of Textiles, and numerous high technology corporate and government partners. This library is positioned deliberately at the forefront of emerging trends in research and learning: ever-greater bandwidth and computing power are enabling expanded use of data- and computation-driven inquiry, analysis, and visualization; touch-based user interfaces are making it easier to interact with information and data; and advanced collaboration and communication tools are widely available and increasingly mobile.

Over the past century, research libraries have developed specialized expertise and infrastructures to support print collections, yet during the last two decades it has become increasingly apparent that digital technologies are fundamentally disruptive to the model of research that libraries were designed to support. Scholarship documented in fixed form is no longer the most important raw material for advancing scholarship and the era of the individual scholar creating a polished product is fading as cross-disciplinary and collaborative investigation become central to the research endeavor. Most if not all of interactive scholarship takes place outside the sphere of the current research library; library collections, once a crucial component of the infrastructure for scholarly communication, are no longer central to many researchers’ work. These changes in the model of research require a new approach to designing and delivering research infrastructure. Research libraries with the early ability to recognize these disruptive, yet inevitable, challenges are responding by developing new organizational and service models and remaking their infrastructures to powerfully leverage digital technologies.

In 2007 the North Carolina legislature funded a new library for North Carolina State University’s Centennial Campus. A library had long been envisioned as part of a the campus master plan, but by 2007 the role and purpose of the library in this technology-rich, collaborative context clearly needed to be redefined. When the internationally renowned architectural firm, Snøhetta, was selected to design the new library, the university had the opportunity to engage both a campus community and a world-class design team who were open to rethinking the purpose and significance of the library-as-place at the outset of the 21st century. Crafting a vision for this departure from a traditional library building was driven by the need to both keep pace with the changing nature of contemporary research and to anticipate how it will continue to shift in the coming decades. A successful design
required understanding and responding to the university context in order to identify the niche where the NCSU Libraries could serve as a catalyst for advancing research and student success.

To meet these significant challenges in supporting new modes of research, emerging technologies, and specific areas of faculty research excellence, the Hunt Library was envisioned as a technology sandbox for a campus already actively engaged in large-scale data and visualization, interactive computing, remote collaborations and creative media production. The plan for the building took on the unique characteristics of an advanced technology program based on these focus areas. The key vision for Hunt was embedded in the concept of a building dedicated to ongoing innovation across disciplinary boundaries, a building designed for open use in experimentation, creation, and research in design, engineering, humanities, life sciences, physical and mathematical sciences, and dozens of other disciplines across the university. Through physical spaces and technology infrastructure designed to be adaptable, reconfigurable, and interchangeable, the building itself is designed to be an object of research.

The 225,000-square-foot building boasts a series of large-scale display walls up to twenty-two feet wide that run at over six times the resolution of standard high-definition (HD) displays; a Game Lab to promote the scholarly study of gaming; “black box” visualization and collaboration studios to support fully immersive virtual environments, advanced simulations, and dynamic technology-based collaboration; a Cisco TelePresence Video Seminar room; media production studios; four discrete learning commons environments; and 70 technology-enabled group studies. The building itself is designed as a laboratory for researching cutting-edge technologies, with flexible and scalable infrastructure, reconfigurable facilities and furniture, shared high-performance computing (HPC) and high-speed storage, as well as a skilled support team of librarians, technicians, programmers, systems engineers, and project managers.

In its first year, the Hunt Library has delivered a model of innovation that is redefining the concept of the library as an integral piece of the academic enterprise and as a key component of the campus research infrastructure. Faculty have hailed the building as the single largest, most visible investment by the campus in the future of scholarship. New segments of the faculty are engaging with the library and its staff as both enablers of and partners in their research. As a building, an integrated technology environment, and a suite of services, the Hunt Library is an innovative model for the research library as a high-technology research platform, an essential enabler of faculty and student success, and a competitive advantage for the 21st-century university.
I. THE RESEARCH LIBRARY’S CONTRIBUTION TO RESEARCH INFRASTRUCTURE

“Fewer and fewer researchers working at the frontiers of knowledge can carry out their work without cyberinfrastructure of one form or another.” - “Cyberinfrastructure Vision for 21st Century Discovery,” National Science Foundation

A. DIGITAL INFORMATION DISRUPTS THE TRADITIONAL RESEARCH LIBRARY PARADIGM

The traditional research library’s mission has been to make the cultural and scholarly record available to current and future members of its community. Research libraries make the knowledge contained in books and journals more accessible than it otherwise would be, creating a shared central resource that is too expensive and unwieldy to be reproduced by individual researchers. A common infrastructure of catalogs and other access tools, circulation policies, and expert assistance support equitable access to the knowledge resources necessary to support research and learning. Libraries have been—and arguably still are—an efficient mechanism to manage the university’s subsidy for access to costly or difficult-to-obtain research materials, although their role in providing discovery tools and expertise is now greatly diminished.

In the early days of scholarly resources moving from print to digital form, the research process was significantly enabled by library-mediated online access to databases and journals. There was even a certain status and quality distinction associated with library content in comparison with the “open web.” Now, however, the alignment between “library” content and validity and/or research value no longer holds. Often the only difference between library-licensed and openly available content is an information provider’s current business model; and if that information provider is the researcher himself, then openness is usually the default. Both the use and value of library-sponsored content are shrinking in relative terms.

What we see several decades into networked information is that a scholarly record based on the print journal model has moved to the periphery and is no longer the primary raw material for communicating and advancing research in many fields; knowledge is now advanced through frequent, fluid and rapid exchanges of data, communications, and preprints. The products of science and starting point for new research are increasingly born digital. Most if not all of this is happening outside the sphere of the current research library.

In an oft-repeated analogy, the library is the “laboratory” for the humanist. Until recently, every librarian and library user alike knew exactly what that meant, and it was epitomized by the iconic image of the researcher leafing through the newly-received periodicals in their field and then heading up to the stacks to serendipitously discover new inspiration for their research. The scientist always had a much more tenuous connection to the physical library, however. Once journals moved online, that researcher seldom stepped into the library. In a 2007 study of scientists’ use of the library, nearly half of physical and life scientists said that by 2011 they expected to visit their library less than once a month, and 12% of physical scientists and 23% of life scientists said they would never visit the library. Three recent major studies of U.S. and U.K. researchers found that faculty saw libraries as primarily fulfilling a procurement/custodial role. It is not hard to imagine that such a circumscribed function could be assigned to another entity within the university.
**REPURPOSING LIBRARY SPACES**

At the same time as libraries are contemplating the impact of digital collections on their identity, universities are asking. Does the rise of virtual research, teaching and learning undermine the value of the physical university? International research teams are (at least theoretically) able to meet virtually from their desktops and can be supported by a centralized research infrastructure. A distance degree can be orders of magnitude less expensive than a residential degree. What is the role of the physical campus? This is a question for which the research library can and should contribute a compelling response as the university positions itself strategically for the future. Dynamic, accessible library spaces are spaces that support both research and teaching, faculty and students. The relevant library provides a full range of tools for both knowledge discovery and knowledge creation; it welcomes and supports all disciplines and has a user-centered service model.

Library spaces have come a long way from the book-centered paradigm, manifest in monumental reading rooms and buildings full of print collections. A new paradigm for learning spaces is beginning to emerge, one that emphasizes collaboration, exploration, and engagement, and recognizes the importance of good design. In terms of meeting the needs of undergraduates, libraries are experienced with the “learning commons” model of effectively repurposing study spaces to meet the needs of today’s connected learners. By offering a variety of inviting spaces for individual or collaborative work, academic libraries have responded well to students’ participatory culture, where everybody creates and shares, and where informal, peer-to-peer learning is strong. In combination with our expertise in discovery tools, we should be ready to expand the learning commons paradigm to accommodate emerging technologies such as interactive computing. It is much less clear, however, that libraries have responded effectively to emerging faculty needs.

**B. NEW RESEARCH METHODS AND TOOLS OF KNOWLEDGE CREATION**

“Data-intensive research, interdisciplinary research, and multi-institutional research are considered hallmarks of the emerging research environment.” – Scott Bennett

**DATA-INTENSIVE SCIENCE**

The tools of knowledge creation across a very broad spectrum of disciplines have shifted from text-based modes to visual- and data-intensive compute-based modes, including large-scale visualization, gaming, animation, and modeling. Jim Gray characterized data-intensive research as “the fourth paradigm” of science, joining experiment, theory, and computational simulation. “The techniques and technologies for such data-intensive science are so different that it is worth distinguishing data-intensive science from computational science as a new, fourth paradigm for scientific exploration.”

As Cliff Lynch notes in response, “Gray’s fourth paradigm provides an integrating framework that allows the first three to interact and reinforce each other.”

**COLLABORATIVE AND INTERDISCIPLINARY RESEARCH**

Modern research questions require approaches that are increasingly multidisciplinary and, as a result, research is often team-based and geographically distributed. Funders recognize the need to support these new ways of working; research teams that are successful in taking collaborative and interdisciplinary approaches to important research questions have a competitive advantage in receiving funding.
Visualization

Visualization is a research method that links data with collaborative inquiry and is applicable across a broad range of academic disciplines. The goals of scientific visualization are to promote a deeper level of understanding of the data under investigation and to foster new insight into the underlying processes, relying on humans’ powerful ability to visualize.

Visualization designers exploit the high-bandwidth channel of human visual perception to allow people to comprehend information orders of magnitude more quickly than they could through reading raw numbers or text ... Advances in visualization enable researchers to analyze and understand unprecedented amounts of experimental, simulated, and observational data and through this understanding to address problems previously deemed intractable or beyond imagination.12

Desktop-based visualization is insufficient to support data-intensive research: “The primary limitation in interactive visualization interfaces is the number of available pixels; we are pixel-bound, not CPU-bound or even render-bound.” 13 Thus, large-scale visualization requires resources provided by campuses. Several research universities have made major investments in complex visualization spaces.14

C. Research Infrastructure

Data-intensive, cross-disciplinary collaborative research, especially across the science and engineering disciplines, increasingly relies on significant research infrastructures, including high performance computing and storage, visualization tools, and collaboration platforms.15 “Research infrastructure” is a term that is commonly used to describe the tools, services, and installations that are needed by the research community—particularly but not exclusively science and engineering—to function and to do their work.16 Cyberinfrastructure is a related concept that encompasses the hardware, software and support services that support research.17 A modern and effective research infrastructure (cyberinfrastructure) is critical to the nation’s competitiveness and leadership in science and engineering.18

Analogously, the competitiveness of higher education institutions increasingly depends on their ability to identify and deliver on their core research competencies. Attracting and retaining an outstanding faculty requires competitive research infrastructure. Excellence in research infrastructure is much more than digital “plumbing;” it is central to the institution’s success in realizing its core mission. The CIOs at the CIC schools19 noted in a recent report to their provosts, “There are no longer any non-computational disciplines—just disciplines that have not yet solved the resourcing problems created by scholars who are attempting things that were not possible previously.” 20 Brad Wheeler, CIO at Indiana University, writes, “E-science, e-research, and e-scholarship ... are best understood as ‘e-research,’ where the ‘e’ will eventually be silent.”21

In 2007 the National Science Foundation (NSF) identified cyberinfrastructure as a priority not just for funders but also all institutions of higher education. NSF’s priorities, which represent the intersection of its analysis of infrastructure needs and current gaps, include high-performance computing; data, data analysis, and visualization; virtual organizations for distributed communities; and learning and workforce development.22 The NSF laid out a specific role for institution-based resources, which was “Providing access to moderate-cost computation, storage, analysis, visualization and communication for every researcher.”23 Researchers also expect their institution to provide research infrastructure appropriate to the institutional level: “There is a level of research...
information infrastructure service that any researcher should expect and that every university should deliver [...] there are some services that provide distinct competitive advantage to a university. It is these that will yield the greatest investment benefit in the medium term.”

LEVERAGED INVESTMENT

Universities invest in a variety of infrastructure resources in support of their research mission. The question university administrators ask is, when and where can those investments be made more efficiently by investing in shared resources? Leveraged investment is an alternative funding model to requiring each project or researcher to procure its own resources. Leveraged investment supports more efficient cross-institutional investment, opening up greater opportunities for access for all researchers, including graduate student researchers. Funders increasingly expect research infrastructure to be leveraged. “Funding agencies have made clear their lack of interest in single-researcher approaches and are insisting on collaboration among researchers from different disciplines.”

There remain, however, disincentives in funders’ practices and researcher incentives for leveraging campus investment in research infrastructure. “Many current practices of funding agencies and hiring incentives for faculty contribute to the problem by structuring awards of funding in ways that encourage faculty to make individual CI investments that fragment and balkanize the campus CI.” In this environment of rough but unstable equilibrium between incentives of key players on campus there lie opportunities for campus entities that are not already wedded to existing models for research infrastructure provision.

D. POSITIONING THE RESEARCH LIBRARY TO CONTRIBUTE TO RESEARCH INFRASTRUCTURE

Libraries were core to the research infrastructure when they supported unique print collections physically located on campus. From the 1870s to the 1990s the collections of research libraries increased a hundredfold. This growth was undeniably a challenge to accommodate in many ways, particularly when the pace of collections growth greatly accelerated after World War II, but research libraries were well equipped to handle it. Still, acquiring and managing collections was what libraries did but in itself did not constitute what they were for. In 1998 David Lewis reminded us that our core purpose is not acquiring, organizing and storing information; it is economic: managing a shared investment on behalf of a community. That shared investment clearly still includes knowledge resources, but do we want to find ourselves in the position of asking yet again, what is next artifact? Both universities and research libraries are now incentivized to think about their contribution to research infrastructure in a more holistic way.

Because existing collections and services are still valued by our communities, the transition in which libraries find themselves is, ironically, inevitably gradual at the same time that it is in the long run irrevocably disruptive. Libraries have already extended prior roles and leveraged our community’s collective expertise to novel purposes. Libraries could go in any number of useful directions in embracing a re-conceptualized role in support of scholarly communication, many of which can be characterized as contributing to research infrastructure. Libraries have been deeply engaged in building mass digitization and preservation infrastructure (HathiTrust, LOCKSS, DuraSpace, DPN, and others), and are prioritizing digitization of their unique collections (with local efforts now being aggregated through the work of the Digital Public Library of America). Some research libraries are active participants in scholarship through Scholars’ Labs and other digital humanities collaborations. Data curation is another emerging area of intense interest and investment.
Centralized university administrative entities, such as the library, have the responsibility to identify and make the case for their role in areas of leveraged investment and how that approach will maximize impact in areas of institutional priority, specifically research. As libraries look at supporting data-intensive scholarship, particularly in the sciences, they are identifying some new opportunities that meet these criteria. Research libraries have developed significant digital library expertise over the past decade and are now positioned to contribute data management expertise, digital repository and preservation expertise—and in some cases infrastructures and tools—to the university to improve support for more of the digital scholarly communication lifecycle. They are already doing so in two of the three basic activities of data-intensive science: capture, curation, and analysis. Libraries have identified opportunities and developed services both in the area of capture (e.g., metadata services) and curation (e.g., data management plan consultation, data repositories), but less so in analysis. This is a potential area of opportunity.

One way to approach the question of identifying appropriate areas for library engagement is to return to the library’s core function from the institution’s perspective, namely to manage the institutional investment in widely-needed but costly or scarce raw materials of knowledge creation. Correctly placing investments in shared resources can have a measurable impact on overall institutional research competitiveness. While the university seeks efficiencies in providing core computational resources or expensive lab equipment, it is unlikely that the library is the best home for leveraged investment in those types of resources. In some cases, individual researchers may see their technology needs as specific to their research, and may in fact be responding to funder and other incentives to aspire to secure information technology resources individually. Yet, in fact, greater overall value could be achieved for both the institution and the individual researcher if the infrastructure were made openly accessible with expert staff to support its use. As libraries think about research infrastructure and how they can support it—and fund it—it is also important to appreciate the relative scale of resources across the disciplines. The research dollars flowing into the typical large research institution massively favor the sciences and engineering, in a ratio (at the national level) of over 20-to-1.29

Recognizing that moving research infrastructure from the periphery (the individual researcher or his department) to the core (a central service provider, whether central computing or the library) is potentially a contentious issue,30 libraries can look to areas that are both connected to their core mission and that offer an especially clear value proposition as a shared resource. Attributes of the latter include resources that support a relatively new or emerging area that is not yet well supported on campus, either in the center or periphery, and are not appropriate for external service providers. If these are at a level that is not realistically fundable by an individual researcher’s grants and if a potential hosting entity is prepared to provide support, “competition” or controversy related to providing that research infrastructure is unlikely. Large-scale displays and associated infrastructure to support visualization of big data31 and other advanced collaboration spaces are components of research infrastructure needed by many different disciplines but that also meet the criteria of being associated with the library’s core mission (providing tools of knowledge creation) and present a clear value proposition to offer as leveraged resources.
II. DEVELOPING THE HUNT LIBRARY VISION

"The Hunt Library is all of NC State’s best ideas, all put into one building.” NC State student on Twitter

A. THE NCSU LIBRARIES AND ORGANIZATIONAL PREPAREDNESS

The NCSU Libraries vision is to be NC State’s competitive advantage. That vision has guided the library for two decades before the Hunt Library was realized. Several strategic directions taken during that time prepared the institution and its staff to be able to develop, embrace and realize the Hunt Library vision.

One overarching strategic direction was to invest more aggressively than our peers in the digital library. The NCSU Libraries helped support one of the earliest online journals, Postmodern Culture, founded in 1990 and whose editor, John Unsworth, was then a faculty member at NC State. The library’s collection development policy early on embraced digital collections. The library incubated a digital initiatives unit, later a department, in the 1990s, and supported it—and continues to support it—with an ongoing innovation budget of $425,000 a year. The NCSU Libraries, again earlier than most of its peers, reallocated positions from print-centric functions to technology positions to support development of the digital library, information technology and, later, technology-rich learning spaces.

Close collaboration and partnership with faculty in determining priorities, shaping our strategic direction and advising the library in support for the research lifecycle, is the second strategic direction that prepared the library for the Hunt vision. Faculty have supported the growth of the library in a myriad of ways, most notably in the mid-1990’s when they voted to provide state-appropriated funds earmarked for faculty raises to the library—sacrificing their pay increases to support the vision of a truly great library at NC State. The university community’s response to this user-centered approach has been to trust the library leadership’s strategic directions and recommendations. The Hunt Library seeks in many ways to reward that faith, by providing the types of spaces, expertise, and technology that help faculty increase their research productivity, creativity, and funding. The University Library Committee, a standing committee of the university, has for many years advised the provost and the library administration on matters of library policy, including development of resources for instruction and research, the allocation of library space, and overall programs and services. A Student Advisory Board also provides feedback and suggestions on library programs and services. Subject specialist librarians maintain close and wide-ranging collaborative relationships with faculty members in each academic college and department, and significant emphasis is placed on outreach and services to graduate students.

Staff recruitment and development is a third overarching strategic direction that prepared the library for the Hunt vision. The NCSU Libraries enjoyed several advantages here over its peers, including a contract (no tenure) system for librarians, a flexible career banding classification system and absence of unions, and a period of significant budget expansion in the late 1990s. The library has long hired staff who are a good fit with the organization’s culture, which is fast-paced and rewards those at all levels who show initiative and are able to embrace ambiguity. A critical engine of innovation and recruitment has been the Libraries Fellows program, founded in 1999, which each year hires two to four new librarians for a two-year appointment during which they develop expertise in a functional area and contribute to an initiative of strategic importance. The Libraries typically has four to six Fellows at a time, and brings a significant portion of the graduating Fellows into ongoing positions, often in emerging or growing areas of focus.
Librarians are expected to identify emerging areas for innovation, big and small, and take the initiative to make the case, develop a strategy to advance the initiative, and follow it through. During times in which academic libraries are challenged to respond to rapid changes in information technology and learning and research paradigms, the ability to be nimble and adapt is a critical organizational and individual capability. While less visible than digital projects or learning spaces, the library's organizational culture stands at the core of the library's readiness to develop, implement and succeed in the Hunt vision.

In addition to digital library collections and services, the NCSU Libraries has emphasized learning spaces as an area of investment and innovation. A highly successful learning commons opened in 2007, followed by other renovated user spaces in subsequent years. In 2009 the library opened a Technology Sandbox space for piloting new technologies, which was supported with a $100,000 LSTA Technology grant administered by the State Library of North Carolina. The Libraries was also lead in a $313,000 two-year National Leadership Grant from the Institute for Museum and Library Services (IMLS) to develop a model for next-generation learning spaces, which resulted in the freely available Learning Space Toolkit.35

The NCSU Libraries, its staff, and library building projects, including the Hunt Library, have been honored by numerous awards, including the first ACRL Excellence in Academic Libraries award in 2000 and eight Library Journal’s "Movers and Shakers" awards (see Appendix B).

B. UNIVERSITY CONTEXT

NC STATE AND CENTENNIAL CAMPUS

With more than 34,000 students and nearly 8,000 faculty and staff, North Carolina State University (NC State) is a comprehensive university known for its leadership in education and research, and globally recognized for its science, technology, engineering and mathematics programs. As a land grant institution, NC State has had a special role and responsibility to enable the greatly expanded federal investment in academic and industrial R&D after World War II. NC State’s research expenditures are $380 million annually, with almost 70 percent of faculty engaged in sponsored research and 2,500 graduate students supported by research grants. NC State is ranked eighth nationally among all public universities (without medical schools) in industry-sponsored research expenditures.

NC State’s Centennial Campus,36 home to the James B. Hunt Jr. Library, is 1000-acre research campus adjacent to NC State’s main campus. Centennial Campus is home to the university’s largest college, the College of Engineering, as well as the College of Textiles. It is also home to more than 130 corporate and government research partners, incubator companies, and university research units; the France-based SKEMA Business School offers classes on Centennial. Centennial Campus is a unique community of collaboration where industry and government partners work alongside faculty, staff, postdocs and students conducting cutting-edge research in state-of-the art facilities.

NC State is currently embarked on an ambitious vision to change the paradigm for higher education and research by virtualizing Centennial Campus, creating vCentennial, the first research campus combining the physical and the virtual.37 vCentennial will leverage advanced cloud computing and other technologies to make equipment, training, and educational facilities available to corporate or educational partners anywhere in the world 24/7.
TH E UNIVERSITY STRATEGIC PLAN
As the Hunt Library was in its design phase, the university was engaged in a strategic planning process. The resulting NC State Strategic Plan has five top-level goals, all broad-based enough to be advanced through evolving strategies over the next decade or more. Each campus entity is expected to develop its own goals and strategies that align with the university's. As a building and library that serves the entire campus community and is exhibiting a transformative impact on Centennial Campus, Hunt is reasonably expected to advance all university goals in meaningful ways. Hunt's overall program supports all five goals and its services in support of research directly addresses Goals 2 through 5. The goals are:

1. Enhance the success of our students through educational innovation
2. Enhance scholarship and research by investing in faculty and infrastructure
3. Enhance interdisciplinary scholarship to address the grand challenges of society
4. Enhance organizational excellence by creating a culture of constant improvement
5. Enhance local and global engagement through focused strategic partnerships.

TE CHNOLOGY RESEARCH INFRASTRUCTURE
Information technology services at NC State are delivered through a decentralized model, with approximately half the university's technology staff working outside the central computing unit, Office of Information Technology (OIT). OIT provides core network, storage and HPC services, support for enterprise applications (excepting the learning management system), identity management, centralized software procurement, and some web and desktop support services. Reflecting this decentralized organizational structure, the culture of NC State technology innovation is distributed. NC State's college IT units serve, in essence, as a set of mini-start-ups, developing innovative solutions and products, several of which have extended beyond NC State—in authentication (WRAP), virtual labs (VCL), and a course management testing tool (WebAssign). The library operates as a peer with the largest and most influential colleges, and OIT trusts the library to pilot new technologies that could either stand alone or eventually feed into the core of centrally offered services.

C. VALUE PROPOSITION FOR A NEW LIBRARY
The Centennial Campus Master Plan included a library from the early 1990s. It was recognized that the as the campus expanded to include the College of Engineering, the College of Textiles, and corporate partners, with up to 20,000 students primarily located there, it would need an intellectual center and library services. In addition, severe space shortages for both collections and users in the existing main library, D.H. Hill, made the value proposition for a second main library on Centennial clear to university administrators and campus planners. A Master Plan for the Libraries was developed in 2002 and included both a renovation plan for the D.H. Hill Library (the 2007 Learning Commons and east wing renovation) and a two-phased approach to building the Centennial Campus library. Principles developed during the master planning process included that the library would maximize the use of electronic resources, store infrequently used print collections offsite, and would be designed for current and future technologies. The Libraries Master Plan built on the Libraries' 2000 “vision for 2010” strategic vision, which stated, “Because access to knowledge and information resources is the keystone to the university's success, a technologically advanced library is essential to its future” and “A new innovation and learning center would complete the dynamic environment of innovation and partnership that is the Centennial Campus vision.”28
The University of North Carolina system designated the Hunt Library at NC State as its highest-priority building project in 2007, and in that same year the project was fully funded at $125 million by the state legislature.
III. PLANNING A LIBRARY TO SUPPORT RESEARCH

A. PROGRAM PLANNING

The Hunt Library was envisioned from the beginning as a signature building for NC State University, and the university conducted an international competition for its lead designer. After a competitive multi-day charrette process, the internationally renowned Norwegian architectural firm Snøhetta was selected as the lead designer. This was the first step in assembling a world-class design team that was well prepared to partner with innovative thinkers at the university to creatively re-envision the research library for the 21st century. The design team consisted of architects from Snøhetta and the North Carolina executive architect, PCB&L (now Clark Nexsen); space planning consultants, DEGW (now Strategy Plus); the audiovisual (A/V) design firm, The Sextant Group; and representatives from building systems and construction contractors. The campus team included the library leadership team (director and associate directors), along with representatives from the University Architect's office, Capital Project Management, Facilities, Environmental Health and Safety, and Learning Technologies. Between 2008 and 2010, the campus team worked closely with the design team on program planning. The Hunt Library began construction in January 2010, opened to the public in January 2013, and was formally dedicated in April 2013.

The Hunt Library program was developed through interviews and focus groups professionally facilitated by the consulting firm DEGW. Focus groups of undergraduate and graduate students, faculty, library staff, members of the University Library Committee and the University Building Committee, and Centennial Campus Master Plan stakeholders explored issues related to key concepts, program elements, site analysis, and budget. The user research delved into the specific needs of the Centennial Campus community and, more broadly, the needs of all ten colleges across campus, many of which leverage visual technologies as a core part of their curriculum and research.

The shared vision that emerged for the new building highlighted its function as a technology “incubator,” a central, open, inspiring facility where anyone could come to get hands-on access to the latest technology and where real and virtual worlds came together. The core concept was that by providing cutting-edge technologies that are open and accessible to all, the library could integrate visualization and collaborative capabilities into the research fabric of the campus and help to drive innovation across the academic research enterprise. The services identified during the needs assessment phase featured both commodity and advanced technologies that would not only directly facilitate the work of students, faculty, and researchers in high-tech disciplines, but would allow them to push the boundaries of technological innovation and research. That user research became the fundamental grounding for the building’s technology design through work with Sextant, the project’s A/V design consultant.

PRINT COLLECTIONS

The 2002 NCSU Libraries Master Plan included stack space for 870,000 volumes; even while incorporating some off-site storage of lesser-used print materials, 37 percent of the new library was planned to be dedicated to bookstacks, with only 21 percent for users (and 26 percent unassigned). By 2007, after the opening of the Learning Commons at the D. H. Hill Library, it was evident that a much greater proportion of user space was an essential priority for the new library. Fortunately, during the planning phase, an efficient, high-density onsite print storage solution (an Automated Storage and Retrieval System, ASRS) was identified that could store print collections in one-ninth the space of open shelving. The library decided to integrate a two-million volume ASRS into Hunt, in
which would be stored the print working collections for engineering, computer science, and textiles, as well as low-use collections relocated from other libraries and storage locations. An interactive Virtual Browse application was developed locally to explore digital analogies to open shelf browsing. Most critically, the high-density storage solution enabled the Libraries to free up space to devote to more innovative research, study and collaboration spaces.

B. NEEDS ASSESSMENT AND TECHNOLOGY VISION

“Design your infrastructure to match the research excellence of your faculty.” -- R. Michael Young, Computer Science Professor, NC State

The formal library program planning process looked at all user communities and, in fact, developed greater detail on the vision for supporting collaborative and undergraduate spaces than how the library could support research. The focus on research support only came to fully emerge after program planning through the technology visioning and design process that followed. In engaging with faculty during the ongoing needs assessment process we sought to identify faculty critical to our future success versus those critical to past successes. We talked to faculty who saw no use for the library after their research materials went online. We looked closely at the university's strengths, identified leading faculty, especially in defined areas of focus for the university, and with a special emphasis on programs and faculty located on Centennial Campus. Rather than simply asking, What can a new library do for you? We asked researchers about their research and how they worked. We then looked at what the library might provide that would make them more successful: in their research; in advancing their research through access to new tools and capabilities; in securing grants; in attracting the best graduate students. We looked at what would enable the institution to attract and retain the best faculty, increase its sponsored research base, and enhance its reputation. Advancing these goals would demonstrate in concrete ways that the NCSU Libraries is a competitive advantage for the university.

The technology vision for Hunt started from an understanding of broad environmental factors related to how research is enabled and advanced:

- Ever-greater network bandwidth and computing power are enabling expanded use of computing-intensive applications such as large-scale visualization;
- User interfaces are becoming touch-based, making it easier to interact with information and data; and
- Computing and communication functions are converging, enabling new possibilities for people to interact with information, spaces, and each other.

To hone in on the specifics behind the technology vision and create an ongoing technology sounding board, in 2012 the Libraries established a Hunt Library Technology Advisory Board. Faculty and corporate officers on the board advise the NCSU Libraries on strategies, programs, and partnerships.

DEVELOPING A HOLISTIC TECHNOLOGY VISION

The vision developed before the Libraries Master Plan back in 2000 was that the new library would be “a technologically advanced library.” What that meant had naturally evolved in the intervening decade but the core direction had been set and already permeated the organizational culture. The Hunt technology vision staked out ambitious goals in line with a new research library building being constructed at the outset of the 21st century. The Hunt Library would still support access to formally
packaged knowledge but it would also offer new tools and spaces for knowledge creation. The library sought to position the Hunt Library at the leading edge of a forward-looking vision for developing a competitive research infrastructure for NC State, and to support the Centennial Campus and vCentennial vision.

In early 2009 library technology leaders prepared a technology vision document, “A Technology Program for the Hunt Library,” to serve as an aspirational environmental scan to facilitate internal library and design team conversations. Importantly, this document also served to “jump start” technology planning with the A/V consultant and NC State’s OIT. The Technology Program document drew on DEGW’s continuum of technology model, from Basic to Enhanced to Advanced to Experimental, as outlined in their Programming and Pre-Design Final Report. The identification of potential technologies at each level did not answer the question about the appropriate balance between them but reinforced the importance of embracing the full range of technologies in the same space, and making them all available to the full range of users from learners to researchers. This vision was ultimately realized in the range of technology-enabled spaces which are described in detail in Section V.

Throughout 2010 and 2011 a high-level technology vision was introduced to academic departments and individual researchers. Their feedback guided the identification of focus areas, specific candidate technologies, and thinking around staffing and service model design. The overarching vision was still encapsulated in “library as technology incubator,” but that tagline vision was consistently expressed through five high-level goals that were shared with all audiences during this period. They are:

- Create next-generation learning spaces to support new modes of learning
- Make emerging technologies available to the entire NC State community
- Democratize access to cutting-edge technologies and empower users to engage actively and creatively
- Provide technologies that are open, integrated, and accessible
- Integrate the visualization and collaboration capabilities of the Hunt facility into the research fabric of the campus

These goals were elaborated to make explicit the principles on which the library was selecting directions, spaces, and technologies. These principles reflected core library values and our intention to invest in campus research infrastructure to advance university goals.

Support Research, Teaching and Learning. The research library reflects and supports the research university model where faculty research feeds into teaching and the training of the next generation of scholars.

Applicable to many disciplines. The library will have areas of specialty, reflecting its parent institution’s areas of focus, but it also must aspire to serve as a research platform for faculty across all disciplines.

Available to all researchers. Spaces and the building’s research capabilities will be available to graduate students as well as faculty.

Offer new capacities. The library will identify and offer infrastructure and services that are not already being provided by other entities on campus, although it will partner with those entities, particularly the Office of Information Technology, in designing and delivering services.
**Design flexible and reconfigurable spaces.** Hunt Library high-technology spaces and the expert staff who support them will be in high demand and therefore spaces cannot require extensive customization for particular use cases.

**Support cross-institutional work.** The library will enable blended physical and virtual collaborations, responding to the ways that researchers currently work.

**Enable academic/corporate partnerships.** In the spirit of Centennial Campus, the Hunt Library will be an active partner in campus academic/corporate collaborations.

### C. USE CASE DEVELOPMENT AND IDENTIFICATION OF FOCUS AREAS

**LEAD USE CASE IDENTIFICATION**

In pursuing its research infrastructure agenda and the associated technology support model, the library had to decide whether it would attempt to provide individually customized responses to users’ identified needs or offer broadly applicable technologies and capabilities associated with broadly defined use cases but not specifically identified by them. The Hunt Library largely adopted the latter model, a focus on broadly defined use cases, with the recognition that additional customization would at times be necessary for strategically important projects. The greater risks inherent in this model were ameliorated by the identification of a significant gap in the university’s research infrastructure—large-scale visualization—where the Hunt Library could make a critical contribution within a domain of use case scenarios and technical expertise.

Over three-dozen potential use cases were developed by looking closely at university programs across all colleges and disciplines. These were later enriched with detail derived from a representative set of lead use cases. Library IT staff worked with lead use case researchers to understand their needs and how Hunt infrastructure could support their work. These lead use cases served as the basis of technology prototyping and testing in Mini Hunt. Several (but not all yet) resulted in deep engagements after Hunt opened. These lead use cases served to tell a story about the work that happens at the university and the aspirations of the library to meet unmet needs and thereby provide a competitive advantage for research innovation. Research use cases that arose directly out of faculty work became the fundamental building blocks for the prototyping efforts in Mini Hunt, which were indispensable to testing, tweaking, tuning, and integration of the A/V and IT technologies that would be implemented on an enterprise scale in the building itself.

The lead use cases were:

- Big Data Harvester and Business Analytics (College of Management);
- Interaction Design & Large-scale Graphics Rendering (College of Design);
- Game Design, Game Artificial Intelligence and Human Computer Interaction (Departments of Computer Science and Electrical & Computer Engineering, College of Engineering, and College of Design);
- Thunderstorm Simulations, GIS Visualization (Department of Marine, Earth, and Atmospheric Sciences, College of Sciences);
- Interactive text visualization (College of Humanities and Social Sciences); and
- Virtual Recreation: St. Paul’s Cross (Department of English, College of Humanities and Social Sciences).
As a result of broad-based and lead use case engagements, the library identified five specific areas of technology focus for the research and learning spaces at Hunt. The five areas, discussed in more detail in the Section IV, are large-scale visualization and display; gaming, interactive computing, and programming; communications and collaboration; prototyping and creation; and supporting the research community.

D. PROTOTYPING: TECHNOLOGY SANDBOX AND “MINI-HUNT”

As part of the preparation for Hunt, the library recognized that our students and faculty, as well as our IT and public services staff who would support the new facility, needed a prototyping environment to try out various technologies on a small scale in order to discover which ones were most useful and which most sustainable. The result was the Technology Sandbox, which opened in 2009 at the D.H. Hill Library. Technologies in the Sandbox include: an 88-inch Perceptive Pixel multi-touch display, a quad-display video wall, Microsoft Surface (PixelSense) tables, a SMART Board, and motion and gesture-based gaming.

In late 2011 through 2012, the Libraries extended the prototyping concept by creating the “Mini Hunt” lab at the D.H. Hill Library, a miniature replica of the same technologies that were to be installed in the Hunt Library when it opened in 2013 (see Figure 1). Library staff worked with Design and Computer Science faculty during spring 2012 to enable students in a game development studio course to develop against a prototype of the high-resolution video display walls from Christie Digital that would be installed in the Hunt Library. For the whole semester, the class of designers and programmers worked to create a single game customized for the 21-foot Christie® MicroTile® display wall that was to be installed in the Hunt Game Lab and based on thematic content drawn from the design and service program of the building itself. Asked about how the course turned out, its lead professor said, “The experience provided a huge competitive advantage for my students. Anyone can future-cast and blue-sky scenarios for new hypothetical technologies and spaces. But these NC State students now actually have real-life experience in developing for demanding and complex real-life opportunities. It will be a huge proof point of excellence on a resume.” Indeed, one student expressed appreciation for the unique experience, saying, “I feel like I’ve been handed the keys to the spaceship.” Another said, “It was probably the greatest experience I’ve had so far in college.”

Fig. 1. Mini Hunt prototyping lab.
Lead use cases identified specific functional requirements for the technology while Hunt’s technology infrastructure was still in the design phase. Solid research use cases raised the technology program from being simply a state-of-the-art audio and video installation to becoming a piece of research infrastructure. The library’s IT staff used Mini Hunt to partner with lead use case faculty and technology vendors, all of whom were comfortable with experimenting and designing on the leading edge of technology. The learning during this phase was key to successful upfit and support for the Hunt technology at opening.

Both the Technology Sandbox and Mini Hunt were critical to learning and testing the core Hunt Library technologies and applying them to real-world research problems. The Technology Sandbox is documented at www.lib.ncsu.edu/technologysandbox. One of the primary experiments conducted with students in the Mini Hunt lab is documented at go.ncsu.edu/minihunt.

E. “POWERED BY” PARTNERSHIP PROGRAM

As a technologically cutting-edge facility located on Centennial Campus the Hunt Library early on inspired a great deal of interest from technology companies in becoming a part of the vision. In order to advance mutual goals, the library developed the “Powered By” partnership program, which offered the opportunity for corporate partners to contribute financially or in kind to enable the library to realize the full Hunt vision.

Powered By was not simply a fundraising campaign, however; it opened the door to ongoing relationships with critical technology partners. The partners worked with library IT staff to develop unique solutions, to push the boundaries of their products and engineering, and to learn from how researchers and students engaged with them. Collaboration between technology company engineers and library IT staff was critical across six major technology areas being developed for Hunt with which library IT staff had little or no prior experience: graphics-intensive applications, large-scale display, interactive computing, cloud computing, media infrastructure, and storage infrastructure.

The library also worked with the Powered By partners to deliver value to the companies from our relationship through publicity, library workshops featuring the partners’ technologies and NC State students, and feedback on how researchers and students were using the capabilities of the technologies. In spring 2013 seven companies participated in a “Corporate Partner Technology Showcase” that provided open drop-in seminars in the Fishbowl Seminar Room at Hunt where engineers and executives engaged students on the most recent technologies and developments in their portfolios.
IV. HUNT LIBRARY AREAS OF FOCUS

A. LARGE-SCALE VISUALIZATION AND DISPLAY

The Hunt Library contains a wide variety of large-scale displays with different sizes, aspect ratios, configurations and capabilities. Complementing university and external compute and cloud storage services available to researchers, the Hunt Library’s visualization spaces serve as a “presentation cloud” for the campus.

Hunt’s diverse visualization spaces and capabilities are designed to support data visualization (to understand and interpret data); interactive visualization (to explore the underlying data); collaborative visualization (to share visual representations of data between co-located or distributed teams); and visualization research (technical, social and evaluation challenges). Holistically, the Hunt presentation cloud supports a process of social interaction around data.

B. GAMING, INTERACTIVE COMPUTING AND PROGRAMMING

Gaming is often the driver of new human-computer interaction (HCI) technologies and the Game Lab at the Hunt Library is designed to support this highly multidisciplinary field of research. NC State’s own Digital Games Research Center acts as a hub for a program that spans the Colleges of Education, Engineering, Design, Management, and Humanities and Social Sciences. The 21-foot Christie MicroTile display wall in the Hunt Library Game Lab gives faculty and students an experimental platform to explore research topics ranging from large-screen game environments and methods of interaction to full-motion gait analysis for the development of prosthetic limbs in biomedical engineering.

C. COMMUNICATIONS AND COLLABORATION

Communication and collaboration technologies are key for capturing activity in the building, preserving artifacts created by researchers in the spaces, and connecting Hunt to the outside world for purposes of remote collaboration. These capabilities are realized through a dedicated Cisco TelePresence videoconferencing room, and through the available capture, streaming, and broadcast capabilities in the Teaching and Visualization Lab and Creativity Studio. The library also supports a cart-based mobile media capture rig for use outside the dedicated high-tech spaces.

D. PROTOTYPING AND CREATION

The Hunt Library media production studios, Makerspace, and technology lending service support a broad range of production and creative activities. The media production studios enable work with animation, audio, and 4K imagery with sufficient compute, GPU, and storage resources to enable robust creation of content for the display walls in the building. The Makerspace supports 3D prototyping and laser engraving. The technology lending service, which began in the Libraries in 1999 as a laptop lending service, offers dozens of technologies, including new, emerging devices and tools in keeping with Hunt’s “incubator” role, that can be used in media creation and prototyping.

E. SUPPORTING THE RESEARCH COMMUNITY

Dedicated research and collaboration spaces for faculty members and graduate students were deliberately included in the Hunt Library program, based on evidence gathered in the needs assessment process and library leadership’s awareness of the need for and value of these spaces in
support of the university’s strategic goals. The Faculty Research Commons and Graduate Student Commons offer accessible, well-equipped spaces for both individual and collaborative work, and for meetings with library subject specialist liaisons in support of university research initiatives. An example is the library’s engagement in the Chancellor’s Faculty Excellence Program (http://workthatmatters.ncsu.edu/) (described in more detail in Section VI).

The four public display walls in the Hunt Library (Art Wall, Immersion Theater, Commons Wall, and Teaching and Visualization Wall) provide opportunities to showcase the university’s digital assets, including promoting the work of faculty and students and topics of disciplinary conferences and symposia occurring on campus, as well as showcasing the library’s growing digital collections. The walls are also opportunities for faculty to fulfill the research dissemination requirements of their sponsored research.
V. SUPPORTING RESEARCH: SPACES AND TOOLS

“What I would have loved to see is an API for Hunt Library itself. Imagine if students actually had an interface where they could write Apps for the library, where students could launch the apps from any of the displays or study rooms in the building? Enterprising developers could leverage the touch screens and Microtile displays for any number of artistic, social, and educational purposes... Give us the tools to add to the library! There is wisdom in the crowd, especially the crowd of Computer Science and Engineering students looking to make their mark on the world!”

Barry Peddycord III, Computer Science Ph.D. Candidate

A. ADAPTABLE TECHNOLOGY DESIGN

Successful 21st-century learning spaces will be characterized by their versatility and flexibility—their readiness to be transformed to accommodate a variety of activities and technology configurations. By aligning the technology design, support, and replacement processes, more holistic and cost-effective solutions can be created. For instance, design decisions can be made with lifecycle costs in mind so that a near-term decision like using a more inexpensive but less durable material doesn’t lead to higher maintenance and replacement costs in the long term.

The overarching goals for technology in the Hunt Library can be summed up with a set simple principles for practical design and implementation:

- Technology at every level should be opened up and placed directly into the hands of faculty and students for their own use and experimentation;
- Update, refresh, and introduction of new technology in the building should be driven by the pace of the innovation and interest of the faculty and students;
- The interfaces, controls, and content in the building should be designed and informed by faculty and students to the greatest extent possible; and
- A person of any skill level should be able to be comfortable and productive in any space and with any technology in the building, from students beginning their first year to researchers with multiple Ph.D.s.

Adaptability became a key factor for planning research spaces and infrastructure in the Hunt Library as designers delved deeply into the campus use cases. Unlike more purpose-built research and lab spaces in science and engineering, the library spaces needed to be able to serve many different disciplines with a variety of needs. Compute power, high-resolution graphics, large-scale display, and high fidelity audio were common technology elements, but beyond these general fundamentals the specific needs quickly diversified depending on the type of content that would be displayed, the applications that would run, and the type of collaboration taking place. The display needs could be a single screen (simple presentation), four screens (multiple laptops for group work), or a fully immersive wrap-around screen (simulation and visualization). Likewise, audio requirements could be stereo (simple playback of program material), surround sound (multimedia playback), or multi-channel (3D audio and intensive multi-directional immersive audio environments). Collaborative styles could range from a small working group around a table, to multiple break-out groups, to a seminar-style interactive workshop, to a standing-room-only presentation. The computing requirements ranged over a similarly broad set of requirements, from a standard desktop (simple presentation and standard applications), to a high-performance graphics server (immersive
Designing numerous spaces, each tailored to a certain type of activity, would have been a welcome luxury, but budget and space constraints quickly pointed the discussion towards a small handful of spaces that would have the technical capabilities and physical flexibility to adapt as needed to the requirements of whatever researcher or group happened to book the space that day. In addition to short-term, ad-hoc adaptability to accommodate daily use, the rapid pace of technological change required that it be easy to swap, change, and upgrade equipment over time, whether it be a major replacement of heavy infrastructure components every six years or the pre-release of a test piece of equipment that would only be in place for a few months. The idea of a protean design that is meant to be “tinkered” with turns out to be a disruptive and unusual concept in the technology industry; the majority of institutional customers have a clear purpose for the space they are commissioning and want a specific technology installation put in place that will stand alone and do its designated job until its time comes to be replaced and redesigned. In the academic research environment that the Hunt Library sought to nurture, however, such a fixed technology and space design would have fallen far short of the service and program goals for the building. A classroom makes a good classroom, but a poor visualization lab; a theater makes a good theater, but a poor videoconferencing facility. As a matter of first principles, the research library is prospective rather than prescriptive; it does not pre-define the limitations and constraints for how a researcher may conduct his or her work, but provides a set of raw materials that the researcher may shape in whichever direction his creativity and ingenuity take him. The Hunt Library, as a component of research technology infrastructure, had to be designed to breathe, move, and adapt at the pace of research.

Following is a programmatic description of the technology and spaces. Please refer to Appendix C for a Hunt Library floorplan.

B. CORE BUILDING INFRASTRUCTURE

Realizing the Hunt Library technology vision required converging physical and virtual spaces. Unlike library spaces that support undergraduate study, research-focused physical spaces require complementary virtual spaces that can provide the compute power, storage, and network performance needed for research-class applications. The classic elements of presentation—slide decks, videos, animations, charts, and other finished products—are commonly supported in many classroom and general purpose spaces at the university that have projectors and displays. Such products are, of course, a component of the research lifecycle, but they are relatively low intensity in terms of the compute power needed to run them (usually a standard desktop will do) and tend to come towards the end when there is a product of research that can be pulled together, packaged, and summarized for an audience. The earlier phases of the research cycle—the ones that Hunt specifically aimed to supplement—depend more heavily on graphics-intensive and processor-intensive applications, big data, and big graphics that require massive amounts of fast storage, and rapid exchanges of data between applications that require ultra fast networking. In order to be both attractive and effective for research, Hunt had to quite literally be more than just a pretty face. Thus, infrastructure is a core enabler for the building’s technology program. The building's data center design, IP and A/V fiber networks, HPC and graphics computing, and high-performance storage (integrated with campus infrastructure), are all designed to support extensible use of spaces and to minimize operational staff support.
One of the key drivers for designing the Hunt Library as a research space, particularly in the modern world of compute-based research, is that very little of the research lifecycle takes place inside of the library’s four walls. Researchers work in their labs, their offices, at home, but seldom if ever in the library itself. Any attempt to integrate with and be useful within the researcher’s established pattern of work has to accept this fact as fundamental. For a research library with Hunt’s aspirations, this means accepting the fact that most research activity does not and will not take place in the library, but that the library can fill an essential niche at points in the research lifecycle that draw researchers in to use the building’s resources for short but materially significant periods of time. It would be foolish to imagine that a researcher would come to the library to generate all of his data, run his applications, and produce his final product, as much as it would be whimsical to imagine that his book-based counterparts of the last century read all of their books, too all their notes, wrote their articles, and polished the final form of their research all within the library’s walls.

Today’s researchers and students are highly mobile and work in a wide variety of locations, meaning that if the library-as-infrastructure and library-as-service is to be relevant to them, it must meet them wherever they are, whenever they need it. The library building must to a certain extent become porous, its services and capabilities no longer defined by the walls that contain them, but by the ability for researchers to seamlessly move in and out with their data and applications as they desire, leverage the unique capabilities of the facility for as long as they need it, and then pack up their tools and move back to lab, office, or wherever they wish to keep working until the next time they need to return to the library. Ease of use is of paramount concern. If that experience of moving into and out of the infrastructure is frustrating or time consuming, the researcher is likely to give up and go elsewhere to meet their needs. The requirements for library infrastructure are clear: it must be easy to use, porous, integrated with the general campus infrastructure, very fast, and highly capable. At the same time, the library is not, nor should it attempt to be, central or enterprise computing for the campus. In order to achieve the classic characteristics of better and faster, the library has to do its job cheaper, meaning that the order of the day should be a relatively small installation of shared infrastructure that can provide just enough burst computing and storage capacity to enable key research activities in the library’s spaces for a specific time-limited project, then allowing those resources to be recovered, repurposed, and redistributed to someone else for their use. It is, fundamentally, a model identical with that of how the lending library became an iconic model of research in the print-based era.

**DATA CENTER, IP AND A/V NETWORKS**

For a research sandbox technology environment, network design is of fundamental programmatic importance. In the shared infrastructure design, the entire facility is essentially conceived of as an extended, deconstructed data center (server room). It would be far too expensive to build a physical data center with the necessary capabilities next to each of the high-tech research spaces in the building, not to mention the large-scale displays throughout the facility; neither is it possible to neatly cluster the high-tech spaces in tidy proximity to the data center, making a “nerve center” model that has a centralized computing core with high bandwidth connectivity to an array of spaces on the periphery almost a given. By design, about 90% or more of the heavy equipment in the Hunt Library is located in the data center on the first floor, with the high tech research spaces and the display walls conceived of as distributed extensions of the data center (see Figure 2). That quantity of equipment includes the IT equipment that one would traditionally expect to find in the data center—servers, storage, network switches, etc.—as well as that which would normally be found out in the rooms themselves—video processing, A/V matrix switching, display sources like desktop computers, Blu-ray players, and IPTV set-top boxes.
The data center itself is then the nerve center for all media content and A/V systems in the building, as well as the heavy computing that supports research applications. The server room has rack capacity for all servers, switches, and related A/V machinery in an innovative closed hot-aisle containment rack system that is up to 30 percent more efficient than a traditional server room raised-floor design, with redundant chilled water cooling and scalable power. The cooling and power distribution systems are designed for future growth capacity as the research program expands, with the ability to grow incrementally to more than twice its installed specification.

The centralized equipment model has numerous benefits, but three in particular are important for the research spaces themselves: heat, noise, and space. There are six racks of A/V equipment in the data center that would otherwise have been distributed around the building, three of which would have sat directly in the primary research spaces, the Teaching & Visualization Lab and the Creativity Studio. For the research spaces in particular, removing that equipment from the floor to the server room significantly lowered the overall cooling requirements for the rooms; lowered the overall noise level to make the rooms more conducive to group work and conversation; and saved valuable floor space in the rooms that could be dedicated to programmatic function rather than technology support.

Fig. 2. Schematic showing the building’s five floors and the arrangement of the technology spaces in relation to the network backbone that connects them to the server room. The high-tech spaces are designed as if they were simply extensions of the server room.

The building has two network backbones: a commodity switched IP network for standard data traffic, and a separate point-to-point network for all display, sound, and A/V control. Conduit for the dedicated A/V network runs from all high-end A/V spaces in the building through dedicated A/V “IDF closets” down to the server room, parallel to the switched data backbone. The commodity network in the building has fiber optic risers that supply a ten-gigabit (10G) backbone, with a combination of 10G and 1G connections supplied to every major technology space in the building. Every computer workstation in the building has a dedicated 1G connection, with the heavier workstations in the media production rooms receiving a direct 10G link to the server room. To
support the research-class computing and storage that provides the horsepower for the high-tech spaces, the server room itself has an ultra-fast 40G internal network, four times the speed of the university backbone and the fastest production network on campus.

**STORAGE**
High-speed, high-performance storage is key to the smooth and successful operation of the complex computing environment in Hunt. Storage is tiered out into different classes that are purpose-built to support the various types of activity in the building, whether it be commodity desktop computing, media production, or high-performance computing. All storage is networked and shared to any equipment in the data center from a central pool, enabling use of high-speed storage throughout the project lifecycle by any applications running on any server. A stack of high-performance EMC Isilon storage provides dedicated, highly scalable storage specifically for research and project data that can easily scale to meet the growing demands of the research program over time.

**HIGH-PERFORMANCE COMPUTING AND RENDER FARM**
Two essential strategies for the research program in Hunt are integration with central campus HPC and storage, as well as the Virtual Computing Lab (VCL), which is a massive, cluster-based, shared-time central server farm built at NC State to provide on-demand remote compute power for students and researchers alike. The library does not need to provide central computing power for the campus—it has neither the funds, the space, nor the staffing—but it does need sufficient capacity to enable the unique aspects of the research program in the Hunt Library that are not available anywhere else on campus. While the majority of compute for researchers and faculty takes place on central resources, the library now hosts one of the most powerful render farms in the region for producing ultra-high-definition animations, models, visualizations, and motion graphics, providing disciplines from design to computer science to materials engineering with a distinct advantage in producing complex 3D objects. The library is bringing online a small HPC cluster to complement the massive display capabilities in Hunt and link the Libraries more deeply into the research computing infrastructure of the university, which will give researchers and graduate students the flexibility to crunch data, experiment with software and configurations, and run simulations locally as they are working in the spaces. See Figure 3, below.
DISPLAY WALLS AND GENERAL A/V INFRASTRUCTURE
Display is the cornerstone of the Hunt technology program. The building features over 100 million pixels of research-class display space, distributed across four large-scale public display walls, a Game Lab, a Teaching and Visualization Lab with 270-degree immersive and 3D display, and a Creativity Studio with two wall-to-wall, floor-to-ceiling projection walls. The Game Lab and display walls are Christie MicroTiles and run from four to eight times the resolution of full HD displays. The Teaching and Visualization Lab alone boasts some 80 linear feet of projection space and over 22 million pixels of resolution.

The Hunt Library is designed to be an integrated visual environment, with an extensive variety of high-resolution display walls and immersive projection spaces that support a robust program of visualization, presentation, and large-scale display. The integrated design means that each of the seven major display spaces act as a node along a common backbone and share centralized high performance computing, routing, and switching. Each of the major screens can display up to sixteen sources simultaneously, making them rich digital canvases for research, collaboration, and teaching. The infrastructure design allows a true any-source-to-any-display architecture to achieve optimal flexibility in the use of the entire building as a research hub. Since all of the major compute infrastructure and display servers are located in the central server room near A/V switching
infrastructure, the design allows a researcher to move between any of the major display environments in the building at will without having to worry about moving their applications and data.

**Audio Infrastructure**
The building also has a premium professional audio infrastructure, with three rooms that have 5.1 surround sound, two rooms with 3D sound capabilities, four audio production rooms with full MIDI keyboards, and a local FM broadcast system that allows each of the major display walls to have its own wireless audio to personal devices and portable systems. The building has a fully networked audio system, making it possible to activate any space as an extension of the sound environment simply by activating a network port and plugging in speakers and microphones.

**C. Research Spaces**

**Black-box and White-box Spaces**

*Primary focus areas: large-scale visualization and display; gaming, interactive computing and programming; communications and collaboration*

“Black box” and “white box” spaces are designed so that they can be rapidly reconfigured and can adapt to virtually any use case, experiment, or research question. Much like a stage set, the open floor design, exposed infrastructure, movable furniture, and adaptable lighting, sound, and display components are designed to be dynamically reconfigured to support the event on hand, then changed over to support a new set of requirements for the next event. Because the compute power for the rooms is centralized, every project can have its own discrete space on the servers, enabling easy changeover between users of the space by "lowering" the virtual curtain on one event and “raising” it on the next. Thoughtful automation and touch controls provide self-service support for over a dozen combinations of furniture and technology setups that meet the standard uses and most common bookings of the rooms. A team of technicians, project managers, designers, and programmers supports the rooms with services that provide event and technical consulting as well as custom support for more intensive special projects and research.

There are two such spaces in Hunt: the Teaching and Visualization Lab and the Creativity Studio. These spaces can be continually repurposed to serve the different needs and requirements of dozens of different academic programs across numerous disciplines, including engineering, design, physical sciences, environmental and life sciences, social sciences, and the humanities. The rooms employ a modular design that allows them to be leveraged for any phase of a project lifecycle, including brainstorming and ideation, early experimentation, collaborative engagement, and public presentations and events. As research spaces, they are particularly valuable for this ability to adapt to different phases of the work in progress, as well as for the ability to manipulate hardware and software directly up and down the technology stack to customize them to suit to the research question at hand.

These spaces opened for regular booking at the beginning of the fall semester 2013. The descriptions of technology and example uses described below are from the first semester of operation.
Designed according to the principles of a "black box" theater, the Teaching and Visualization Lab ("Viz Lab") is built on access flooring with an open rack ceiling and grid for A/V equipment and channels in the wall to connect infrastructure and data between the floor and ceiling. The lab's flexible infrastructure is designed to respond over time to the rapid advancements that are being made in visualization and display technologies. It offers seamless 270-degree immersive projection on three walls for a total of 80 linear feet of blended-pixel display surface with 3D capability. It offers multiple computing platforms for use on demand. It also has a professional zoned 21-channel audio system, along with cameras for real-time video capture, broadcast, and collaboration. The room is tied into the video infrastructure of the building, with the capability to take delivery of streamed video and HPC power directly from the server room, as well as the capability to capture content being created in the room and broadcast it out to remote sites. The exterior wall of the lab has vertical floor-to-ceiling Christie MicroTile columns that will display passive video or static image content streamed from the server room.

The room supports a variety of uses, including interactive learning; large-scale, high-definition visualization and simulation; command/control room simulation; immersive interactive computing; game research; "big data" decision theater; and comparative social computing.

The range of bookings for the Viz Lab illustrate the versatility of the space as well as the range of technical and collaborative use cases that it can support. In its first semester, the space hosted the opening of the Virtual Paul's Cross project, an immersive visual and aural digital humanities recreation of St. Paul's Cathedral in London in the year 1622, which allowed viewers to move around inside of the space and experience what a sermon by John Donne would have sounded like from different parts of the church yard to the north of the cathedral. The lab was used by Computer Science graduate students to demonstrate a new technology for scanning objects in 3D and uploading them in real time to a virtual crime scene environment that allows investigators to recreate a crime
scene with millimeter precision. A joint team of graduate students from Veterinary Medicine and Landscape Architecture presented a proposal to the provost and the deans of their respective colleges, as well as faculty and colleagues, for a new zoological research facility at the university. Students worked with library staff to host music production and 3D printing workshops. A team from the Transportation program turned the room into a 270-degree immersive fly-through of an urban overland bridge and demonstrated their investigations into creating a real-time game environment that could simulate traffic conditions and the effects of various changes to landscape, roadways, and traffic controls. A research team met to work on a proposal for quantitative research methods in sound. Through over two dozen events in the fall of 2013, the faculty members and researchers embraced the flexibility and unique capabilities of the room.

A core principle of the room is that it must be adaptable to uses by researchers or instructors throughout the course of the day, even if room bookings are back-to-back. For a room with as many configuration options as the Viz Lab, maintaining the flexibility of the room and meeting the demands of the schedule without placing excessive demands on staff time calls for a strategy to maximize the number of options available to users while minimizing the effort to change and set configurations. For both the Viz Lab and the Creativity Studio, technical staff worked with the public services and facilities teams to come up with a core set of six “standard use cases” with default configurations of furniture and technology that cover approximately 80 percent of the use cases for which faculty book the room (see Figure 5). The standard use case layouts and options are available to choose from at the time of room booking. Each standard configuration can be customized during the consultation that each faculty member receives after placing a room reservation request. For the bookings that go beyond the capabilities of the standard configurations, faculty are taken into an in-depth research and technology consulting process that allows for individualized customization of the room and its technology.
Fig. 5. Examples of furniture layouts for the six standard use cases for the Teaching and Visualization Lab. Each configuration can be paired with a standard technology setup for numerous possible combinations that suit most events.

Fig. 6. Teaching and Visualization Lab
The Creativity Studio is a high-technology "white-box" space designed to encourage creativity, experimentation, and exchange. The Creativity Studio can be configured for a wide variety of research, teaching, and collaborative activities in many disciplines. The infrastructure is similar in design to the Teaching and Visualization Lab, with the addition of design elements drawn from studio and gallery spaces. It features an open ceiling grid, movable white board panels on a ceiling-mounted track system, curtain panels, portable seating, flexible tables, and two rotating center walls that can divide the room into two distinct spaces. There is a large floor-to-ceiling curved projection screen at the north end of the room and a large floor-to-ceiling flat projection screen at the south end. The room has the capability to hang fast-fold projector screens and portable green screens from the ceiling grid, as well as sound-absorbent panels to adapt the space for audio recording applications. A theater lighting kit provides multi-colored LED lighting and zoom spots, and projection-quality materials make every surface a potential display. Powerful cameras, microphones, a professional zoned audio system with 42.2-channel surround, and cameras for real-time video capture, broadcast, and collaboration combine with the visual technologies to allow the room to adapt to almost limitless configurations, including simulated environments, ideation and brainstorming, gallery space, interactive classroom, film studio, and remote collaboration suite.

The Creativity Studio has the capability to support similar use cases to the Viz Lab, though its shape and special features make it better suited for brainstorming and collaborative group activities, as well as certain types of more intimate interactive and dynamic simulation and visualization, whereas the Viz Lab is better for larger-scale “set piece” immersive environments because of the larger space, greater screen real estate, and more open sight lines. Other uses for which Creativity excels include brainstorming and ideation on the extensive quantity of whiteboard walls; gallery-like exhibition and presentation/review space; remote collaboration, capture, and engagement; and studio-style camera recording.

One of the premier uses of the Creativity Studio in fall 2013 was for an interactive Naval Maritime Skills simulator, a real-time vessel simulator for the Naval ROTC at NC State that allows midshipmen and instructors to recreate the experience of being on the bridge of any vessel in the US Navy Fleet at any port of call in the world. The simulator offers a full recreation of all duty stations and controls on the vessel as well as the capability to simulate different weather conditions, nearby vessels and aircraft, and threats. While the simulator was used primarily for instruction, it demonstrated
ancillary research benefits by leveraging a number of infrastructure components that successfully demonstrated the research uses and applications possible in the space, and sparked numerous ideas for simulations that could be built using the same techniques. Other uses of Creativity included a sponsored competition for the Walt Disney Imagineering program; workshops for brainstorming game design concepts, generative design, and algorithmic architecture; joint use for a component of the Transportation visualization and research workshop; a Computer Science Ph.D. written qualifying exam; and, in one of the more esoteric yet highly appropriate uses of the space, a two-bridge simulation of the Starship Enterprise.

Similar to the Viz Lab, the Creativity Studio has standard supported use cases for furniture and technology usage that can be selected at the time of booking (see Figure 8).

Fig. 8. Examples of furniture layouts for the six standard use cases for the Creativity Studio. Each configuration can be paired with a standard technology setup for numerous possible combinations that suit most events.
GAME LAB
The Game Lab (see Figure 10) anchors the third-floor Next-Gen Learning Commons and supports the scholarly study of digital games, as well as offering a place to take a break and play for fun. The room is built around a massive 20x5-foot high-resolution display that can be used as a single ultra-high resolution digital canvas running at eight times the resolution of HD, or carved up into multiple screen spaces to display the numerous console gaming platforms and computer sources that are available in the room. Three sides of the room are snap glass, or smart glass, which can be turned from transparent to opaque with a single touch on the room’s control panel, enabling total privacy for teaching, research, or development needs.

The room was designed in close consultation with faculty members from Computer Science and the College of Design who lead NC State’s Digital Games Research Center, a national top-20 gaming program that is interdisciplinary by definition, requiring teams of programmers, designers, storytellers, and business people. Because of its interdisciplinary nature, the program did not have a proper home for its joint activities, but was left to find collaborative working space and appropriate technology as it could on a semester-to-semester basis in one college’s space or another. With interdisciplinary collaboration and research into core technologies as one of the key goals of Hunt, these faculty leaders were eager demonstrate what could be accomplished in a truly multi-purposed space that can be highly visible and public, yet instantly private when it needs to be; highly sophisticated for research applications, yet perfect for commodity entertainment gaming; comfortable for a handful of gamers using the space for the afternoon, yet easily able to accommodate 20 for an extended research session.
Fig. 10. Professor Michael Young in the Game Lab

D. CLOUD SPACES

*Primary focus areas: large-scale visualization and display; gaming, interactive computing and programming; communication and collaboration; prototyping and creation*

As an aspiring component of the compute-based research enterprise at the university, the Hunt Library had built-in challenges from the beginning. Research that depends on compute power, highly capable networks, and mass data storage have of course been active in the university context for some time, though the research library has been largely peripheral to computational research, except beyond providing content that is valuable to the early design and later dissemination phases of the lifecycle. Compute-based research takes place in so many existing places on campus—the university HPC cluster, departmental or college resources, and especially hardware that belongs to the individual researcher, purchased with grant funding. Moreover, the library would be providing a limited resource that must be shared; as with the older book model, it would not be financially or logistically feasible for the library to provide enough individual resources for everyone on campus to use them simultaneously, so they must become a shared resource. The challenge boiled down to a simple problem statement: if I am a researcher standing in the Viz Lab with all of these high quality visual and audio capability, how do I access my research data to bring it up in front of me and get to work? Given this context, the technology strategy for the Hunt Library had to be engagement and integration: go where the faculty are, and allow them to move their applications and data easily into and out of the building. The programmatic direction to support research happening on other campus infrastructure, but supply unique capabilities that augment the ability to interact with, visualize, and present that research, indicated early on that some form of cloud computing would be crucial for the overall success of the program.

PRIVATE CLOUD

Cloud computing has become a buzz word throughout the consumer and business industries as a method to increase the efficiency, availability, and service quality for applications and data. In essence, the cloud computing approach takes applications and data that otherwise would have been hosted on local computer hardware and storage, with the associated limits on when the computer
can be accessed as well as when and how a user can access their files, and lifts them up to servers that are accessible from anywhere, at any time. The cloud computing approach has clear benefits to research as well as the consumer and business environments. According to the NSF cloud research agenda, “The cloud model promotes availability [...] The five essential characteristics are on-demand service, broad network access, resource pooling, rapid elasticity, and measured service.” (3) Each of these elements was a factor in considering how the building could act as a beneficial service to the researcher. If the Hunt Library were to be an attractive resource to researchers and faculty, the services offered had to provide an easy mechanism for users to get their projects into the library to use the unique visualization and collaboration resources, and just as easy a method to pack up the results of their time in the library and take it back to their lab, office, central computing, or wherever they may spend the majority of their research time. Following these design principles—to allow researchers access to their library-based work any time, from any device; and to give broad access to a limited pool of resources—led to a cloud computing strategy as part of the service program for the Hunt Library.

In order to enable integration of Hunt visualization resources with central compute resources and central storage, and to enable continuous work on projects when not inside the physical space of the library, a private cloud is the practical and cost-effective solution. The Libraries has added over 100 terabytes of high-performance, research-class storage that is freely available to any member of the community on a registered, time-limited basis to conduct project work in large-scale graphics, modeling, animation, big data, or any other area of compute-based project work or research. The Hunt private cloud is in active development, with active testing and implementation of integration with campus infrastructure and remote, anytime access to compute infrastructure. A reference architecture was developed by library staff as a conceptual planning document that was used to illustrate the plan for how to integrate technology-rich spaces with A/V and IT infrastructure to enable the programmatic and research use of the building while making it accessible as a cloud-enabled resource that would, in essence, allow a student or researcher to have the Hunt Library accessible from their pocket.

GRAPHICS INTENSIVE APPLICATIONS
Any form of visualization and digital media requires intensive compute resources simply to process and view, much less to create. With visualization as the core programmatic element of the Hunt technology program, the capability to provide machines and infrastructure that could support fluid and usable interaction with graphics-intense applications was essential. Each of the high-tech spaces and display walls are equipped with display servers that provide top-of-the-line graphics capabilities. Through its media production labs, workstation-class machines throughout the public learning spaces, and custom software configurations, the library provides robust media, imagery, modeling, CAD, and animation platforms in-house for student use.

RENDERING & VISUALIZATION
Even comparatively low-resolution imagery can stress the capability and capacity of traditional desktop computers in the finishing phase of rendering out the final movie or model. Rendering a full HD movie only a few minutes long can take an entire day or more. Attempting to produce movies and models that match the full resolution capabilities of the display walls in Hunt could literally take weeks or months on desktop computers. Given this physical limitation of the computers that students and faculty typically have access to, a server-based render farm that could off-load the processing load from the desktop where the graphics are produced, and vastly increase the speed
with which large media files could be produced, became a key piece of the infrastructure design. Server-based render farms are rare outside of the animation and movie industries, which closely guard information on how they configure and deliver large-scale, high-capacity rendering services, which led to over a year and a half of research, prototyping, and trial-and-error to configure and tune the system. A sixteen-server render farm is currently in production in the Hunt Library data center, providing render services for the production of high-resolution imagery, 3D objects, models, simulations, visualizations, video, animation in support of library spaces.

**ANYTIME, ANYWHERE, ANY DEVICE PROJECT SPACE**

By design, the Hunt Library aims to provide technologies that are on the leading edge or difficult to acquire in the commodity marketplace, as well as a wide variety of technologies that are more familiar and commonly available. The unique capabilities of the building are best leveraged from computers and infrastructure that is in the building and is much more highly capable than the computing that most students have access to. The library will provide the computing power necessary to collaborate and create in its physical spaces in the form of project-based, temporary virtual spaces that have direct access to the large displays and other advanced technologies in the building. In a circulation analogy, researchers and students can “check out a terabyte” and compute capacity on a time-limited basis for carrying out projects related to library spaces and project areas.

**INTEGRATION WITH CAMPUS AND COLLEGE INFRASTRUCTURE**

The Hunt Library infrastructure has "service lanes" into central campus compute and storage facilities, such as HPC/VCL, as well as college compute environments, to provide seamless and “anytime, anywhere” access to Hunt spaces and technologies. It is in the Hunt technology roadmap to also provide service lanes to external cloud infrastructure providers such as Microsoft, Amazon, and Dell for burst capabilities or sustained extension of building resources such as storage.

**E. INTERACTIVE AND DISPLAY SPACES**

*Primary focus areas: large-scale visualization and display; supporting the research community*

The Hunt Library is conceived to capitalize on the recent, significant advances in visualization that are energizing the latest wave of scientific, engineering and design productivity. The building was designed to be an integrated presentation and visualization environment from top to bottom—not simply a number of screens in rooms, but a connected series of display spaces, each with a different character, that connect together and play off of the strengths and characteristics of each other to create a unified context that is suitable for any phase of the research lifecycle. From the closed-door, black box visualization and teaching spaces on the fourth floor, to the dynamic public/private Game Lab with smart glass that can hide the room from public view with a touch of the screen, to the large display walls placed throughout the public areas of the building, the display spaces in Hunt are tailored to suit the wide variety of research, event, presentation, and publicity needs that make up the daily rhythm of the library.
DISPLAY WALLS

The massive display walls throughout the Hunt Library are composed of hundreds of individual Christie MicroTiles that stack together to form a variety of unique, ultra-high resolution display surfaces for game research, simulation, interactive visualization, presentation, modeling, animation, and media display. The LED light source in every tile has a seven-year half-life and can display a range of colors not seen in any other display manufactured today. Each MicroTile wall in the library can display images and video over four times the resolution of standard HDTV—some as high as eight times HD—creating an ideal digital canvas for research and teaching.

The “Art Wall” sits above the Ask Us service point at the entrance of the library and acts primarily as a welcoming advertisement of the building’s program and capabilities, as well as a showcase for research and project work taking place within the building and on campus.

The “Visualization Wall,” located on the outside face of the Teaching and Visualization Lab, is intended for programmatic content showcasing dynamic visualization of data and general visual content and graphics. It is also used to broadcast events and activities that are taking place in the Viz Lab and reflect them back into the general Commons area.

The “Commons Wall” sits above the open stair that leads from level three to level four above an open seating area, with wide, Roman-style stairs at the far end. The space is designed much like an open theater, with standing and seating space for several hundred people, making it an ideal community and event space. Programmatically, the wall is designed to act as a vibrant and stunning venue for
events of academic and community interest, such as lectures, demonstrations, world events, and sporting events.

In terms of building function, each of the display walls are tightly integrated with the technology in the Viz Lab and Creativity; each one of them (or all of them acting together) can act as “overflow” for overcrowded events by displaying camera views and content from either one of the rooms, and by playing room sound through a ceiling speaker array. For example, a researcher giving a demonstration in the Viz Lab has the capability to quickly convert a presentation from one that reaches the 40-person capacity in the Viz Lab to one that reaches an audience sitting in the Game Lab or the Immersion Theater, or can project the presentation throughout the entire building.

**IMMERSION THEATER**

A highly visible spot located just inside the Library entrance, the Immersion Theater features a "curved" 7x16-foot video display wall, creating an immersive visual experience. Programmatically, the space serves a dual purpose. First it acts as gallery and show space, strategically placed only steps inside the library entrance, to give the visitor to the library an immediate experience of the character of the building and what happens in it, a constantly changing montage of multimedia content, interactive applications, research events and demonstrations, and immersive virtual environments. Visitors to the Immersion Theater are able to browse through a gallery of content, projects, and demonstrations particular to the Hunt experience and select them to view on the display wall. In its second purpose, the Immersion Theater acts as a presentation space, an open-air theater immediately off the high-traffic main entrance path where faculty can showcase their research, students can demonstrate their projects, library staff can quickly inform and orient students and visitors, and anyone who has an idea they would like to share can spin up an ad hoc workshop or presentation.

Media can be displayed either from a local-source computer (input/output panel on the north wall) or streamed from the library's server room. In addition, a small rack and input/output panel located behind the display offer more control and connectivity options. The space can serve as “overflow” for
a lecture or event taking place in either the Teaching and Visualization Lab or the Creativity Studio by providing camera views, display content from the room, and audio.

Fig. 13. iPearl Immersion Theater

F. VIDEOCONFERENCING AND EVENT CAPTURE

Primarily supports focus area: communications and collaboration

The Hunt Library was designed to be more than just a unique resource for Centennial Campus at NC State. The communications infrastructure that pervades the design raise the building to the level of a local, national, and even international hub for research collaborations.

VIDEOCONFERENCING
Technology-enabled collaboration is woven into the very fabric of Hunt and is designed to suit the needs of three different tiers of use. Formal high-resolution video conferencing that recreates a traditional sit-down meeting at a conference table is available via Cisco TelePresence in the Video Seminar Room. Dynamic high-resolution conferencing is provided in both the Viz Lab and the Creativity Studio through controllable point-tilt-zoom (PTZ) cameras placed in each corner of the room. True to the flexible and adaptable spirit of these rooms, the conferencing capabilities are designed to bring remote guests into the middle of dynamic collaborative sessions, allow them to experience unique research installations that take advantage of the rooms, or enable them to participate as an invited expert in a seminar. Informal conferencing accommodates the wide variety of web-based chat software used on a daily basis by many students and faculty, including Skype and Google Hangouts. This level of conferencing support places webcams in every room and accommodates seamless integration and use of user-owned devices with technologies in the building, including laptops, tablets, and phones.

CAPTURE AND STREAMING CAPABILITIES IN HIGH-TECH SPACES
In keeping with the concept of a vCentennial Campus, collaboration as a mode of engagement and creation is built into the fabric of the library—both within its spaces and extending out to remote
locations— in the form of collaborative computing, content capture, video streaming, and conferencing technologies. The PTZ cameras in the Viz Lab and the Creativity Studio are connected to the same classroom capture recorders used in every classroom on campus, with familiar record buttons on the touch screen that allow users of the room to adjust camera angles and capture their session on demand. Users can choose to save their sessions to the campus classroom capture server for later retrieval, or stream their session live to a public Internet site that anyone can view.

G. INTERACTIVE COMPUTING

*Primary focus area: interactive computing*

Interactive computing for the purposes of the Hunt Library is defined as any form of manipulation of a computer interface or application by means other than a keyboard and mouse. Touchable glass screens have become the most common form of interactive computing in the consumer market, particularly the small, four-inch to ten-inch displays on phones and tablets. Large-scale touch screens of 42” or larger are less common, but important in such areas as retail and interactive wayfinding maps for malls and conference centers. Other forms of interactive computing include motion-based, touch-free systems are increasingly visible for advertising and interactive content in airports, theaters, and malls, and for several years have been a feature of gaming platforms such as the Microsoft Kinect, Still other forms of interactive computing use gyroscopes inside devices to interpret motion and velocity into actions within an application—for example, shaking an iPhone while typing is a gesture for “Undo.” Interactive computing encompasses a wide range of emerging technologies, accompanied by a wide-ranging set of arguments about what are the most natural and usable ways for human beings to manipulate computers, all of which makes the field a rich subject of research. Researchers such as Robert St. Amant in Computer Science study interactive computing specifically, while others, such as Patrick Fitzgerald in the College of Design and David Rieder in the Communication, Rhetoric, and Media department, incorporate motion- and gesture-based control into interactive applications and content that they build in their research groups and classes. The prevalence of research and experimentation with interactive computing at the university made it a natural primary focus area for the design of the Hunt Library.

**LARGE-SCALE MULTI-TOUCH DISPLAY**

In keeping with the principle of putting technologies that are emerging or difficult to obtain directly into the hands of faculty and students, there are numerous large-scale touch monitors available throughout the building, including the largest—an 82” Perceptive Pixel display—in the Fishbowl seminar room on the fourth floor, just across from the Viz Lab. The Viz Lab itself is equipped with two 55” multi-touch displays for use in research and teaching applications for the room.

The Level Three Commons was designed as an interactive, collaborative, and flexible technology-rich learning space, with interactive computing a particular feature of the floor. The Game Lab boasts the largest touch screen in the building, with its twenty-one foot display fully enabled for up to fifty simultaneous touches. A pod of workstations at the other end of the floor feature touch screens on each computer to facilitate programming and development of touch-based applications. A mobile SMART Board that provides touch-based interaction with projected images on a white board surface can be moved to any of the collaborative group spaces on the floor. A Microsoft Surface table, a wall-mounted Perceptive Pixel display, and a Perceptive Pixel mounted on a mobile, adjustable frame that allows the display to be tilted at any angle round out the touch screens on the floor.
Students and faculty are able to create and install touch applications on any of the available screens. In support of usability research applications by Computer Science students, the library provided an equivalent touch screen to Professor Robert St. Amant’s research group to support in-depth study and development of interactive computing applications.

**VIRTUAL BROWSE.** The large amount of collaboration and computing space available to faculty and students in the Hunt Library was made possible by the early decision to place the vast majority of the collection that needed to be housed in the building into the two-million-volume-capacity Automated Storage and Retrieval System (“bookBot”). While the bookBot recovered a large amount of user space from what would otherwise have been book stacks, those gains were counter-balanced by the reality that the books would no longer be openly browsable, creating a significant shift in how the community engaged with the collection. A team of library staff studied the problem and conducted a series of focus groups and interviews with both faculty and students to determine what elements of the browsing experience were most important to their use of the collection. The results of that study were turned into a set of descriptive requirements for building a facsimile of the shelf browsing experience that could be represented on a digital shelf. Creating the application for a touch screen was an early design decision to give the user a sense that they were still reaching out and touching the books.

Virtual Browse was deployed on the first floor at Hunt on a 55-inch multi-touch screen next to the windows into the bookBot. Virtual Browse supports interactive access to the Libraries’ collection and other research collections through a touch interface, with “bookbag” and requesting features that allow immediate request and retrieval of materials that are housed in the bookBot. Virtual Browse has proven very popular with students as well as visitors for the unique, interactive view that it provides into the collection. Virtual Browse is used by 542 users per day on average. A usability study is currently underway to determine the next phase of feature development. Major features in the tentative road map include integration with HathiTrust full-text previews, request and delivery of materials from anywhere on campus, and faceted browsing to allow quick, dynamic filtering of results.

*Fig. 14. Virtual browse.*
GESTURE-BASED INTERACTION

The Microsoft Kinect is widely used at the university as an inexpensive and easily accessible tool for accomplishing hands-free, motion-based control of computer applications. The student game created for Mini Hunt in the spring of 2012 by a class of designers and programmers was premised on using two Kinect cameras acting in tandem in order to take full advantage of the unprecedented width of the display in the Game Lab. Other experiments with the Kinect include a poem visualization application developed by a faculty member in the Communication, Rhetoric & Digital Media department. The application reads in the text of a poem and uses the Kinect to create a 3D map of the viewers standing in front of the screen; it then maps the words of the poem onto the shapes of the bodies in front of the screen and reflects the results back to the viewers, so that they are effectively watching themselves in poem-form. Patrick Fitzgerald, faculty in the College of Design, uses the Kinect extensively in his experiments with building new forms of media and interactive content.

H. PROTOTYPING AND CREATION

Primary focus area: prototyping and creation

One of the core technology design principles for the Hunt Library conceptualized that not only should the technology in the library be open and accessible, but it should invite the community to interact with it, manipulate it, transform it however their imagination and curiosity led them. The maker culture is deeply embedded in Centennial Campus, with the College of Engineering and the College of Textiles both flanking the library building. Facilities for producing both digital and physical objects exist elsewhere on campus, but service planners for the library noticed that they belong to one college or another and have a long list of restrictions on who can use them and how. The concept for putting maker capabilities into the Hunt Library was not one of equipment, but of service. Whether 3D printing, creating experimental computers, building visualizations, or producing a music track, the prototyping capabilities of the library are open to use by anyone at the university for whatever purpose their imagination and creativity can invent.

MEDIA PRODUCTION STUDIOS

Two Media Production Studios support video production, capture, and recording with ultra-high resolution (4K imagery) and high-fidelity audio capability. Standard equipment for these rooms includes a multi-monitor LCD array, high-end recording and editing system, local storage, portable video cameras and stands, monitoring loudspeakers, portable mixer, microphones, and stands. Most equipment here consists of desktop components, but these systems rely on access to high-speed networked storage and server-based media delivery platforms via 10GB fiber connections to the server room. Both rooms provide a touch panel for equipment control (AMX Modero line).

Four Music Rooms support audio recording and music practice. Like the Media Production Studios, these rooms contain desktop equipment connected to server-based storage and applications, and with touch panels for equipment control. They are fully equipped for creating and mixing music, voice recording, audio transfer, and digital media editing, with full 88-key MIDI controller/keyboards, professional microphones, turntables, cassette decks, and digital media workstations.
Fig. 15. Media Production Studio.

MAKERSPACE
Researchers and students use the 3D printer in the Makerspace for prototyping and iterative design. Research examples include a tactile map to assist blind pedestrians to navigate a complicated intersection. The Computational Multi-Physics Lab in Mechanical and Aerospace Engineering used the library’s NextEngine 3D scanner to prototype the respiratory tract; the printed prototypes provided the realism and accuracy needed to accomplish reliable measurements and predictive computer simulations. Entrepreneurs are also using the 3D printers to prototype inventions. One product designed by NC State students from the Engineering Entrepreneurs Program and prototyped in the Hunt Makerspace is “Jar with a Twist,” which received national press coverage. Graduate students have used the laser cutter to make a tube amplifier for gaming. (See Figure 16 below.)

Fig. 16. 3D tactile map, Jar with a Twist, and tube amplifier.

TECHNOLOGY LENDING SERVICE
The Technology Lending Service supports the “technology incubator” role of the Hunt Library. As new tools and devices make their way onto the market, the library acquires and makes them available for students and faculty to use and test. Since 1999 when it was launched with a focus on laptop computers, this service has offered a wide range of computers and tablets; cameras and media production tools; specialized portable scientific tools; and various accessories. At the Hunt Library we also lend prototyping platforms (Arduino boards, Makey Makeys, and Raspberry Pis) so that students and others can experiment, prototype and create with technologies that they do not otherwise have access to and around which there is some curricular and extra-curricular “maker”
activity on campus. The prototype/create culture is particularly strong with undergraduates. One junior in a joint Textiles/Design program was inspired by a MakeyMakey she got from the Hunt Library to build an interactive “book.” (See Figure 17 and letter of email from Megan Wood in Appendix D).

I. SELF-SERVICE INTERFACES

The library supports multiple approaches to room control. These include AMX panels, a web-based room control application, and custom interfaces to the display walls.

The library offers dedicated and custom-programmed AMX control panels in each of the high-tech spaces. The user interface and pre-programmed capabilities are customized for each space. Below is an image of the Creativity Studio and Game Lab interfaces.

Magnolia, is a web-based content management and room control tool developed by the NCSU Libraries. Magnolia is used to document the spaces’ capabilities, to enable users to upload content.
(PowerPoints, images, videos, etc.) and format them for the space's display (dynamic content manager), and identify which applications from our standard set (web browser, Excel, etc.) will be needed during an event.

The Magnolia room control tools enable users to access the standard use cases and administer the rooms (on/off, load demo content, etc.). Non-standard use cases are accessible through the in-room control panels and staff-mediated programming interfaces to the room components and building infrastructure.

**Fig. 19. Magnolia web-based content management and room control tool**

**Fig. 20. Magnolia dynamic content manager**
The library also developed an iPad interaction for the Immersion Theater so library users could select content to display on that wall. The first application of the interface was for the Places and Spaces: Mapping Science exhibit, featuring well-known scientific visualizations in history (http://www.lib.ncsu.edu/event/places-spaces-mapping-science).

Fig. 21. iPad-based display wall control interface.

Fig. 22. Magnolia room control interface for staff.
VI. CASE STUDIES

The high-tech spaces (Game Lab, Teaching and Visualization Lab and Creativity Studio) were open for booking fall 2013 semester (although they lost probably 30-40% of their bookable hours due to continuing A/V installation and programming). Eighty-six events were booked through the room reservation system in those spaces during the semester, not including regular events such as the Naval Maritime Simulator training sessions. Additional events occurred outside the system, such as gaming tournaments and Disney Imagineering networking in the Game Lab. Other examples include a "proposal jam" hosted by a computer science faculty member in the Creativity Studio, an event where attendees brainstormed and then broke into groups to get a proposal written in a day. The Institute for Advanced Analytics held a data visualization workshop in the Viz Lab and the Integrated Learning Research Institute held a workshop, also in the Viz Lab, to demonstrate technology uses in teaching foreign languages.

Case studies were vital throughout the design and construction process for the Hunt Library. They served to guide discussions, test design ideas, verify assumptions, correct flaws, and generally to develop a coherent narrative for what the building would ultimately become. This section details a few of the use case projects that were part of the design and prototyping phase, as well as other projects that used Hunt spaces.

A. EXAMPLE RESEARCH PROJECTS

VIRTUAL PAUL’S CROSS - COLLABORATIVE DIGITAL HUMANITIES PROJECT
http://vpcp.chass.ncsu.edu/

Fig. 23. Virtual Paul’s Cross opening symposium
Dr. John Wall, Professor of English, contacted the library in September 2011, while the Hunt Library was under construction, to explore using a Hunt space for an exhibit of a collaborative digital humanities project he was leading to recreate the experience of preaching at St Paul’s Cathedral in 1622. The project was already well underway as a web-hosted project and had already received press coverage in The Atlantic's blog. For hundreds of years, Paul’s Cross, as the pulpit in the churchyard was known, served as a crucial and influential venue for social, political, and religious life in London. The churchyard was a cavernous outdoor courtyard formed in the space between the cathedral itself and low buildings built up around perimeter of the church. Capable of holding over 5000 people, it was the largest public gathering place in London, yet the only experience left to the modern researcher of sermons delivered there is text on paper. The purpose of the research grant was to bring Paul's Cross back to life in a virtual model in order to understand the elements of experiencing performance in that space that delivered such impact for speaker and listener alike.

For the next two years, the Virtual Paul's Cross research team (Dr. Wall, Professor David Hill and graduate student Josh Stevens) worked with library staff and the Hunt Library technical infrastructure to realize a vision for a fully immersive exhibit/installation that was inconceivable when they originally planned the grant. The unique aspect of the project was an acoustical model of the church yard that paired with the 3D visual model to recreate an impression of what the space actually sounded like. An actor voiced John Donne, and acoustical engineers added a variety of atmospheric sounds such as horses, birds, and carts. Crucial to answering the research question, the model allowed the listener to move to any one of nine different points in the churchyard to experience how the sermon would sound from different locations, as well as to change the crowd size in increments from 500 to 5000 people.

The final model of Paul’s Cross was visually and aurally sophisticated to a degree that an online video could hardly convey. The reality of the Hunt Library, which was a year and a half away from opening when Dr. Wall approached the library, provided the opportunity to present the full impact of the research. Rather than a web-page with a video that one could play to view the results of the intense visual, aural, and historical research efforts that went into the project, students would be effectively able to “walk in” to Paul’s Cross, the cathedral’s church yard, to interact with a full-scale immersive model that effectively presented the full capabilities of the research model. The project’s research team worked with the library’s systems administrators to process the very large graphics files through Hunt’s render farm and customize their model to the 270-degree, 80-linear foot display in the Teaching and Visualization Lab. The library’s visualization programmer worked with the project’s acoustic engineers to customize and install the audio component of the installation.

As one of the deep pilot engagements for the Hunt Library, the project enabled library IT staff to understand how projection, audio, rendering and other capabilities of the building could be deployed together to meet a research use case. More importantly, it served as a key demonstration to the students, faculty, and administrators of what the Hunt Library was capable of, particularly how the building could provide unique capabilities for enhancing research that would otherwise not be possible at the University. The installation was tested in the space at multiple stages of development, and on November 5, 2013, the 391st anniversary of John Donne’s Gunpowder sermon, the Virtual Paul’s Cross opening event and daylong symposium was presented to a standing room-only crowd in the Hunt Teaching and Visualization Lab.
IC-CRIME - COLLABORATIVE INVESTIGATIONS OF THREE DIMENSIONAL REPRESENTATIONS OF CRIME SCENES
http://iccrime.ncsu.edu/

Fig. 24. IC-CRIME project using the Game Lab

IC-CRIME is an NSF-funded collaborative project to develop a platform for interdisciplinary, cyber-enabled crime reconstruction through innovative methodology and engagement (IC-CRIME). PIs and senior personnel come from NC State’s Colleges of Textiles, Engineering and Design; Indiana University; and Arizona State University. Using 3D laser-scanning technology paired with browser-based 3D game engines, the IC-CRIME system creates 3D virtual reconstructions of real-world crime scenes. The sophisticated scanning technology can recreate a room and its contents with millimeter precision. Within IC-CRIME, a group of investigators collaborate in a virtual meeting space, which appears in the form of a virtual investigative laboratory. From a given laboratory, multiple different crime scenes can be simultaneously accessed by an unlimited number of other investigators or forensic experts who no longer need to be physically co-located in order to collaborate on tasks related to the physical space of a crime scene.

As part of the prototyping work that preceded the opening of Hunt, library IT staff worked with the IC Crime research team to install the various elements of the application on the library’s own servers in order to understand the structure of the game engine and the services that run the application. IC Crime became a key use case for two different spaces in Hunt, the Game Lab and the Creativity Studio. As a large multi-year research grant with multiple partners, it was an ideal use case for the use of the Game Lab by research teams, who could use the Game Lab’s 7472w x 1744h pixel large-scale display to support visualization of environments at a much higher degree of fidelity than was previously possible. Projects like IC Crime were important not only for testing the large display, but the seating and arrangement of the room to support collaborative working research sessions.
For the Creativity Studio, IC Crime became a core use case for how to extend the capabilities of the room to create interactive, hybrid environments that blend physical and virtual environments. One of the capabilities in active development for IC Crime allows real-time scanning of a room with a commodity camera, which allows objects to be scanned and placed into the gaming environment instantly. Within the Creativity Studio, the combination of real-time 3D scanning and the immersive and collaborative technologies embedded in the room create a compelling scenario for new modes of interaction between research teams that are local in the facility and those that are in the field. For example, an immersive facsimile of the crime scene could be created in the Creativity Studio using the movable white board walls and the multi-wall projection systems. A remote research team could be in the field, scanning a room and uploading it in real time while communicating with the local team using the room’s video conferencing cameras and microphones to discuss and analyze evidence as it is uploaded. As a final touch for later in-depth recreations, key pieces of physical evidence from the scene—such as a broken lamp or weapon—could be 3D-printed in the Makerspace (immediately adjacent to the Creativity Studio) and placed in the room. This use case for the Creativity Studio with IC Crime is in active development with the research team.

TRANSPORTATION RESEARCH

http://www.ncsu.edu/huntlibrary/create/
video: http://www.youtube.com/watch?v=US1kcbKrBeI

Researchers from NC State’s Institute for Transportation Research and Education (ITRE) learned about the library’s 3D printing service during a tour of Hunt and realized that a 3D tactile map of a real-world roundabout could be useful for transportation planners. The Hunt Library’s 3-D printers offered the ITRE research team a chance to turn their own custom design—a map of a busy roundabout—into a scale-model reality in a matter of days. That experience led to continuing
conversations between library User Experience staff and research center staff, resulting in their use of the Teaching and Visualization Lab to run complex visual simulations of possible solutions to traffic problems (video: go.ncsu.edu/ITREhuntlibrary). Without any IT staff intervention, they were able to leverage Teaching and Visualization’s standard use cases and quickly deploy their content in one of the room’s templates provided through Magnolia.

ALICE - INTELLIGENT CONTENT CREATION AND MANAGEMENT

Fig. 26. ALICE conceptual overview.

The Adaptive Learning Spaces and Interactive Content Environments (ALICE) project received a National Leadership grant from the IMLS in fall 2013. R. Michael Young, Professor, Computer Science, and founder and executive director of the NC State Digital Games Research Initiative and director of the Liquid Narrative research group, is lead PI. Maurice York, Head of IT for NCSU Libraries is co-PI.

Library staff had worked closely with Dr. Young from the early days of planning Hunt Library and, in particular, the Game Lab. This project was conceived in response to the unprecedented research opportunity presented by the fully integrated and immersive learning spaces in the Hunt Library and stemmed from Dr. Young’s deep knowledge of the what technologies deployed in Hunt were capable of (some of which were not yet fully deployed when the grant proposal was written), and how the building could both be applied to an area of his research that was of long-term interest and provide benefit to the library as well. Dr. Young was particularly interested in the potential of digital content displayed in formal and informal learning spaces to intelligently adapt to the interests and activity of the people who are in the space.
For example, museum exhibits often present a static set of digital components that “play back” for each new visitor to the space, but are completely fixed from one viewer to the next, no matter the size or makeup of the group. If a visitor goes back repeatedly, the experience will be the same every time. Dr. Young’s question was, would it be possible to put an Artificial Intelligence engine into the space that could “read” the size and nature of the group, present options to interact with, and dynamically generate a version of the content that was tailored to the group. Dr. Young had gone through several research funding cycles with the concept without success since he was missing a key component that the NSF was looking for—a physical environment and the displays and associated technology necessary to conduct the research. The Hunt Library supplied just that—a 24/5 informal learning space filled with a range of individual and group activity, supplied with large-scale displays throughout the space that require a labor-intensive content management process to select media and build queues to play around the clock through every phase of the daily academic cycle. The confluence of the research concept with the library space created the funding opportunity with an organization that was previously unlikely but now made perfect sense: the IMLS.

The Adaptive Learning Spaces and Interactive Content Environments (ALICE) project is a multi-disciplinary research project to “sense” how people are using the Hunt Library through various inputs (data, light, sound, people density, location, computer usage, etc.) and coordinate content and applications for the large displays in the library spaces based on those inputs. The ALICE engine will procedurally generate the digital/virtual component of the learning environment by constantly monitoring the space and changing the nature of the digital environment based on what it “sees” in the physical commons. In essence, the project concept is a complex game, played on the scale of an entire building, within an environment constructed out of community-generated content, driven by an artificial intelligence story engine that adapts its behavior according to interaction with the community. Through its assessment model and data collection and analysis tools, the ALICE engine will provide tools that help address a number of key ongoing technical and content challenges that confront libraries and museums on a daily basis, including wayfinding, service delivery, content ingest, production and delivery, indoor navigation, user location, and sustaining an interactive and engaging digital component of physical learning spaces. The prototyping and investigative phase of the project, funded by IMLS, started in January 2014 and will run for one year, with the goal of producing proof-of-concept results sufficient to apply for a larger round of grant funding.
NAVY MARITIME SIMULATOR
http://www.ncsu.edu/huntlibrary/immerse/

One of the library's early partnerships, predating the opening of Hunt like Paul's Cross and IC-CRIME, was with the U.S. Navy, which was seeking a site on NC State's campus for a naval training simulation classroom. With the Creativity Studio, the library presented an opportunity to install a training environment unlike any other at dozens of university ROTC programs throughout the US. Instead of the traditional classroom setup, with rows of desks facing an instructor at the front of the room, the Creativity Studio put the simulator in an open, flexible space in which the furniture could be arranged to approximate the actual layout of a vessel's bridge, with a massive floor-to-ceiling curved screen that occupied the front wall and served as the immersive forward view from the ship. The Naval Training Command provided funding to acquire equipment that would supplement existing technology in the Creativity Studio to enable the Navy ROTC program to conduct training in the space using the Navy's Mariner Skills Simulator (MSS). The MSS is a software program that helps midshipmen learn to navigate and communicate in real-world operational scenarios on any vessel in the US fleet. Capt. Library IT staff worked closely with the Navy software development team, based in Florida, to test and adapt the application for use in the Creativity Studio.

Doug Wright, commanding officer of the North Carolina Piedmont Region, described the impact:

While this is certainly a valuable tool for Midshipmen, N.C. State was able to create an MSS lab that goes well beyond the functions of the basic product. Thanks to the opportunity the Hunt Library provided and the overwhelming support from the university, this particular MSS package has been turned into a full mission bridge simulator, second only to those located in major fleet concentration areas.48

This collaboration is an example of applying infrastructure designed for research to training and simulation, which then can generate new research ideas for simulation and virtual environments. It exemplifies the spirit of Centennial academic-corporate-government partnership.
B. SUPPORTING THE RESEARCH COMMUNITY AND INSTITUTIONAL PRIORITIES

DISPLAY WALLS

Funders such as the NSF require demonstration-of-impact of research findings and wide dissemination of research outcomes. Hunt Library has four display walls that can facilitate this requirement by highlighting faculty research. These digital spaces blend architecture and digital media to support conversations about the research happening on our campus. The public visibility of the large-scale displays allows scholars to communicate the stories behind their work, the results of their research, and the impact of those results on society. Indeed, the content for these displays is largely crowd-sourced from the research outputs of our faculty. The content program is designed to allow serendipitous discovery of knowledge, from the visualizations of biomolecular protein structures published by a materials science and engineering professor to a digital exhibit cataloging the achievements of NC State agriculture, plant biochemistry, and horticulture researchers in the last 125 years. In a recent user study of the display walls, respondents from diverse backgrounds repeatedly explained that the large digital canvases provided them with a window into NC State's scholarly endeavors. With many research activities happening behind the closed doors of high tech labs, the video walls add a layer of visibility to the research process.

The Virtual Paul's Cross immersive exhibit in the Teaching and Visualization Lab was itself a scholarly output. However, it was in the Hunt iPearl Immersion Theater where the story of a research process that spanned the Atlantic Ocean and required dozens of collaborators was told. A documentary of the exhibit featured interviews with the project's two principal faculty members side-by-side with the historical artifacts they studied and the architectural models they produced for the exhibit. The Immersion Theater documentary gave our visitors a better understanding of the methodology required to do groundbreaking digital humanities research.

Figure 28: Still from Virtual Paul's Cross documentary

Another project for the Immersion Theater illustrates how scientists can use the display walls to satisfy National Science Foundation funding requirements to demonstrate the broader impacts of sponsored research. “Your Wild Life” is a multi-project program that brings together scientists and ordinary people to explore the biodiversity found in our daily lives. In “Meet Your Mites,” volunteers allow scientists to collect microscopic parasites from their hair follicles. The Immersion Theater provides a platform to disseminate the results of this research to the public and recruit even more citizen scientists to help with the study of these mites over time. In this way, the display walls create public engagement with science research and increased scientific literacy.
LISTENING TO WIKIPEDIA

Listen to Wikipedia (http://listen.hatnote.com/) (see Figure 30) is a visualization and audiation of real-time Wikipedia activity. Bubbles with article titles are shown for each edit and the pitch and bubble size changes based on the size of the edit. Bells indicate additions and string plucks indicate subtractions. This combination of a visualization and pleasant, long-running audiation in a public space made it a good fit for the Immersion Theater.

The developers of Listen to Wikipedia allowed us to modify it for the Immersion Theater. Library staff added the ability for people to enter the space and effect real-time changes to the visualization and audiation via their own mobile device. When Listen to Wikipedia is running if you walk past the Immersion Theater the wall has a prominent “Interact” title and instructions on how to use a mobile device to immediately change which languages are displayed and heard. Multiple users can make changes simultaneously and the selected languages stays in sync between devices.

This visualization uses open standard web technologies and exemplifies the technology principles “empower users to engage actively and creatively” and “provide technologies that are open.” It can serve as a model for how others can develop interactive applications or work with library staff to develop templates or services to support that work.
Faculty Visualization Working Group
Visualization as a mechanism to facilitate research is a tool widely employed across disciplines as diverse as fluid mechanics, textiles, meteorology and nuclear engineering. One of the characteristics of research at the university, expressed in the faculty interviews that went into the planning of Hunt, is that it naturally seeks to be collaborative and supersede disciplinary boundaries. Yet faculty expressed the continual frustration that the college structure and the geographic and political distinctions that arise between disciplines located in different buildings or different parts of campus are not only poorly suited for encouraging interdisciplinary collaboration, but tend to make erect artificial barriers that make it difficult to even discover researchers working in areas that are closely aligned, much less to collaborate. As a direct result of that input from faculty, promoting interdisciplinary research was a natural fit and a core driver for the design of Hunt. In response to further requests to increase support for collaborative research around the specific technology tools available in Hunt, the library put out a call for participation and convened a faculty visualization working group. Some two dozen faculty from a broad cross-section of disciplines expressed interest. Now that the group has been established, it will meet regularly to share ideas, showcase research, communicate with library subject area and technical experts, and generate collaborative and grant funding opportunities.

Veterinary Medical Campus Master Planning
The Teaching and Visualization Lab provides a presentation environment like no other on campus. The wraparound display and high-quality audio create an immediate and impactful environment for the discussion of big ideas. In the spring of 2013, in the first semester the library was open, a cross-disciplinary research team from the College of Design and the College of Veterinary Medicine (CVM) used the Viz Lab to present the results of an intensive collaboration to design a zoological research facility on an undeveloped portion of the existing CVM campus. Library technical staff worked with the presenters to develop techniques for adapting their content and utilizing the full capabilities of the room. Leveraging the full 80 linear feet of display to present maps, diagrams, models, and analysis, the team of graduate students presented their proposal to the deans of the colleges, faculty, and colleagues. The presentation was so compelling, and the use of the massive visual space in the Viz Lab so uniquely suited to the content, that the research team was asked to do an encore presentation after the semester was over, this time with the provost in attendance. The experience of working with the CVM team and observing the technical challenges and large amounts of time needed to adapt and prepare content for the room led directly to the development of the Magnolia software to enable web-based rapid development of content to greatly increase the usability and convenience of the space to showcase groundbreaking ideas.
CHANCELLOR’S FACULTY EXCELLENCE PROGRAM

A core university strategy under the strategic plan goal “Enhance interdisciplinary scholarship to address the grand challenges of society” is the Chancellor’s Faculty Excellence Program. The initiative involves hiring 38 new faculty members in 12 select fields in a single year, creating what are informally known as "clusters" in the interdisciplinary areas of focus. 50

The library’s vision for Hunt was embraced in the university’s strategic planning process as a significant asset that would enable the interdisciplinary collaboration on which the success of Chancellor’s Faculty Excellence Program depends. The tools and technologies used by the 12 clusters map well to the technology focus areas of Hunt, and library services and expertise are well-positioned to extend in greater depth to support the clusters. The Provost’s Office, which is managing the initiative, has worked with library subject specialists to use Hunt to develop the cluster faculty as a community by assembling them for luncheons and other programs in the Hunt Faculty Research Commons. Almost immediately, the Data-driven Science cluster was drawn to Hunt for collaborative meetings and large-scale data display, and the display walls are being used by other clusters for public communication of results tied to grant objectives.

To promote Hunt as a research platform to the cluster faculty, subject specialist librarians who have ongoing liaison relationships with them are trained in the library’s technological and research capabilities and are able to offer demonstrations or partner with them for specific activities in the spaces. This makes for an effective pairing of Hunt Library tools and resources with deep consultative services from the subject specialists; a conversation with a faculty member may start from either a technology-focused or a disciplinary perspective and develop into a multifaceted engagement across all of these domains. With the Hunt Library as a catalyst, librarians seek to become “embedded” with the cluster groups while offering a full suite of services across the research lifecycle (data management, visualization, bibliometric analysis, copyright, multimedia creation, etc.).
VII. Service and Staffing Models to Support Research

A. Diversified Service Model

The Hunt Library operates with a new service and staffing model, one that allows the NCSU Libraries to fulfill its commitment to (1) offering an unparalleled user experience characterized by quality, creativity, and attentiveness to student and faculty needs, and (2) maintaining this level of service into the future even in the event of declining resources, while capitalizing on significant trends in education and society at large toward more mobile and self-service options. In the year before Hunt opened, many library managers and staff members participated in an in-depth, consultant-led planning process for services and staffing. The Libraries’ long investment in recruitment and development of a highly capable, flexible, and user-focused staff (described in Section II) made the implementation of these new approaches possible.

Team-based Support

Service at Hunt involves a team-based approach where any given user inquiry may involve multiple staff members with complementary expertise. A basic tenet of the service and staffing model is that staff members from throughout the organization—the two main libraries and three branches—move frequently among locations, both physically and virtually, to collaborate with and support faculty and students in their research and in the use of specialized spaces, collections, services, and technology. Thus, library users at Hunt draw upon the full range of knowledge and skills of the library staff as a whole.

Frontline user support is provided primarily by staff and students of the User Experience Department (UE), a public services department that was created the year before Hunt opened in anticipation of the stresses that would be felt by the organization in supporting two main libraries with few new staff positions. UE physically staffs the Ask Us center; provides frontline interactions for collaborative and media production spaces; and fields queries from users about use of the high-tech spaces received through the room reservation system or direct communications.

Frontline staff primarily support the building’s core capabilities, its standard use cases. Their transaction rate is very high and includes a mix of user inquiries of all types, circulation of library materials or technology devices, and user support for the over 100 technology-equipped spaces within Hunt. Such frontline interactions have always occurred in libraries, particularly in those that have adopted a single service point, but in Hunt these interactions have become significantly more complex because they now engage IT staff and students who, until Hunt, had not provided direct end-user support.

Research uses of the spaces require a second, more complex, level of support. This model closely follows the hybrid liaison/specialist model described by Brewerton, Hahn and Jaguszewski and Karen Williams. Hahn describes the role:

Knowing when to call in a colleague, or how to describe appropriate expert capabilities to faculty, will be key to the new liaison role. Just as researchers are often working in teams to leverage compatible expertise, liaison librarians will need to be team builders among library experts where this advances client research.
This role differs from that of a traditional subject librarian in taking a library-wide—or even organization-wide—approach. As Brewerton notes, “It is not just about Subject Librarians—it is really about whole structures, a Library-wide approach.”

Service providers at the Hunt Library comprise a range of staff, including engineering and textiles librarians, collection managers, emerging technologies librarians, branch librarians (Veterinary Medicine, Design, and Natural Resources), and functional experts in IT, GIS, and visualization. All of them are engaged in matching the capabilities of the building with a particular use case or project need. Functional specialists in Hunt must broadly understand its technological capabilities—such as visualization, communications, and interactive computing—and also have enough understanding of the more specialized areas—such as audio environments and design, graphics-intensive computing, or gaming—to be able to make informed referrals. The NCSU Libraries is offering its subject specialists unique opportunities to develop their skills, such as collaborating with a faculty member in the College of Management to develop a "short course" on big data visualization concepts and tools for library staff.

Technology services that most span the boundary between frontline and more specialized staff include videoconferencing, interactive computing, and media production. Support for these technologies consequently requires the greatest level of organization-wide coordination. Similarly, the subject librarian-IT relationship will remain symbiotic; typically, both the subject specialist and the IT specialist will engage with the researcher, either in a handoff model as the project enters the more technical phase, or in a more team-based model throughout the project. Because these technologies are research infrastructure components and not library-centric, the specialist must have broader contextual knowledge of experts and services outside the library. They must understand that they are part of virtual teams of expertise across campus, within which they are able to define their role and work together toward mutual goals.

**Balancing Broad-Based Services with Deep Engagements**

An effective and sustainable service model for a research facility like the Hunt Library must balance broad-based services with deep engagements; this principle is applicable across the organization but will be discussed here in more detail as it relates to research uses of spaces and infrastructure. The research library’s core mission to serve its entire community, as well as the Hunt technology goals to “make emerging technologies available to the entire NC State community” and “democratize access to cutting edge technologies and empower users to engage actively and creatively” clearly justify the model of providing broad-based services.

The foundation that supports the broad-based service model in the high-tech spaces in Hunt consists of well-defined standard use cases and user tools that lower the barriers to use of the spaces. Standard uses are pre-programmed into the spaces’ room control systems and are accessible from in-room panels or the user’s own mobile device using a locally-developed web-based tool, Magnolia, discussed in greater detail in Section V. Staff at multiple levels of expertise were trained in use of the Magnolia tool.

Deep engagements are as critical as broad-based services to the overall Hunt model and are core to Hunt’s support for research, especially in the longer term. The learning that comes from the deep engagements feeds back into the broad-based engagements. Deep engagements enable Hunt to be a living organism: they push the boundaries of the capabilities of the library’s high-tech spaces and
exemplify the vision of the library itself a platform for research; they enable the library to enhance the standard use cases; they identify gaps or other areas of weakness to be addressed through technology refresh and training; and they enable staff to remain close to leading researchers at the university and continue to position Hunt services to respond to their needs.

For deep engagements the library provides the necessary consulting and technical resources to work with faculty, typically over a significant period of time, to apply and adapt Hunt spaces and technologies to specific research needs. The portfolio of deep engagements requires a sustainability strategy, including a balance of projects taken on for their inherent mutual value with projects that are supported through grant or sponsored research funding that comes to the library and increases our overall capacity. The faculty member of course defines the value from the research perspective; the library looks at its relationship with the researcher and how the project intersects with building capabilities and can extend to other use cases.

B. PROJECT LIFECYCLE SUPPORT

The Hunt model has been informed by failed or underutilized deployment of previous cutting-edge technologies, in both in the library and elsewhere on campus, that were disconnected from associated tools and services in the researcher's or student's workflow. Hunt spaces and services were designed to enable lifecycle support for projects—in both physical and virtual spaces. The library provides the complementary virtual spaces to enable the project lifecycle. The library provides the project-based time-limited compute and storage space necessary to collaborate and create in the physical spaces, applications and resources that have direct access to the large displays and other advanced technologies in the building. Following the well-understood paradigm of circulating library collections, researchers and students can “check out” compute power and a terabyte of storage for a designated period to accomplish their project. To see how this could apply to a real-world example, a game design project could utilize the Creativity Studio for concept development, ideation and design; then move to the Teaching and Visualization Lab for prototyping; then move to the Media Production Studios to create graphics and animations; then move to the Game Lab for critique and demonstration. During that project the researchers or students could leverage Hunt's permeable boundary with external infrastructures and bring files in from their own cloud storage environment, store them in Hunt project space while they make use of Hunt's graphics rendering capacity and spaces for project work, and then take the results back out into their own compute and storage environment.
C. Staffing and Skills

The NCSU Libraries’ Information Technology Department began a realignment of existing staff skills to prepare to support the Hunt Library over two years before its opening. Key objectives were to develop expertise in the core Hunt technologies, namely virtualization, A/V systems and interfaces, interactive computing, data visualization, and videoconferencing. The ambitious technology program for Hunt also required IT staff to move beyond their traditional behind-the-scenes role. In Hunt, IT staff not only keep equipment running and services supported but also provide intermediate and advanced user support.

Several new technology positions were created or reassigned from other functions, including an academic technologist librarian position, media specialist, visualization programmer, and A/V technician. The library’s IT workforce relies to a much greater extent than ever before on graduate students with specialized skills, ranging from programming to interface design.

In operating the Hunt Library as a research platform with the broad and deep service model, we, like other research libraries,54 see the need for more advanced research and academic technology specialist positions. These are cross-cutting roles not tied to specific disciplines, such as academic technologist, visualization coordinator, and informatics and analytics specialists. These positions require significant technical background and excellent communication/interpersonal skills, if not particular specialized degrees and experience. This is a new role in research libraries and one for which it is currently a challenge to find qualified candidates.
VIII. SUSTAINABILITY

A. A BALANCED TECHNOLOGY PORTFOLIO AND SERVICE MODEL

The Hunt Library took a whole-building portfolio approach to the design of its technology program and services, taking into consideration a range of sustainability-related factors from initial space design through selecting specific technology solutions. As discussed in detail in Section V, the building’s core infrastructure was designed from the ground up with sustainability in mind, by means of an adaptable technology design.

All technology-equipped spaces in Hunt also fall into a balanced spectrum that took into account issues such as experimental/high-risk vs. established/low-risk; a range of refresh timelines; build vs. buy, etc. Thus, there are large numbers of “commodity” spaces such as group studies, presentation practice rooms and learning commons: many fewer complex user spaces such as media production studios, and even fewer high-tech spaces, which are the primary focus of this document.

The Hunt library's service model also took a portfolio approach by balancing broad with deep research engagements; enabling projects across a range of disciplines; and developing existing staff and adding new staff. The greatly increased use of students and at higher levels of technical expertise, including in mission-critical roles such as software development and interface design, was anticipated to be necessary two years before Hunt’s opening and an ongoing budget was established to support that expansion.

B. A DIVERSIFIED FUNDING MODEL

With a radically new vision and portfolio of services, it was not possible to have future financial requirements known upfront. Technology refresh is a relatively new challenge for libraries, but one which all libraries are faced with now to a greater or lesser degree. Of course with an approximately $8 million investment, Hunt’s stake in this question is relatively greater than most. Hunt’s sustainability from a financial perspective necessarily depends on demonstrating its value within the campus research infrastructure and tapping into resources not previously available to the library. As Hunt proves itself to be core to the university’s research infrastructure, refresh becomes a critical question for the institution.

NEW OR ENHANCED FUNDING SOURCES

INTERNAL RE-INVESTMENT

The library leveraged its existing budget over two fiscal years in order to open Hunt, as well as redeploying staff lines to meet Hunt staffing needs with only 12 new public services positions provided by the university. Specifically, several new technology positions were created, including academic technologist, A/V technician, visualization programmer, and digital humanities librarian, in support of the Hunt research program.

EDUCATION AND TECHNOLOGY FEE

The library advocated for and received two one-time allocations of the Education and Technology Fee (ETF) ($500,000 in FY 12 and in FY13) and the revenue from a permanent fee increase—voted on by students—of $500,000 annually beginning in FY14 to support the Hunt Library. ETF
is a student fee and that new revenue was applied to help upfit the student technology spaces in Hunt and will be used for ongoing maintenance and refresh.

**Facilities and Administrative (F&A)**
The library has also been recognized as contributing at a much higher level and in entirely new ways to the university’s research infrastructure based on the Hunt facility. As a result, NC State’s Research Administration office is currently conducting an evaluation of the library’s contribution to the university’s overall negotiated F&A rate as well as what “overhead” is returned to the library to help offset library costs in supporting research.

**Grants**
As described in Section VI, researchers using the capabilities of Hunt have already begun to be successful in bringing in sponsored research dollars. At least $1.5 million in research funds has been awarded thus far based on leveraging the Hunt research infrastructure since January 2013 when the building opened. There are several larger proposals in the pipeline. Over time, funded research is an important route by which the library can increase its technology staff capacity to be able to support a larger number of deep engagements as well as other programmatic and service enhancements.

**Sponsored research**
Sponsored research represents an agreement with a corporate or government entity to undertake specific research and development work, or develop a specific product. Until Hunt, the library had not been engaged in this type of activity, which is common for faculty at NC State. The library’s partnership with the Navy to support the Maritime Skills Simulator is one example of this type of partnership. Another is the university’s licensing the Christie MicroTiles heat monitoring application developed by library staff to Christie Digital Systems, Inc.; Christie, for example, has expressed additional interest in engaging with us in further sponsored research.

**Corporate partnerships**
The initial round of Powered By partnerships engaged mainly A/V, storage and networking companies because those were the areas of focus critical to realizing the full Hunt technology program on Day 1. Fourteen Powered By technology partners contributed over $2 million in cash and in-kind gifts before opening. A roadmap is now in place to expand the number of companies in this program over the next several years. As we move “up the stack,” there are corporate partnership opportunities under the Powered By umbrella for companies in other technology sectors, such as software, commodity computing, and 3D printing. Powered By partners have continued to remain engaged with the library and continue to contribute engineering time to work with library staff to develop new solutions to new challenges; in this respect, in particular, the partners are key to Hunt’s sustainability.
IX. Extensibility of the Hunt Model

A. The Research Library Re-envisioned

The Hunt Library at NC State University is an investment in the future of the research library. It is not an investment in every future for the research library, but in a particular one. The Hunt Library’s support for research is focused in four specific areas: large-scale visualization and display; gaming, interactive computing, and programming; communications and collaboration; and prototyping and creation. During this first year, the library community has shown great interest in the Hunt model, with an oversubscribed Designing Libraries for the 21st Century II conference in October 2013, and waiting lists for three two-day “Our Library of the Future” symposia.

Apart from its specific areas of focus, Hunt shows that research libraries have a great deal to offer to enable faculty success in the digital age, that a meaningful library niche in campus research infrastructure can be identified, and that a library organization can secure campus support and significant investment.

Visualization, Interactive Computing and Communications

While each institution must identify its areas of need and opportunity, data visualization, interactive computing and communications are areas of focus in Hunt that respond to very broad and pervasive trends in the research landscape and are likely directly extensible to other research library contexts. They are areas where infrastructure has a meaningful role to play. Other universities have invested in these areas outside of their libraries, or outside of libraries but with connections to library staff and services, which may be the most appropriate path depending on local facilities and organizational context. The Hunt model shows is that the research library is particularly well positioned to support its institution’s research mission through spaces and services across these broad areas.

Building Connections to Related Services

Engaging in support for research beyond provision of library collections extends the library’s involvement into the research lifecycle, and parallels and potentially strengthens the library’s increased involvement with non-publication scholarly outputs such as research data. Lifecycle functions such as computation, storage, analysis and processing, and visualization are early-stage functions, while the functions libraries are already involved in—data curation, discovery and reuse, copyright and policy issues—are later lifecycle functions, albeit earlier than books and journals. Library services in one area can lead to, or reinforce, services in another, strengthening the overall library-faculty relationship. The NCSU Libraries engagement with the Chancellors Faculty Excellence Program applies this lifecycle-oriented, holistic relationship approach even though the library is not currently providing the full range of data management services to these faculty.

Hunt’s research infrastructure has points of connection and potential pipelines into new research data services, tools and workflows. While those workflows and tools have not yet been designed, the foundation is in place for the library to support a researcher “archiving” their data after visualizing it in Hunt to meet data management plan requirements. Analogously, other libraries that have invested in data services infrastructure, such as repositories or storage, could leverage that expertise into lifecycle services with a physical space component.
B. STAFF ROLES AND SKILLS

The library profession is increasing its focus on development and recruitment of the workforce it needs at the outset of the 21st century. Models and best practices have an important role to play in building new collective capacities and expertise across research libraries. Through its decades-long track record with organizational transformation and staff development, the NCSU Libraries is in a good position to contribute to these best practices in library support for technology spaces.

The NCSU Libraries staff exhibit the traits identified as important at the 2012 ARL Fall Forum on the Library Workforce: entrepreneurialism, creativity, leadership, competitive intelligence, project management expertise, and capacity for brokering deep collaboration with faculty. The NCSU Libraries also endorses Cawthorne, Lewis and Wang’s recommendation to hire for competencies rather than credentials and potential (attitudes, aptitudes), and to create career-building opportunities. A critical additional trait that the library seeks for most positions is what Wing described in her influential editorial as “computational thinking.” As she notes, computational thinking is not just for computer scientists and does not mean programming skills. Computational thinking is reformulating a seemingly difficult problem into one we know how to solve. [...] It is planning, learning, and scheduling in the presence of uncertainty.

At a high level the NCSU Libraries’ experience with evolving staff roles and skills echoes recent thinking in the profession around the evolution of subject specialists and identification of skills gaps to enable libraries to better support the full research lifecycle. The Hunt experience highlights, however, that discussions of new roles in the profession have thus far been focused around virtual scholarly communication services, with little or no discussion of roles and skills related to supporting space- or advanced technologies-based services. The Hunt experience could complement the predominant vision for e-science services with a role for the library to contribute to the campus physical research infrastructure as well. The NCSU Libraries’ repositioning of subject specialists to have more complex liaison functions vis-a-vis the research capabilities of the spaces, along with the development of new IT roles can serve as a model for what this means in practice (i.e., how to get from here to there).

“Interface” roles are becoming recognized as important for libraries to develop. The Hunt model can contribute to the understanding of several quite distinct “interface” roles. Faculty have explicitly recognized the importance of one interface role: Computer Science professor Michael Young told the audience at the 2013 Designing Libraries conference, “Design your staffing plan and hire people who understand the culture of research and who are themselves masters of the point of intersection from their own disciplinary perspectives.” Part of understanding the interface role is to understand the different types of collaboration required in technologically-complex library spaces, and how staff in interface roles should work, both functionally and organizationally. Interface roles are also skills-based, for example, people who can bridge the historically distinct technology and audiovisual spheres to support an environment where IT and A/V are deeply intertwined. “Interface” also reflects a broad-perspective mindset and capabilities in negotiating institution-wide context.

C. RESOURCING AND PARTNERSHIPS

The Hunt Library was in the first instance made possible by the University of North Carolina system and the North Carolina legislature. Without leadership from both those entities to prioritize a library for NC State, the Hunt Library would not have happened. (This confluence of events likely would not have happened just one year later, when the recession hit.) No research library can control all
political and resourcing factors that stand between a vision and its realization, but every research library can work within its own resourcing context to advance part of its vision. The NCSU Libraries marshaled existing resources and strategies, and deployed new ones, such as the Powered By partnership program and financing over multiple years a major portion of the building's technology upfit. The "go for it" strategy the library took with Hunt, not doing things gradually over time as the money became available, increased the impact of the building on campus and demonstrated to the university the library's commitment to the vision over the long term.
X. CONCLUSION

"This is a signature building for us, transformative for how people think about NC State." - Randy Woodson, Chancellor, North Carolina State University

"The Hunt Library sets a pole out into the future and says 'we’re going to be a leading-edge technological university for many, many years to come.'" - Michael Young, Professor, Computer Science, NC State University

WHAT DOES SUCCESS LOOK LIKE?

One year after success, the Hunt Library is bustling with student activity and is enabling research across dozens of projects and uses of its high-tech spaces. Hunt’s impact has of course been broader than in its support for research; its diverse and technology-rich collaborative learning spaces have made a significant contribution to the life of the campus. The buzz is not something that can be quantified, but one can get a sense of it from the comments users post to social media, a few of which are quoted below. The Hunt Library is clearly viewed as a model of innovation for NC State and is regularly cited by members of the campus community from the Chancellor to other executive officers, deans, faculty, students and staff. Chancellor Woodson said, “The opening of the James B. Hunt Jr. Library was an important defining moment in the history of NC State and Centennial Campus. The new facility redefines the role of the library to one of collaborative innovation—a library that not only stores knowledge, but also creates it.” Dr. Michael Young, Professor, Computer Science, said at the recent Designing Libraries for the 21st Century conference, which was held at Hunt Library, “the Hunt Library is the single largest, most visible investment in the future of scholarship on our campus. I completely believe that the Hunt Library was designed for me. I’m not alone. Every faculty member engaged in research with the library feels this same thing.” The international attention Hunt has received for its architecture and interior design have brought attention to NC State and enhanced its overall reputation.

Fig. 33. Tweets from Hunt Library users
A TRANSFORMED LANDSCAPE

Every research library has a mission to remain not just relevant but essential. Whatever the parent institution's vision, implicit in it must be that the library is indispensable, that the university cannot imagine succeeding in its core mission without the library. The Hunt Library was an unprecedented opportunity to redefine both library spaces, and, more broadly, commons spaces at the university. The spaces within a building designed by an internationally renowned architectural firm could not be ordinary; the responsibility fell to those at NC State and in the library during this time to ensure that they not be. If we were successful, it will have been because we were able to release the energy inherent in the intersection of a intellectually curious and risk-taking faculty and library staff, cutting-edge technology, and brilliantly designed physical spaces.

The university and library were extraordinarily fortunate to have a design team that both worked well together and, critically, who were open to rethinking the purpose and significance of the library-as-place at the outset of the 21st century. Although not discussed in detail in this document, the Hunt project demonstrated that it is possible to work through challenging issues and overcome roadblocks in technology, facilities, and project management to achieve in the end what researchers need, to design for the future and not the past.

SERVING THE SCHOLARLY RECORD AND THE INSTITUTION

Research libraries, when viewed collectively as an ecosystem, have an important and continuing role as stewards of the scholarly record for current and future researchers. In the current world of networked information and diverse scholarly resources, an individual university's library increasingly makes its contribution to this collective scholarly record by digitizing its unique holdings and ensuring that they are discoverable and preserved.

The research library also plays an important role at the institutional level in serving its local community and its institution. Over the past two decades libraries have reduced print collections in their buildings and expanded and renovated spaces for users. To serve researchers, they are staking out new roles around scholarly communication support, research data management, and other services. The Hunt Library model shows that there are additional roles the research library can play to serve the institution and its researchers, roles that once again make the physical library relevant to faculty.

The value proposition of the Hunt model does not simply match new services to traditional areas of library strength (print-to-digital collections; physical-to-digital preservation; cataloging-to-metadata description); it stakes out fundamentally new roles to support research, teaching and learning for the library that leverage its spaces and relationships with the whole community. The result are services and spaces that support many disciplines; that are both broad and deep; and that enable partnerships that strengthen the research community.

The Hunt Library is providing unique research infrastructure to NC State. Like all libraries, the NCSU Libraries itself does not itself have a research agenda, so the infrastructure is deployed generically and flexibly to serve known and unknown future research uses across disciplines. Library staff cultivate and manage an ongoing portfolio of research engagements. For the Hunt Library, this means supporting researchers in innovative collaborations, and in using technology to explore new research questions. The end result is a transformed relationship between faculty and library staff.
While the NCSU Libraries staff was prepared culturally and operationally for the immediate and disruptive impact of serving two main libraries, this transformed relationship, which will only be fully manifest over time, is more fundamentally disruptive and is how Hunt will serve as a model for other libraries research libraries going forward.
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ENDNOTES

1 Centennial Campus, North Carolina State University, http://centennial.ncsu.edu/

2 Cyberinfrastructure Vision for 21st Century Discovery, National Science Foundation Cyberinfrastructure Council (2007), 5.


6 MacArthur Foundation, Confronting the Challenges of Participatory Culture: Media Education for the 21st Century.


11 “Introduction to Interdisciplinary Research,” National Science Foundation.

12 NIH/NSF Visualization Research Challenges, IEEE (2006), 5, 6


15 In 2010 the CIOs within the Committee on Institutional Collaboration issued a report, “A Research Cyberinfrastructure Strategy for the CIC: Advice to the Provosts from the Chief Information Officers”, that described the needs they were seeing within their institutions. “These new kinds of scholars require access to a staggering array of advanced resources: high performance computing systems that can model enormously complex processes, huge data sets formed from instruments generating countless observations, advanced visualization tools that help create meaning from otherwise unfathomable complexity, sophisticated telecommunications networks capable of moving large streams of data and supporting synchronized distance interaction, and collaboration support platforms that allow formation of virtual organizations drawing experts
from many fields working all over the globe.’ (CIC report, 4). “Some of the most dramatic breakthroughs in the disciplines are being achieved through advances in visualization.” (CIC report, 6)

16 Science and Engineering Infrastructure for the 21st Century: The Role of the National Science Foundation, NSF (2003), 7. “Research infrastructures are facilities, resources or services of a unique nature that have been identified by research communities to conduct top level activities in their fields.” European Research Infrastructures with Global Impact, 2012.

17 Cyberinfrastructure Vision, 5.

18 Science and Engineering Infrastructure, 8.

19 Committee on Institutional Collaboration. Big Ten schools plus the University of Chicago.


22 Cyberinfrastructure Vision, 10.

23 Science and Engineering Infrastructure, 3.


29 $65.07 billion STEM, $3.18 billion non-STEM. Table 1. http://www.nsf.gov/statistics/infbrief/nsf13305/

30 There is lack of consensus among both CIOs and researchers around the question of shared cyberinfrastructure. (IT Engagement in Research, 83).

31 "The use of [visualization] tools is still limited because they are still expensive, and their costs are not always justified with respect to the actual usage for most researchers.” (Attene, Marco, Franca Giannini, Marios Pitikakis, and Michela Spagnuolo, “The VISIONAIR Infrastructure Capabilities to Support Research,” Computer-Aided Design & Applications 10:5 (2013), 1-2).


33 http://www.lib.ncsu.edu/fellows
34 http://www.lib.ncsu.edu/technologysandbox
35 http://learningspacetoolkit.org/
36 http://centennial.ncsu.edu/
37 http://www.slideshare.net/genepe7/vcentennial;
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41 http://news.lib.ncsu.edu/2012/06/25/%E2%80%9Cprobably-the-greatest-experience-i%E2%80%99ve-
 had-so-far-in-college%E2%80%9D-designing-the-hunt-library-%E2%80%9Cxperience%E2%80%9D/
42 Isenberg, 320.
44 E.g., an evening short course, “Processing and Arduino in Tandem: Creating Your Own Digital Art Tools led by
Humanities faculty. “Arduino Basics,” a wiki site maintained by engineering students:
45 https://magnolia.lib.ncsu.edu/tech_specs/
preach/244339/
47 http://vpcp.chass.ncsu.edu/symposium/
48 “Mariner Skills Simulator unveiled at North Carolina State University,” America’s Navy, April 8, 2013,
49 Listen to Wikipedia was originally developed by Stephen LaPorte and Mahmoud Hashemi. The original Listen
to Wikipedia subsequently won an [Kantar Information is Beautiful award](http://www.informationisbeautifulawards.com/2013-winners/#interactive) in the Interactive
Visualization category.
50 http://provost.ncsu.edu/special-initiatives/chancellors-faculty-excellence/;
http://workthatmatters.ncsu.edu/
51 reference all 3.
52 Hahn, 2.
53 Brewerton, 108.
54 Jaguszewski, Janice M. and Karen Williams.
Scenarios Approach,” ARL Fall Forum (October 11, 2012).
56 Ibid.
50 Ibid., 33, 34.

59 Jaguszewski and Williams; Hahn, Karla, "Introduction: Positioning Liaison Librarians; 2012 Research Libraries
UK report, Re-skilling for Research [http://www.rluk.ac.uk/content/re-skilling-research]

60 Michael Young in presentation at Designing Libraries for the 21st Century, Raleigh, NC, October 8, 2013,
https://www.lib.ncsu.edu/sites/default/files/designinglibraries/Young%20Michael-stopworrying-dl2.pdf


62 "The Hunt Library Story"

63 [http://www.ncsu.edu/about-nc-state/chancellor/]

64 Young, presentation at Designing Libraries.
APPENDIX A. PUBLISHED MISSION STATEMENT OF NCSU LIBRARIES

NC State Mission

As a research-extensive land-grant university, North Carolina State University is dedicated to excellent teaching, the creation and application of knowledge, and engagement with public and private partners. By uniting our strength in science and technology with a commitment to excellence in a comprehensive range of disciplines, NC State promotes an integrated approach to problem solving that transforms lives and provides leadership for social, economic, and technological development across North Carolina and around the world.

NC State Vision

NC State University will emerge as a preeminent technological research university recognized around the globe for its innovative education and research addressing the grand challenges of society.

[http://info.ncsu.edu/strategic-planning/overview/pathway-to-the-future/#our-foundation]
APPENDIX B. HUNT LIBRARY IMPACT

VIDEOS

Hunt Library users tell the story of Hunt on Storify: http://storify.com/ncsulibraries


“Engineers create 3-D models to help the blind navigate safely through intersections,” Inside Science TV, December 3, 2013, http://www.insidescience.org/content/3-d-street-map-blind/1503


“Virtualized Desktops with 3D Graphics at North Carolina State University,” VMWare, September 2013, http://www.youtube.com/watch?v=lKFyU8btbbA


Institute for Transportation Research and Education, http://go.ncsu.edu/itrehuntlibrary

PRESENTATIONS


**FUNDED RESEARCH**

Virtual Paul’s Cross, NEH grant, 2012-13


Laboratory for Analytic Science (announcement forthcoming)

**EXHIBITS AND EVENTS**

Hunt Library hosted the Second Designing Libraries for the 21st Century conference, attended by 250 library leaders, higher education leaders, architects, and others from the US, Canada, Europe, and Australia. October 6-8, 2013, [http://www.lib.ncsu.edu/designing-libraries-II](http://www.lib.ncsu.edu/designing-libraries-II)


**AWARDS**

AIA/ALA Library Buildings Award, Hunt Library (2013)

> Biennially, representatives from the AIA and the American Library Association (ALA) gather to celebrate the finest examples of library design by architects licensed in the U.S. The 2013 AIA/ALA Library Building Awards honor six separate projects.

Triangle Business Journal Real Estate Award (top university development), Hunt Library (2013)


City of Raleigh Environmental Award (non-residential green design), Hunt Library (2013)

> Presented to recognize local individuals and organizations that have demonstrated a commitment to protecting or improving the environment.

InfoComm Best A/V Technology Project of the Year - Higher Education (2013)

> InfoComm is the national professional organization for the Audio-Visual industry and hosts the largest A/V Technology show in the world once a year. This award recognized the Hunt Library as the most innovative technology project in higher education.

VMware TAM Innovative Customer of the Year (2013)
VMware is one of the leading providers in the world of software for cloud computing and virtualized data centers. VMware software many drives many components of Hunt Library infrastructure. This award was specifically for innovation in the user of virtual desktop computing and graphics-intensive cloud-based computing.

PRESS COVERAGE
Well over 250 articles on the Hunt Library have appeared in print, television, and online media in local, national and international venues. Selected video and print/online coverage is listed below:

In April 2014, the Hunt Library will be featured in the new PBS primetime series Cool Spaces (www.cools Healthcare) as an iconic building driving educational change.

SELECT PRINT AND ONLINE COVERAGE
Hunt Library: Think and Do. http://www.ncsu.edu/huntlibrary/


"The James B. Hunt Jr. Library," Christie Digital case study, 


**Hunt Library Visitors**

There have been 545 scheduled tours with 14,634 visitors between Hunt Library’s opening in January through November 2013. In addition there were numerous tours related to special events on campus, tours arranged by other departments, and tours that were not officially scheduled. The countries that the library knows to have been represented on our tours include: Angola, Argentina, Australia, Belarus, Belgium, Canada, Chile, China, Costa Rica, France, Germany, India, Israel, Japan, Mexico, New Zealand, Norway, Peru, Russia, South Korea, Spain, United Kingdom, Ukraine, Uzbekistan, and Venezuela.

**SELECT NCSU LIBRARIES AWARDS (NON-HUNT)**

**NCSU LIBRARIES**

*American Libraries* Architecture Showcase, Outdoor library, Technology enabled, Collaborative learning projects (2012); Information Commons (2008)

Endeca Navigator Award (2006)

*Library Journal* Librarian of the Year, Susan Nutter (2005)


**STAFF AND SERVICES**

*Library Journal*’s "Movers and Shakers", eight NCSU librarians 2002-2013

ALA Emerging Leaders Initiative, four NCSU librarians 2008-2011

CLS ProQuest Innovation in College Librarianship Award, Mobile Scavenger Hunt (2012)

ALA Office for Information Technology Policy Cutting-Edge Library Service Award:  
Web Design Project Team (2011); Course Views Project (2009/2010)
APPENDIX D. LETTERS OF SUPPORT

LETTER FROM DR. MARC HOIT, VICE CHANCELLOR FOR INFORMATION TECHNOLOGY, NC STATE

LETTER FROM DR. MICHAEL YOUNG, PROFESSOR, COMPUTER SCIENCE, NC STATE

LETTER FROM DR. JOHN WALL, PROFESSOR, DEPARTMENT OF ENGLISH, NC STATE

EMAIL FROM DR. PATRICK FITZGERALD, PROFESSOR, ART AND DESIGN, NC STATE

EMAIL FROM STUDENT ON USE OF HUNT TECHNOLOGY LENDING

LETTER FROM Harriette Hemmasi, University Librarian, Brown University

LETTER FROM Mary Sommerville, University Librarian, University of Colorado Denver
Stanford University Libraries Advisory Council
Stanford University
Stanford, California 94305

January 10, 2014

Dear SPIRL Jury:

I am writing to provide my enthusiastic support for the submission of the Hunt Library for the Stanford Innovation in Research Libraries Prize. As is clear from the submission, the press and worldwide notoriety, the new Hunt Library is a progressive shift in research library resources. Libraries have always been about connecting people to knowledge. They have been the link to what has often been expensive and/or hard to get resources that allow researchers, teachers, students and regular people to enhance their mind, knowledge, and understanding of the world.

As the world has progressed from print to digital resources, and basic access has become more common to the home, work and even mobile, libraries have encountered an inflection point. It was clear to the NC State Libraries even well before the building of Hunt that shifting from traditional print resources to leading edge digital resource access was the clear evolution of a research library.

For a research intensive campus, the demand for access to very high end digital tools, flexible display technology, emerging 3D printing and more is the new expensive knowledge resource that individuals or departments cannot afford to own. It was clear in the development of Hunt that new research services would help transform the library back to the center of research activities.

Hunt has also had a strong influence on the soon to be finalized University IT Strategic Plan. One of the strategies is for the campus to create innovation spaces for research, teaching and learning to explore innovative activities. Hunt is the premier example of a new space that allows faculty and students to explore new pedagogy, use of visualization techniques in non-science fields, use of simulation and adaptability of spaces for research experiments. An example is the new Paul’s Cross 3-D simulation that is a combined effort with faculty from English, Architecture, and IT support.

Hunt is clearly a transformational library and offers innovative spaces, advanced digital tools and a place where faculty and students from all disciplines can work together in the search for new knowledge in our increasingly interdisciplinary team approach to discovery.

Sincerely,

Marc Hoit, Ph.D.
Vice Chancellor for Information Technology and CIO
Dear Stanford University Libraries Advisory Council,

I am writing to convey my strongest support for North Carolina State University's Hunt Library in their application for the Stanford Prize for Innovation in Research Libraries. I am a professor in computer science at NC State University, serve on the technical advisory board for the Hunt Library and have a large-scale, externally funded research program that is directly integrated with and leverages the enabling research infrastructure of the core capabilities that the Hunt Library brings to our campus.

In my experience, there are many critical factors that contribute to a computer science faculty member's relationship with a library as a research partner. These include, among others, the information technology infrastructure of a library, library staff support for this infrastructure, the level of staff experience in seeking funding via external grants, the overhead agreements within the university between the library and other academic units, etc. These aspects are indeed critical and are areas where the Hunt’s excellence is well documented. But the single most important factor in the design of the Hunt Library as a research component on our campus is the new relationship it defines between the library and the faculty member.

Prior to the opening of the Hunt Library, my historical view of university libraries had been one of resource management, where a library held close control over scholarly resources in order to maintain those resources for a wide range of people over a sustained period of time. This was typically managed by a library though careful control of the access and use of these resources. The rise of internet culture, with direct access to information and the ability to create and share one's own resources (that maybe of comparable quality to that of curated library content), has significantly disrupted that relationship, whether most universities realize it or not.

The Hunt Library was designed to turn the conventional relationship on its head.

In the design of every visible element of the Hunt, it is clear that they intend to join research faculty as equal partners in the effort of scientific innovation. From the initial design efforts, the Library made it clear to faculty that they were designing the Hunt infrastructure to match the research excellence of the faculty on campus. They designed their staffing plan to hire people who understand the culture of research and who were themselves masters of the point of intersection between libraries and research in their own disciplinary perspectives. At
its core, their design for the use of the Hunt, at every point, demonstrates an expectation that the faculty shares equally in the responsibility to innovate, to take up the outstanding research infrastructure built in to the library and to exceed expectations in pursuit of our research goals.

Because of the unique combination of best-in-class technology infrastructure and commitment to a collaboration of equals in pursuit of innovation, the Hunt Library now stands as the single, largest, most visible investment in the future of scholarship on our campus. And amazingly, in every interaction I have with the Library, my clear sense is that the entire library was created specifically for me.

I know this is not really the case. And yet it appears to be so.

I’m not alone in this feeling. This is the feeling that every researcher I speak with feels when working with the Hunt Library staff and infrastructure.

In the 12 months since the library has opened, I have taught or co-taught four undergraduate classes in the library that provide my students with access to resources no other students in the country have. I have

- Co-directed (with Hunt Library staff) 2 Research Experience for Undergraduate project funded by the National Science Foundation, integrating touch screen large displays into an ongoing $1M NSF-funded research project

- Submitted 4 proposals for external research whose content would not be feasible without Library staff and infrastructure

- Been awarded 2 externally funded research grants totaling over $1.5M, including a Institute for Museum and Library Science National Leadership award that supports both Library staff as well as computer scientists, electrical engineers, education theorists and visual artists from across campus.

In all regards, the Hunt Library has made a remarkable change to the research culture on our campus. It has done this through the installation of information technology infrastructure that lies beyond the state of the art. It has done this through the creation of a core set of library staff with expertise in collaboration, research and innovation. But these elements would not have been transformative without the commitment that the Hunt Library has made to establishing an expectation of excellence and true partnership in all that they do. I cannot imagine an effort by a university library that would bring more innovation to our campus. Without reservation, I support their application for the Stanford award in the strongest possible terms.
Michael Young is a professor of computer science at North Carolina State University, where he leads the Liquid Narrative Research Group. He's the founder and co-director of the NCSU Digital Games Research Center. His work focuses on the computational modeling of interactive narrative, especially in the context of computer games and virtual worlds. He teaches courses on game design and development and interactive narrative.

In 2000, Michael received a CAREER Award from the US National Science Foundation, NSF's highest award for young scientists and engineers. He has received awards from NCSU for both outstanding teaching and outstanding activities in engagement/economic development. In 2010, Michael was awarded a GlaxoSmithKline Faculty Fellowship for Public Policy and Public Engagement. He is a senior member of the Association for the Advancement of Artificial Intelligence and of the IEEE and is an ACM Distinguished Scientist.

Michael was editor-in-chief of the Journal of Game Development from 2007 to 2008. He serves as an associate editor of the Journal of Virtual Reality and Broadcasting, of the IEEE journal Transactions on Computational Intelligence and AI in Games and the ACM journal Transactions on Intelligent, Interactive Systems.
January 14, 2014

To Whom It May Concern:

I am honored to write you in support of NC State University's application for the Stanford Prize for Innovation in Research Libraries, in recognition of its achievement in the design and implementation of an extraordinary vision for the James B. Hunt Library.

I write as one of the first beneficiaries of this facility's incredible array of technological resources for the creation and dissemination of knowledge. My digital humanities project, the Virtual Paul's Cross Project, has benefited to an extraordinary degree from these resources. Thanks to the Teaching + Visualization Lab at the Hunt Library, this project can now be experienced in a room with a 10-projector display and a 21 speaker immersion audio presentation.

This project, funded by a Digital Humanities Start-Up Grant from the National Endowment for the Humanities, recreates two hours of time in London, in the churchyard of St Paul's Cathedral, from 10:00 am until noon, on Tuesday, November 5th, 1622. It enables us to experience a sermon preached by John Donne, Dean of the cathedral, on that day, as an event unfolding, moment-by-moment, in real time, within a digital model of the visual and acoustic properties of that space.

This project lives on a website (http://vpcp.chass.ncsu.edu) on our university’s servers. The website provides a listening and visual experience as well as a large body of information about how we were able to do this project. But the website has all the limitations of websites – a very limited scale of display for the visual model and usually inadequate audio for playback.

In the Hunt Library’s Teaching + Visualization Lab, however, this project becomes a full-immersion experience, both visually and acoustically. Visitors have the experience of being in the space of Paul’s Churchyard, surrounded on three sides of the room by a wrap-around visual display. They can hear the actor Ben Crystal perform Donne’s sermon as members of the crowd (and the crowd can be 500, 1000, 2500, or 5000 people), from several different locations around the churchyard.
The immersive visual display changes appropriately as we move from one listening position to another. The visual display exhibits weather conditions and the effects of time on the buildings. The acoustic display includes the random ambient noise of birds, horses, and dogs, as well as the regularly occurring sounds of the cathedral’s clock tolling the hours and marking the passage of time.

This dramatic display has helped us take full advantage of the Paul’s Cross Project as a research tool, helping us document, for example, the audibility of the preacher at different places in the space and in the presence of different sizes of crowd. We have learned that because of the configuration of the space the preacher could be heard anywhere, so long as the crowd was quiet and the preacher delivered his sermon at a deliberate pace.

In addition to what we have learned about the historic conditions of outdoor preaching in the early modern period, we have also found that this immersive display has helped us bring attention to the project itself. The installation opened on November 5th, 2013, 391 years to the day of the month, the day of the week, and the hour of the day after its original delivery.

The local media found the event worthy of front-page coverage (http://www.newsobserver.com/2013/11/05/3344227/a-famed-poet-and-17th-century.html), a story that was republished many times in subsequent days and as far away as the Guardian newspaper in London.

In large measure because of the positive publicity we garnered for this project, the National Endowment for the Humanities now features our project on its home page (http://www.neh.gov/divisions/odh).

In the effort to get my project out of the computer and into the installation, the staff of the Hunt Library has been exceptionally helpful, knowledgeable, and creative. I will never forget the first time I saw our visual model in a 270 degree wraparound image – breathtaking! – and it was the work of Scott Williams and others on the staff of the Hunt Library.

I give the NC State Libraries and the folks at the Hunt Library my complete, wholehearted, and most enthusiastic support for this award. I commend them to you as truly brilliant, innovative, and forward-thinking re-envisioners of the university library. Their work is a great gift to me, and to the digital humanities community. I am profoundly grateful for their support in my own work. I commend them to you.

If I may be of further assistance to you in your deliberations, please do not hesitate to contact me.

Sincerely,

John N. Wall
Professor of English
North Carolina State University
Raleigh, NC 27695-8105
jnwall@ncsu.edu
919.515.4162
Pat Letter of Recommendation -

To Stanford Prize for Innovation in Research Libraries -

My name is Patrick FitzGerald and I am an Associate Professor in the College of Design at NC State. My area of interest is centered around emerging technologies related to new ways for people to interact with computers. Our research team has spent the last few years looking at the Microsoft Kinect and how it might be used to manipulate media and information in public spaces for entertainment or learning. We collaborate with other disciplines whenever possible, and the opening of the Hunt represents an exciting new "sandbox" for us. It enables us to experiment of projects and ideas with great ease and flexibility.

Last year, we were invited to work with the Hunt to explore how the large scale Microtile screens might be used in a dynamic fashion. Our course ADN 419 explored various linear and interactive visualization techniques with these displays. Some of the experiments included 360 interactive video spaces where "hot spots" could be selected for more information or investigation. The Hunt library was very open and encouraging to our explorations and the staff at the Hunt conducted many meetings and demonstrations for us over the course of the semester.

This year, I will be part of the IMLS National Leadership Grant team that will be conduct research at the Hunt library. We couldn't be more excited to work with the researchers and staff at the library on this grant, which will explore using gaming technology in an educational application on the library's numerous Microtiles.

The Hunt Library is positioned to be a world class library with technology and creativity as it's core assets. It is making a contribution to our community's research infrastructure by making tools available to faculty and researchers that both inspire innovation and provide capabilities and capacities not available to us before the library opened. This letter is to highly recommend the Hunt Library for the Stanford Prize for Innovation in Research Libraries for 2014.
From: Megan Wood <mfwood@ncsu.edu>  
Date: Tue, Feb 26, 2013 at 11:25 AM

Currently, I’m a junior working on a dual degree in the Anni Albers Scholars program. Which consists of a Bachelor of Science in Textile Technology from the College of Textiles and a Bachelor of Art and Design from the College of Design. I am a lover of old-fashioned things whilst an adopter of new media. As in, I love to sew and create things with my hands, but I also thoroughly enjoy interactive mediums and just started delving into open source hardware projects thanks to a MaKey MaKey that I borrowed from The James B. Hunt Jr. library.

Initially, I was reluctant to embrace the new library, as I am one who enjoys perusing isles of books and getting lost in them. However, after my first encounter with the new library, I quickly realized that every aspect of it was created to cultivate the "User Experience" and found myself engulfed and overwhelmed by all of the intricacies and beautiful details, delicately crafted into the building to satiate and stimulate its users.

A building such as this, where every element was truly designed with its end-user in mind, demands our respect and attention. There is such beauty abound; I found myself so constantly captivated by all of its little details that I completely forgot I came in with the predetermined decision of not liking it, and downright fell in love with it.

Attached you will also find pictures of the book that I made after that first trip to the library, which is when I took the finalist picture. I made the paper out of old communications medium: cassette tapes, floppy discs, circuit boards, a VCR and other electronics. Then attached the book to a makey makey and used graphite (and myself) as a conductor which allows you to run/control any program on your computer. You will see me playing Tetris in one of the photos simply from using the "keypad" I drew on the paper. As you can see, the library has inspired me on many levels.

The picture that was selected as a finalist in the contest was taken with an iPhone 4 and uploaded with instagram, no special effects or filters were used, just a beautiful building on a beautiful day.

Regards,

Megan Wood
TO: SPIRL Jury
FROM: Harriette Hemmasi, Joukowsky Family University Librarian
DATE: January 6, 2014
RE: Stanford Prize for Innovation in Research Libraries

The construction of Hunt Library at North Carolina State University is a monumental accomplishment that exceeds all boundaries of academic vision, impact, and innovation. The potential for this facility, its attending staff, and the library users who have the great fortune to be part of this transformative experience is limitless and as yet, largely untested. While there are a number of impressive, tangible results that have emerged during this first year of the library’s operation – such as support for research grants, providing the campus with new teaching and study environments, and widespread praise and publicity – the deeper, longer-term significance of Hunt Library will be revealed over time. And the reverberations of its influence will not be limited to North Carolina.

The dimensions and directions of change embodied in the newly constructed Hunt Library are unprecedented. Where, other than NCSU, can we find a university (and state) that has invested so deeply and trusted so explicitly in the capacity of its new library to stimulate current and future methods of research, promote creative modes of teaching and learning, and transform both the reputation and capacity of its faculty and students? And where, other than Hunt Library, can we find a leadership team so dedicated to aligning its services and spaces with the needs and aspirations of today’s faculty and students, while being equally determined to create an adaptable, extensible environment complemented by a set of evolving services and staff ready and able to interact effectively with current and future generations of scholars and learners?

Despite the brevity of its existence, Hunt Library stands as a beacon of inspiration and hope not just for academic libraries but also for universities worldwide. At a time when libraries and their universities are decried as being unsustainable and are consistently called on to justify their existence and demonstrate their value, NCSU has boldly advanced the evolution of its library and itself into a technologically sophisticated environment uniquely capable of supporting cutting-edge research and preparing a student body that will shape the future of education and commerce locally, nationally, and globally. Yet the impressive diversity of high-end digital technologies housed within Hunt Library do not represent the library’s (or the university’s) genius. Its true genius lies in the all-out commitment to reshape and restore the role of the library, and the university, as the center of research and learning, by both creating a hub and becoming a catalyst for individual as well as collaborative experimentation, innovation, contemplation, and education across the disciplines.
Dear Colleagues,

When the doors of North Carolina State University's James B. Hunt Library opened on January 2, 2013, the Hunt staff demonstrated 'proof of concept' for transferable and scalable academic library transformation principles. Pro-active dissemination of details about this epic journey over the past decade – from planning processes to technical specifications – ensures benefits across the globe from the Hunt Library example. It is therefore a real pleasure to write a letter of support for Hunt Library's application for the 2014 Stanford Prize for Innovation in Research Libraries, which aims to recognize and celebrate extraordinary innovation.

The founding design principles for the Hunt Library reflect a bold forward-looking approach to invention of technology spaces, tools, and platforms. While the particular outcomes are specific to the Hunt Library's location on NCSU's entrepreneurial Centennial Campus, the inclusive planning framework and innovative workplace culture offer valuable lessons and best practices for all academic libraries impacted by the new realities in contemporary scholarly communications and researcher workflows.

In an earlier age, library collections were crucial components of the scholarly ecosystem; however, curated collections are increasing less prominent in research workflows. Rather, researchers advance knowledge through frequent, fluid, and rapid exchanges of research data and other communications. These changes in research models require bold new approaches to designing and delivering research infrastructure. In response, over the past decade, Hunt Library staff members have developed new capacities and focus areas expressed through innovative organization, infrastructure, and services models that leverage digital technologies. Fundamentally rethinking the purpose and significance of library-as-place in the 21st century depends on shared organizational vision. Therefore, leadership must be exercised not only by formally designated senior leaders but also by informal thought leaders, boundary spanners, and knowledge enablers who lead from wherever they are in the organization.

To ensure organizational participants able and eager to re-invent themselves and their outcomes, senior NCSU Libraries' leaders actively promoted experimentation within an evolving culture that interprets failures as learning opportunities. Earlier than most of its peers, NCSU reallocated positions from print-centric functions to technology positions to support development of the digital library, information technology, and, later, technology-rich learning spaces. This aggressive reallocation strategy was complemented by a strategic hiring philosophy; in combination, this two-fold approach produced enthusiastic professionals who thrive amidst ambiguity and transformation.
Integral to the planning and design process, robust collaborations were also initiated and sustained among library staff, campus stakeholders, and corporate partners. These newly invented relationships appropriately acknowledge new disciplinary and cross-disciplinary models of research to explore these questions from the NCSU application: Does the library have a role in managing leveraged institutional investment in research infrastructure beyond collections and, if so, what is the appropriate role? Is it strictly service-focused, or can the physical library again become part of the institution’s critical research infrastructure. The outward focused characteristic of the NCSU Libraries’ culture ensures a strong core for readiness to develop, implement, and succeed in the Hunt Library vision.

Transferable and scalable lessons learned over a decade have been generously shared with educators across the globe. Illustrative of this long tradition, the NSCU Libraries were recipients of the first ACRL Excellence in Academic Libraries (ACRL) award in 2000. The NSCU Libraries was also a lead in a National Leadership Grant from the Institute for Museum and Library Services (IMLS) to develop a model for next-generation learning spaces, which resulted in the freely available Learning Space Toolkit. In 2013, in partnership with the Coalition for Networked Information (CNI), NSCU Libraries offered the Designing Libraries II Conference. My institution sent six delegates, including the campus master planner, our renovation architect of record, and four library design team members. We now have an international network of multi-disciplinary colleagues engaged in pursuing critical questions about libraries, within a rapidly transforming scholarly communications environment, guided by Learning Space Toolkit resources.

In closing, I suggest that the magnificence of the Hunt Library physical structure is equaled by the planning philosophy, magnanimously disseminated so that academic libraries worldwide can receive insight and inspiration. For this, I strongly support the Hunt Library application and urge your thoughtful consideration of its multiple merits.

Yours sincerely,

Mary M. Somerville, MLS, MA, PhD
University Librarian, Professor, and Library Director