



What Engineers Want: Lessons Learned from Five Years of Studying Engineering Library Users

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I. Introduction and background

In 2009, the North Carolina State University (NCSU) Libraries completed the initial design phase of a new library building, the James B. Hunt Jr. Library. At this stage of the process, space- and service-model planning was initiated and in support of this work, various user studies were undertaken. These studies, which were conducted up until the last months before the building opened in January 2013, helped to answer planning questions, as well as build support and awareness of the library among faculty and students.¹ After the building opened, it quickly became apparent that assessment of the effectiveness of the new spaces and the service model was needed and as a result, more studies were initiated. The resulting body of five years of research provides many practical insights into the needs and preferences of Hunt Library users.

The Hunt Library is situated on NCSU's Centennial Campus, a 1,000-acre community approximately one mile distant from the university's historic main campus. Centennial Campus is home to academic departments, labs and centers, as well as offices of corporate and government partners, a public middle school, student housing, and commercial apartments and condominiums. Two of NCSU's 12 colleges are based on Centennial: the College of Textiles and the College of Engineering, and therefore the majority of the print collections located in the Hunt Library support these two disciplines. As the sole library on Centennial Campus, the Hunt Library was envisioned as a multi-disciplinary building that would support the whole university community. This also is in keeping with the vision of a 21st century library that is not defined so much by the subject matter of its physical collections. That said, with 9,000 engineering students and 1,000 textiles students, the vast majority of the patrons using Hunt are from the College of Engineering and (to a lesser extent) Textiles with all of the other groups making up the "fringe" proportion of the user base. At NCSU's other major library, the D. H. Hill Library, the situation is and always has been the reverse, where the majority of users are from the humanities, social sciences and sciences, and engineering students make up a small proportion of the user population.

As much of this paper will describe student use of library spaces, it is worthwhile to take a moment to briefly describe the types of spaces available in the two main libraries.

As already mentioned, D. H. Hill Library is the main library facility on the University's historic campus and prior to Hunt Library's opening was the only major library at NC State. It is a 400,000-square-foot building with an eight-story book stack tower that holds the majority of the NCSU Libraries' print collections. D. H. Hill has approximately 1,700 seats, provided in a variety of spaces, including 15 group-study rooms, a learning commons, an enclosed quiet study room, two large open reading rooms with long library tables, and book stacks with study carrels. There is one faculty conference room and a graduate student space equipped with four group-study rooms, computer workstations, and tables and chairs for small group seating. D. H. Hill has been under constant renovation since 2007.

The Hunt Library is a five-story building of 149,000 square feet. Hunt has almost no book stacks; approximately 30,000 volumes are stored on open shelving on two floors of the building, in lounges and reading rooms. An automated storage and retrieval system (known as “the bookBot”) holds 1.5 million volumes. The library has a very open design with high ceilings and there are hard surfaces in several areas (e.g., wood staircases, wood-and-marble floors and glass walls). Hunt also provides approximately 1,700 seats. There is a significant amount of lounge-style seating on the second, third and fourth floors. Approximately 70 group-study rooms are located throughout the building. There is a traditional reading room with long library tables on the second floor that is designated as quiet space. The third floor consists of flexible seating and public computing. The Learning Commons is located on the fourth floor along with the Graduate Student Commons. This graduate student-only space has group-study rooms, open tables and chairs, lounge seating and computer workstations. The fifth floor has another open reading room with large tables (however this space is not designated as quiet). The Faculty Research Commons is similarly equipped as the graduate student space but does not have computer workstations. More detailed descriptions of the Hunt Library are available on the NCSU Libraries web site.²

II. Engineers as a unique user community

Among engineering librarians there is a widely held belief that engineers are a unique type of library user, clearly differentiated from their counterparts in the humanities and social sciences because of the technical nature of their work and even different from scientists. This last difference is important because scientists and engineers are frequently grouped together by librarians and others – it is very common to see and hear references to “sci/tech” libraries, librarians and collections. And while scientists and engineers share some commonalities – for example, both deal with technical subject matter and both often work in laboratory settings – there are significant differences in the nature of their work and education. Pinelli explains these differences in the work of engineers vs. scientists in great detail,³ but for our purposes what matters is how this plays out in terms of library *use*. As users, engineers behave differently than their peers in other disciplines. Many of them simply don’t use the library, physically or virtually, and are unaware of library resources and services. Neither group is known to ask reference questions in the traditional sense or request mediated searching. Tenopir states, “Even when they do use a library, engineers like to search for information themselves rather than go through a librarian or other intermediary.”⁴ Information literacy historically has been almost non-existent in engineering, and the gains of the last 20 years have been hard won by librarians dedicated to making the case as many times as necessary.

We believe the different attitude engineers have towards libraries is cultural and starts at the undergraduate level. Packed with courses in the fundamentals needed for accreditation, engineering students spend all of their time learning theory and solving problems. In her book on engineering education reform, Galloway describes how jammed the curricula has become:

“A few decades ago, the average number of credit hours required for an engineering degree was 140; today—in more than half of American colleges and universities—the number of credit hours required is 128,”⁵ and “... these requirements continue to be reduced steadily by various universities and legislatures. How can engineers continue to do more with essentially less education?”⁶

The curriculum is textbook-centered, and most of the information students need is given to them in class. The majority of their work consists of weekly problem sets, and there is little time for reading, writing, or information-seeking. The result is that the natural connections that students in other disciplines would make with the library and librarians are less likely to happen. Faculty, who were educated in the same way, are not likely to encourage students to go to a librarian or use the library, and as a result students may assume that using libraries (and reading and writing) are not something that “engineers do.” And so a self-perpetuating culture exists that results in engineers often being ignorant of what libraries offer. There are, of course, exceptions to this. We include ourselves among them, having worked with many faculty interested in building students’ information skills, but these tend to be exceptions. Galloway sums it up well, saying, “Engineers themselves have grown complacent in terms of their education, failing to grasp the importance of a well-rounded educational experience.”⁷

Another cultural element has to do with efficiency and time-saving. Engineers are very focused on methods that succeed using the least amount of effort and/or time. Tenopir, summarizing other studies, concurs, saying, “Engineers typically work under deadlines and therefore seek immediate answers to specific questions... They prefer easily accessible channels and sources and will choose ones most easily accessed over a higher-quality source... Not surprisingly, libraries have never ranked high as a preferred source for information by most engineers.”⁸

While there have been many studies on the information-seeking behavior of engineers, beginning with Allen’s work in the 1960s and 1970s and continuing to recent years (Tenopir provides a thorough review of them), there are very few papers that talk about engineers as users of library spaces and services. Additionally, many of these studies have focused on engineering practitioners working in industry, who may have little access to libraries. One would expect that engineers in academia, i.e., faculty and graduate students, would be more conscious of the library and thus more likely to utilize it. Engel’s 2011 survey of the information-seeking behaviors of faculty at 20 public research universities included two questions on space use. The results were similar to studies of engineering practitioners, showing a preference for electronic resources and personal communication and little interest in visiting the library building. “Close to three-fourths of respondents (73%) indicated that they had visited the physical library fewer than five times in the past year. Only five percent of the respondents indicated they had visited the library 24 or more times during the past year.”⁹ Analyzing the data by sub-discipline made no difference: “Library space to study and conduct research was not valued highly by any branch of engineering.”¹⁰ Bridges’ 2007 study of the differences in library use among undergraduates of different disciplines found that, “Although engineering students did not statistically differ from their peers in their use of the physical library, they were significantly less likely to use the online library resources when compared with students from liberal arts.”¹¹

Our anecdotal experience at NC State has been similar: faculty are more likely to use electronic resources but not the physical space, undergraduates and master’s students are more likely to use the spaces but not the resources, and PhD students are more likely to take advantage of both. However, in every case, resources and spaces must be convenient to access. As we will show, this ultimately played out in use of library spaces.

To work effectively with this unique community, library services to the College of Engineering at NC State have, since 1998, been delivered via a service model that is both location-independent and engagement-centered. By bringing services to them, we have overcome the perceived inconvenience of leaving the building. By engaging faculty and students directly, we have helped change the culture, growing their awareness of library resources and services and improving information literacy. With no dedicated engineering library before Hunt Library opened, librarians worked where the faculty and students were located, meeting in their offices and labs, teaching in their classrooms and conducting office hours for drop-in reference assistance in their buildings.^{12,13} Years of this type of focused effort has produced a team of engineering librarians connected to faculty and students with a deep understanding of the research and curriculum. It is in many ways similar to the experience of branch librarians who are embedded in a user community and who come to know that community thoroughly.

In contrast, the public services staff at the D. H. Hill Library were less mindful of engineering users because they were not working with them directly and because engineers made up a small percentage of their interactions at the service points. As the overall library organization began to transition to the new reality that Hunt Library would bring, it became apparent that these staff had a very different experience of library users, and had many assumptions about what kinds of services would be necessary and important in Hunt. For example, it was thought that staff would need to be trained to handle the types of reference questions that were typically asked at the reference desk at D. H. Hill. However, the engineering librarians knew that these types of questions rarely come up with an engineering population, but that argument could be difficult to make if it were only based on anecdotes and the experience of a small number of people. All of this supported the need to conduct research and accumulate data that would help staff understand the ways that engineers are a different user population and to further evolve the existing service model to the new Hunt Library learning environment.

III. Summary of research

Over the five-year period from 2009-2014, a variety of research methodologies were employed, depending on factors such as the nature of the research question and the timeline in which the data was needed. These fell into four major categories: focus groups, surveys, observational studies and interviews. Some studies were short and simple, put together very quickly to inform an imminent decision in the design of the new library, while others were much longer and more complex in terms of their format, planning and analysis. All of the studies were designed and carried out by engineering subject specialists with assistance from other colleagues in the Libraries as needed. These are described below and summarized in Table I.

Focus Groups

Focus groups are designed to bring homogeneous groups together to discuss topics and gather feedback. In summer 2009, the Libraries held a series of five focus groups with engineering faculty and graduate students. The design of the Hunt Library building had just been completed, and the overall goal was to gather initial reactions to it. The 25-question script focused on preferences for spaces – including how they would use dedicated spaces for faculty and graduate students, use patterns, technology and food needs, and opinions about storing the collection in an

automatic retrieval system. Groups consisted of three to six participants, with two librarians present (one acting as facilitator, one as note-taker). Each session started with a 15-minute presentation of the building spaces, conducted by an architect who was hired by the NCSU Libraries to assist us throughout the process.

Surveys

Surveys can be a very efficient way to capture data (especially large amounts of data). Three surveys were conducted during the five-year period. The first was a short (nine question) “one minute” survey of 177 engineering and textiles students carried out in September 2011. The purpose of this survey was to quickly gather information about student laptop use, frequency of visiting campus and study group size. With regard to this last item, there was anecdotal evidence of engineering students studying in large groups of 12 or more, but what was unknown was how often students studied this way. This short survey was an example of “on the fly” research that was done to meet an immediate need; in this case, the survey was designed, conducted and analyzed in less than five working days. It was administered on paper to 150 students in the engineering buildings and 27 textiles students in the Textiles Library. Afterwards, the data was entered into Survey Monkey for analysis and reporting. Despite choosing students at random, the demographics of the resulting data set were nearly a perfect representative sample of the student body in the two colleges in terms of departmental enrollment and undergraduate/graduate student distribution.

The second and third surveys targeted graduate students in the Colleges of Engineering and Textiles and involved significantly more effort and preparation.¹⁴ They were conceived of in the months prior to the opening of Hunt Library, when the realization began to dawn that additional research was needed to measure the effectiveness of the spaces and services in the new building post-occupancy. Furthermore, to do a post-occupancy study well, baseline data would be needed for comparison. For these reasons, we decided to implement two surveys of engineering and textiles graduate students – one before Hunt opened in October 2012 and one after in October 2013 – thus capturing “pre” and “post” attitudes and opinions. The surveys consisted of 78 and 96 questions, respectively; however, the actual number of questions encountered by students varied depending on their responses – e.g., the respondent who says he never uses the library would not be asked follow-up questions on which spaces he prefers. The pre-occupancy survey received 781 responses corresponding to a 31.0% response rate, while the second, post-occupancy survey received a total of 704 responses for a 27.0% response rate. These surveys were created using Qualtrics software, and invitations were disseminated over email.

With such large sets of data, the graduate student surveys have provided a wealth of information and have turned out to be the most useful of all the research that was conducted over the five-year period. In particular, the surveys allowed us to confirm and clarify findings from the other studies.

Observation

An observational study is a useful way to collect data in a way that has low impact on the user and also documents actual behavior (as opposed to relying on the individual’s reported

behavior). This type of study was employed at various points before and after the opening of Hunt Library. The first observational study was another “on the fly” study implemented in 2011 to quickly gather some data on engineering students’ use of spaces in the engineering buildings. The purpose of this observation was to determine the size of study groups, whether or not students were carrying laptops with them, the types of furniture available and what they preferred to use. Over the period of one week, librarians observed students studying for final exams in the open spaces of the three engineering buildings on Centennial Campus. They counted the number of students they saw, the number of groups and the size of the groups. They also took photographs of furniture and spaces being used as well as those not being used. In all, they observed a total of 1,222 students, including 556 students studying alone and 242 groups of two or more, with an average of 2.75 students in each group.

Two additional observational studies were carried out in the Graduate Student Commons in Hunt Library. The first, in the spring of 2013, was the first post-occupancy study conducted. The purpose was to evaluate use of this new graduate student-only space (the first of its kind at NCSU) in terms of furniture preferences and technology use. Librarians monitored the space five times per day during a sample week in the middle of the spring semester. They counted the number of people in the space, which group study rooms, furniture and technology were being used, whether people were studying alone or in groups, and what personal technology they were using. Data was collected on a paper map of the space and then entered into Microsoft Excel for analysis and reporting.

The second observational study took place in the fall of 2013 but instead of taking place over one week, observations were taken every Monday throughout the semester. The research questions and methodology remained the same and again, this study was solely focused on the Graduate Student Commons in Hunt Library.

Interviews

Semi-structured interviews are useful for gathering information about users’ current behaviors, preferences, needs and aspirations. This method allows the interviewer to adapt the questions based on the flow of the conversation and to ask follow-up questions to clarify a point. In 2011, as we began to think about service models and programming in the Hunt Library (particularly in the dedicated faculty and graduate student commons spaces), we decided to spend some time talking to faculty and graduate students in engineering and textiles in order to learn about their research and teaching, their work-lives, and their current and anticipated use of library spaces. Formal interviews were planned, and a script consisting of 22 questions was designed.¹⁵ Faculty and graduate students in all the departments in the Colleges of Engineering and Textiles were contacted and invited to participate. Over an eight-week period, 25 faculty and 20 graduate students were interviewed. Most interviews took place in the participant’s workspace or office (a few took place in the library at the participant’s request). Two librarians attended each interview, one acting as interviewer and the other as note-taker. The interviews also were recorded, and the recordings were later transcribed. All of the faculty interviews and many of the graduate student interviews involved one participant at a time, but a few of the graduate student interviews involved small groups of two to four students.¹⁶

Analysis of the 2011 interviews resulted in more interviews taking place in the years following. For example, it was found that of the original 20 graduate students interviewed, only five were master's degree candidates, which is not representative of the larger population in which master's students make up over 60% of the engineering and textiles graduate students. To address this, five more master's students were interviewed in the spring of 2012. An additional three PhD students offered to speak to us at that time, so they were interviewed as well. Deeper analysis of the faculty interviews revealed early-career faculty as users that the library might be able to better support, and so additional interviews of faculty in this category were conducted in the spring of 2013 to acquire more data from this group. All of the interviews used the same script originally created for the 2011 interviews.

A different set of interviews was conducted in 2014 in response to student concerns about computing. During the first year that Hunt Library was open, anecdotal evidence began to mount that indicated students were having problems with the public computers available in the library. A series of interviews was planned in conjunction with Libraries IT staff members to better understand the root cause of these issues. To this end, engineering graduate students were interviewed while they demonstrated their typical use of the public computers. This provided us with a first-hand account as they tried to replicate the issues with an IT staff member on hand to observe. A 19-question script was used during these one-hour sessions, and two staff members (one engineering librarian, one IT staff) were on hand for each of the five interviews.

Table I: Summary of research methods

Date	Research Method	Research Question	Participant Category	Number of participants
2009	Focus Groups	Reaction to building design, space, service and collections needs.	F, G	21
2011/2012	Interviews	Research interests, work schedule, work spaces, current and anticipated library space use, collections and service needs	F, G	53
2011	Survey - short	Study group size, laptop use, days on campus.	U, G	177
2011	Observation	Study group size, furniture preferences	U, G	1,222
2012	Survey – Part I	Library use, space, furniture, technology preferences, collections needs, likes/dislikes.	G	781
2013	Observation – Sample Week	Use of spaces and furnishings in Graduate Commons space, technology use, study group size.	G	890
2013	Interviews	Research interests, work schedule, work spaces, current and anticipated library space use, collections and service needs	F	11
2013	Survey – Part II	Library use, space, furniture, technology preferences, collections needs, likes/dislikes.	G	704
2013	Observation - Weekly	Use of spaces and furnishing in Graduate Commons space, technology use, study group size.	G	2,281
2014	Interviews	Public computing problems.	G	5

F= Faculty, G=Graduate Students, U=Undergraduate Students

IV. What engineers want

The results of all of the research can be summarized in terms of a few basic principles that were consistently stated as the basis for the majority of the needs and preferences expressed by our engineering faculty and students. These principles are: functionality (Does it work?), practicality (Does it meet my needs? Are there unnecessary features?), and efficiency (especially related to saving time). Engineering faculty and students repeatedly made it clear that these mattered most to them. As a result, many of the specific comments on spaces, furniture, technology and the like can be attributed to one or more of these basic principles. A more in-depth discussion of the preferences of engineering users is listed below, broken down by major topic area.

Spaces

Students

In terms of library building use, the graduate student surveys of 2012/2013, as well as the earlier interviews, showed that engineering students will use library spaces, but that convenience and proximity weigh heavily against need as deciding factors. Before the Hunt Library opened, 77% of survey respondents reported using campus libraries (see Table II), where library use was defined as having used library space at least one time in the semester during which the survey was administered. In looking at usage by department (at this time, six out of 10 engineering departments are located on Centennial, with the other four still located on the main campus), it was found that engineering students based on Centennial Campus were less likely to travel to the main campus to go to the D. H. Hill Library compared to engineering students already located on that campus (74% vs. 86%, respectively). The students who did make that trip tended to be students without office space, such as master's students enrolled in non-thesis degree programs.

After the Hunt Library opened, library use increased to 90% among all survey respondents. Overall usage among Centennial Campus-based engineering students increased to 93%, including PhD students, most of whom have their own offices. Before Hunt, this group was the least likely to make the trip to the main campus, but once the proximity issue was resolved, they, too, became library users. In addition, the overall frequency of use among all users also went up after the Hunt Library opened, so not only are more students coming to the campus libraries, but they are coming more often (see Figure 1). Not surprisingly, graduate students on Centennial Campus strongly prefer the Hunt Library over D. H. Hill. However, those engineering students still based on the main campus (i.e., those located closer to D. H. Hill) show no preference between the two libraries.

Table II. Graduate student survey respondents' use of campus library spaces

	Fall 2012 (n=714)	Fall 2013 (n=646)
Yes	77.3%	90.2%
No	22.7%	9.8%



Figure 1. Graduate student survey respondents' frequency of use of D.H. Hill, Textiles and Hunt libraries in 2012 and 2013; where frequent use is 2-7 days/week, moderate use is 2-4 days/month, and light use is once a month or less. (Note: the Textiles branch library, which was located on Centennial Campus, closed in December 2012.)

Faculty

Faculty mostly described themselves as non-users of library spaces, and many were notably unaware of how students use study space. Many of them had not set foot in a library building in years, so they did not personally observe students working in library spaces. It should be of no surprise then that, in the 2009 focus groups, some engineering faculty questioned the need for a library building at all. Later, in the 2011 interviews, it was clear that most of those faculty who were engaged with the library tended to do so in traditional and predictable ways that do not involve any use of space; i.e., to support teaching (e.g., putting books on reserve) and to discuss collections issues (e.g., to request a new journal subscription). However, two additional categories of potential library building use did emerge. The early-career faculty described very hectic work lives that indicated a desperate need for a place to work alone or in collaboration with colleagues, making them very interested in the prospect of a dedicated faculty commons space. Lastly, there were several faculty interested in using the library as “a place to impress someone,” i.e., a place to bring visitors, prospective students and faculty hires, to show them a beautiful, inspiring and busy place to demonstrate what makes NC State University special. While this might not seem like a valid “use” of the library, for these individuals it was critically important, and they were (and continue to be) strong supporters of the Hunt Library.

It should also be mentioned that while faculty were nearly unanimous in their status as non-library users before Hunt Library opened, once the case for Hunt Library was made, many did express expectations of being able to use the spaces in the building after it was open and operating. These proposed uses included: holding meetings, classes and office hours, booking multiple group study rooms to work with student groups, using quiet space for “serious” solo or collaborative work away from students and other distractions, and hosting college or university-wide events such as seminars, workshops and orientations, as well as social gatherings. A lesson from this is that if libraries want engineering faculty to come into the building, they should be open to supporting non-traditional use cases.

Group versus individual spaces

Both faculty and graduate students wanted a mix of spaces that would give them the flexibility to match the tasks at hand. Users asked for designated quiet space as well as space where noise was allowed, space to study alone and space to work in groups. In recent years the trends in library design have skewed more towards collaborative spaces, allowing for a more noisy environment. Hunt Library is very much in keeping with this trend. However, its open design and hard surfaces make it difficult to separate noisy areas from quiet ones, and so although students expressed appreciation for the variety of spaces available to them, it also was not surprising that complaints about noise went up in the 2013 survey. Among students' suggestions were requests to ban cell phone and Skype calls in the open areas of the Graduate Student Commons and to create additional quiet areas in the building.

Our observational studies of both engineering undergraduate and graduate students showed an approximate 50/50 split between group and solo work.¹⁷ When studying in groups, most students work in smaller (two to three people) groups; both the 2011 and Spring 2013 studies found that these accounted for 83% of all groups. However, students also reported in the 2011 survey that they study in large groups of eight or more once or twice a semester. It is likely that this is occurring before major exams.

An important takeaway from these results is that engineering students study alone as much as they study in groups. The recent emphasis in higher education on collaborative work may have created an impression that the need for quiet, distraction-free space no longer exists. Our research found that engineering students still need this type of space, and where that space does not exist, students create it by doing things like: using group-study rooms (the spring 2013 Graduate Commons observation found single students occupying group-study rooms 27% of the time), sitting at computer workstations without using the computer, perhaps to create a "study carrel" experience (this was observed 26% of the time), and using rolling white boards to create partitions. Another approach is to go to a different library altogether. Before Hunt opened, the 2012 graduate student survey showed an even split between group and individual study taking place in D. H. Hill. (This data is based on responses to questions about the types of work students engaged in while working in library spaces.) Once Hunt opened, the 2013 survey showed a shift, where a larger percentage went to D. H. Hill for solo work, while Hunt Library was used more for group work (see Figure 2). This was further supported by students' responses to another survey question: When asked what they liked most about the library, quiet/individual study space was the top positive comment in both 2012 and 2013 among D. H. Hill Library users, with a greater proportion of respondents saying so in 2013.

Throughout the research, group-study rooms were by far our students' favorite type of space, with multiple studies showing them to be the first spaces students choose and the ones they consistently asked for more of. One reason for this preference may be because they suit both individual and group work very well. Indeed, one common complaint on the surveys was about group-study rooms being used by individuals.

In addition to group and solo study space, the graduate students we interviewed expressed interests in other types of spaces, such as space to defend their thesis and an exhibit area to

display work and receive feedback from other researchers. Several of these students commented about feeling isolated in their labs and expressed a need for opportunities to communicate the work they are doing and network with others around it. Subsequent comments received from the surveys have shown how the Hunt Library has begun to help meet this need for community, e.g., “It is also creating a community of library-goers that can meet each other on Centennial Campus”; and “[The Graduate Commons] fosters an environment to meet and interact with other grad. students.”

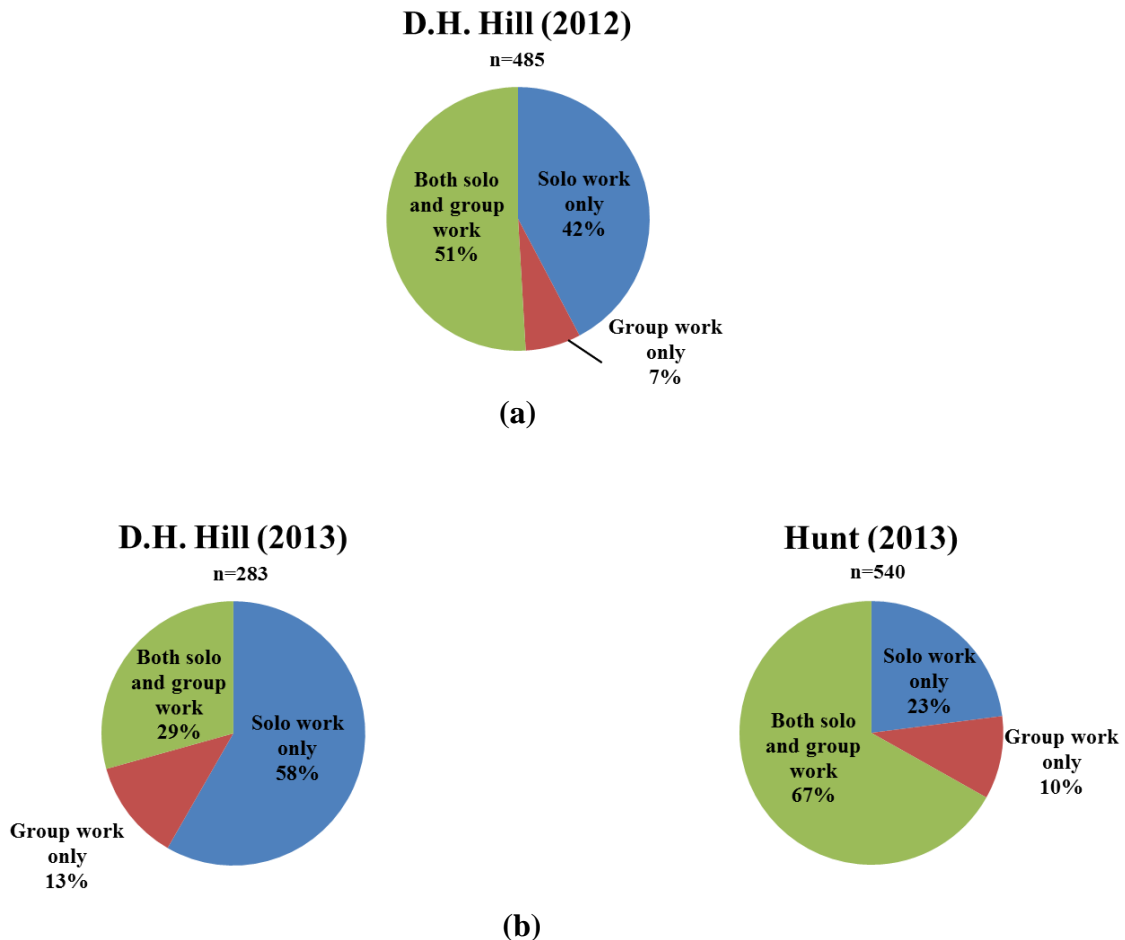


Figure 2. Distribution of individual vs. group work for (a) D.H. Hill Library in Fall 2012 and (b) D.H. Hill and Hunt libraries in Fall 2013

Furniture

In terms of library furnishings, practicality and utility were again important factors. Chairs by themselves, no matter how comfortable or attractive, are not as useful for studying as when paired with a table. Several students explicitly stated this in the 2013 graduate student survey, e.g., “Not enough tables/desks to compliment the amount of seats,” or “Limited table availability in the evenings. Plenty of lounge chairs, but not actual tables and work chairs.” Observational

studies bore this out, with students consistently choosing lounge-type furniture last, even when it was in a desirable space like a group-study room. Similarly, sofas were deemed to be problematic because they lack a place to put a computer or a drink. Only when there is nothing else available is lounge furniture occupied.

Students also made clear the need for tables with room to spread out in both the interviews and the surveys. Most students are carrying laptops as well as textbooks, notebooks and calculators and need space for all of these study tools. Computer workstations were generally deemed as lacking in sufficient workspace. Students also asked for a variety of work surfaces, especially writeable surfaces. Students told us they like moveable white boards and would like the opportunity to print and save white boards, but were mixed in their opinions of smart boards, with several interview respondents saying that smart boards were a “showy” type of technology and not necessarily useful.

Technology

Many of the studies we conducted involved questions about student laptop use. While laptop ownership is required of NC State engineering students, the question of whether students actually carry them to campus (and if so, how often) remained. Having this information would help in designing the laptop lending service in Hunt Library. The short survey of 2011 found that 99% of engineering undergraduates reported owning a laptop and 87% said they brought that laptop to campus. While many did not bring a laptop every day, 50% of undergraduates reported bringing their laptop five or more days per week. Observation done the same year showed that 80% of the undergraduates in groups and 70% of those studying alone were observed using a laptop. In the graduate student surveys, 98% reported owning a laptop, and 70% said that they brought that laptop to campus. These numbers were the same before and after Hunt Library opened.

With so many students owning and carrying laptops, it was interesting to see whether or not students availed themselves of laptop lending. In the graduate student surveys, less than 15% of students reported borrowing a laptop in 2012. In 2013, those numbers rose to 30% for those students who did not bring a laptop to campus and 20% for those who did. Interestingly, the rate of laptop borrowing among non-laptop owners was similar, at 12.5% and 25% in 2012 and 2013, respectively.

Despite ubiquitous laptop ownership, students still stated in the interviews a need for desktop computing, with 50% reporting that they needed to run applications that were too resource-intensive to run on a laptop, or for those times when they do not have their laptop with them. (Some mentioned not wanting to carry a laptop late at night). Students who preferred to bring their own laptops to the library also asked for docking stations and the ability to directly connect their laptops to the Ethernet.

Network and computer speed were also big issues. Slowness of public computers was the top technology complaint in the graduate student surveys of 2012 and 2013, with three times as many comments in 2013. One possible reason for the increased number of complaints is that a brand new, high-tech facility such as Hunt Library raised the students’ expectations of having the fastest network connection and equipment on campus. These complaints led to the

aforementioned 2014 computer workstation study. It was found that the workstations at issue were primarily thin client (virtual machine) Windows computers, where students reported slow performance in the course of their normal work. This consistently slow performance was not found on the other public computers available (Mac, Linux, Windows desktop PCs). The main takeaway from this study was again functionality: Students expect the technology in a high-tech environment such as NC State to work well. As they shared their experiences in the interviews, they made inevitable comparisons with their own personal technology and said that they expect library-provided workstations to work *at least as well* as their own laptops.

Another need is access to multiple monitors. In studies prior to Hunt Library, students described how multiple monitors on the public computers would help increase their efficiency, and this need was borne out in both observation and interviews post-occupancy. All of the Windows workstations in the Libraries are equipped with double monitors, while the majority of Mac computers have one large screen. For both types of workstations, students were routinely observed using not only all of the library-provided monitors but also a laptop at the same time in order to maximize the number of screens available to them. One of the students we interviewed in 2011 stated that his ideal setup would be to have “three or four monitor screens” while a 2013 survey respondent told us how his preference for two screens trumped his OS preference (“I would prefer to use the Macs, but I like having two screens, so I use the PC.”).

When it comes to technology, engineering faculty generally have everything they need in their own offices, departments and labs. However, during the faculty interviews, they spoke about some technologies that the library could provide. Videoconferencing and teleconferencing facilities were the most frequently requested, with one-third of faculty interviewed asking for this. Faculty also asked for visualization/simulation space and 3D display. They were also explicit in their needs for projection in meeting spaces. High resolution and accurate color representation were of critical importance to allow them to discuss and analyze their research. The ability to display a variety of media and to run audio and video files was also a priority.

Collections and Services

Faculty and students also shared many comments about collections and services in the various studies. A major change with Hunt Library was the use of the bookBot, an automated retrieval system (ARS) to store the majority of the engineering collection. Of approximately 400,000 volumes, only about 30,000 are available on open shelving; these are newer books published in engineering and textiles subjects, as well as some specialized collections (e.g., faculty publications). In terms of the ARS, faculty were the most likely to be concerned about the loss of the browsing experience and also about the engineering portion of the collection being split away from the main library collections. At the same time, they stated that they value access to e-journals more than physical space.

Feedback from the pre-Hunt 2012 survey revealed that graduate students found book stacks in D. H. Hill difficult to navigate, with multiple students making comments such as “[i]t takes a long time to find a book” and “finding books in the stacks is difficult.” Conversely, now that the engineering collection has been moved from D. H. Hill to the Hunt bookBot, students find it easier to obtain their books since they no longer need to physically find a book on their own. As

one student commented, “the bookBot is also very useful, as it saves time and lets me just drop by to pick up a text.” At the same time, other students have expressed disappointment with no longer being able to browse the stacks. However, accessibility is important; in both surveys, students were frustrated when a book was not in the library on the campus they used most. At the same time, many expressed extreme gratitude for the number of books the Libraries offers and (of course) asked for more of everything (books, e-books and journals).

The top complaint from graduate students related to collections and services had to do with textbooks. The service provided by the NCSU Libraries of placing on reserve a copy of every textbook can be frustrating for graduate students in large courses. With 150-200 classmates, students complain that there is never a copy available when they need it. This may be an opportunity for the Libraries to manage expectations and communicate to the students that the Textbook Collection is not meant to replace the need for students to acquire their own copies of required textbooks.

Graduate students also asked for the libraries to be open 24/7 – their reasoning being the library should be open at all hours graduate students are on campus. They also asked for more support with technical writing, free scanning of articles (to save them time) and more outreach from librarians on what the library has to offer.

V. Conclusion

The studies we performed from 2009-2014 in many ways corroborated much of the existing research on engineers conducted over the last several decades. Engineering faculty and students continue to value the practical: efficiency, functionality and accessibility are key factors in engineers’ perceptions of usefulness. As libraries look to renovate or build new spaces for engineering users, these factors should be considered important elements in the design of space and selection of furnishings and technologies. Engineering students will come to the library if accessing it is convenient and furniture and technology support the type of work they do. Lastly, it should be recognized that, as non-users of physical libraries, faculty may not initially understand the need for new or upgraded library spaces. Our experience shows the case can be made and support obtained, but libraries should in turn be willing to support the ways faculty may be interested in using these new learning environments.

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