Design of Classlab and Supporting Spaces to Enable a Multidisciplinary Hands-on First-Year Engineering Design Curriculum

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In Fall 2016, Campbell University welcomed its first cohort of engineering majors, after a year of planning, recruiting and hiring. Building a new school of engineering affords a number of unique opportunities, including the building of new venues for engineering instruction. Campbell University intends to focus on the integration of hands-on exercises into engineering instruction, with a curriculum informed by best practices, engineering education research, and the recommendations of national reports such as "Educating the Engineer of 2020."

Campbell University has taken advantage of this opportunity by adapting Louisiana Tech’s classlab concept (integrating class and lab facilities at scale) and large portions of their innovative, NSF-funded LivingWithTheLab (LWTL) curriculum. The LWTL curriculum employs hands-on, project-based instruction for first-year engineering design and demands availability of classrooms featuring equipment often restricted from wide student use by availability and safety concerns. This adaptation included developing an updated interpretation of the classlab concept (where traditional lecture and laboratory activities are seamlessly interwoven into the same course, taught in two-hour blocks) and adding new supporting spaces dedicated to collaboration and access to equipment outside of class hours. As the LWTL philosophy encourages student exploration and investigation of tools and projects outside of the scheduled class meeting times, these outside-of-class spaces enable students to take that exploration and investigation to a new level. Campbell University’s initial wave of facilities are now in use by students.

Response by students and faculty has been overwhelmingly positive. Some additional general working space has been added to the first-year classlab. Students have used the collaboration spaces as envisioned (and twice requested extended hours for the spaces). Lessons learned include the importance of designing space as flexible as possible and intentionally designing different classrooms in different ways to expand the numbers of ways they can be used. Classlabs for sophomore through senior year courses are being designed in a temporary building along thematic lines, grouping courses that utilize similar lab equipment together in the same classlab. Limited additional collaboration space will also be included in this temporary space. A permanent engineering building that unifies all learning and collaboration spaces is planned for the next 4 – 6 years.

This paper will outline the design, rationale, research basis, and final implementation of the first wave of new spaces, along with initial concepts for additional classlabs being built to support second and third-year courses. This paper also includes an informal examination of the response of the university community and beyond to the creation of these facilities, as well as recommendations for programs seeking to implement such classlab and supporting spaces for other hands-on curricula.

Background
Campbell University has a long history of excellence in the health sciences, with doctoral programs in pharmacy, medicine, physical therapy, as well as physician assistant and nursing
programs, pre-pharmacy, pre-med, etc. Other areas of strength include trust and wealth management, PGA golf management and law, among others. In the interest of diversifying offerings, and in response to ongoing interest from prospective students in engineering, the University decided to launch an eighteen-month study on the feasibility of starting a new School of Engineering. The recommendation from the external consultant’s report was in support of a general engineering program with concentrations in mechanical engineering and a second area aligned with the university’s strong health science focus. The Board of Trustees approved establishment of the degree program in 2014. After a national search, the inaugural dean was hired in 2015 with the initial cohort of faculty and staff brought on board at the beginning of 2016. After fourteen months of planning, curricular development, facilities renovation and recruiting, the program was launched with an initial class of approximately 100 first-year students in fall of 2016.

First-Year Classlab Configuration
Building a new school of engineering affords a number of unique opportunities, including the chance to develop a program based on best practices, engineering education research, and the recommendations of national reports such as "Educating the Engineer of 2020," among others. Campbell University has taken advantage of this opportunity by adapting Louisiana Tech’s classlab concept (integrating class and lab facilities at scale) and large portions of their innovative, NSF-funded LivingWithTheLab (LWTL) curriculum.

The LWTL curriculum employs hands-on, project-based instruction for a common, required two-semester first-year engineering design sequence and demands availability of classrooms featuring equipment often restricted from wide student use by availability and safety concerns. Campbell University, in its efforts to understand and adapt the LWTL concept, started with a visit to the Louisiana Tech campus. The goal was to interview faculty, talk with a student focus group, sit in on classes, take detailed tours of the classrooms and out-of-class facilities, and review supporting infrastructure. Topics explored included equipment choices, layout and maintenance to funding, mentoring and training of student and staff support, and mechanisms for supplying replacement parts. A second visit followed, focused around a week-long workshop for faculty teaching the project-based, first-year engineering design sequence to help them prepare to teach LWTL on the Campbell University campus.

School of Engineering faculty and staff spent the spring semester investigating, researching, planning and ordering equipment, furniture and outlining renovation needs. Space renovation took place over the summer before the first cohort of students arrived at the beginning of the fall semester. With a smaller student body, an entire small building to renovate, and adequate funding, Campbell University was able to implement an updated interpretation of the core LWTL classlab concept.

Research on teaching and learning spaces show that they should facilitate active construction of knowledge by the learner. This research discusses the impact of the social setting on learning and the degree to which it supports peer-to-peer transfer of knowledge (versus a focus on a faculty member at the front of the classroom). Informal learning spaces can increase the sense of agency of students and communicate their role as co-learners, or stifle both. It suggests that today’s students are interested in small group workspaces, access to tutors and faculty, table space that
supports a variety of learning tools (books, laptops, projects), integrated lab facilities, IT
tegrated into learning spaces, availability of labs/equipment, accessible facilities, shared
communication spaces, and workgroup facilitation. Moreover, research on learning theory
suggests that supportive spaces should reflect flexibility, comfort, sensory stimulation,
technology support and decenteredness. There are numerous initiatives which have restructured
classroom spaces to support active learning. Some programs have also used a studio design to
teach courses with some lab components. The classlab approach is an effort to combine lecture
and machine shop or experimental equipment into the same space. There are some similar
approaches to this type of space design. For example, Harvard’s SciBox is a flexible learning
space described as half classroom, half lab with an adjacent workshop. SciBox is reconfigurable
and, while not specifically designed to support a specific course or courses, has housed a variety
of courses in its space, as well as theater groups seeking after hours rehearsal space. George
Washington University’s Engineering Lab features desks that can be organized for lecture or
combined to create tables that support smaller lab equipment with common AV displays.

The first-year classlab was the first main instructional space prepared for Campbell University’s
LWTL classes. As suggested by research, the first-year classlab (see Figure 1 and Pictures 1, 2,
and 3) is an example of an integrated lab facility which supports both traditional lecture (seating
students for 24 students at six tables with rolling chairs in the center of a large room, with both
whiteboard and large monitors for PowerPoint, web-based presentations, flexible power sources,
etc.) and lab activities (with lab stations for each table around the edge of the room, portable
whiteboards for each of the six student tables, as well as several common lab stations and work
areas along with some equipment and storage in the back of the room). This design helps
reinforce and support instruction, which integrally incorporates peer-to-peer transfer of
knowledge and students as co-learners. This layout also facilitates easy transition between the
different forms of instruction and different learning activities used in this classlab space. See
Table 1 for a list of major equipment for the first-year class lab.
**Student Workstations**
- Milling machine (Wabeco F1200D)
- Drill bits
- C-Clamps, bar clamps
- Rafter angle square
- Phillips power screwdriver bit
- 1/8 NPT-27 tap and tap wrench
- Claw hammer
- Hand broom/small dustpan
- Vacuum cleaner
- Cordless drill
- Bench vise

**Soldering Stations**
- Soldering Iron
- Heat gun
- Helping hands

**Other Tools**
- Grease gun
- Hand-held engraving machine
- Crimping tools

Table 1-Major Equipment for the First-Year Classlab
It is worth noting that this space, while modeled after the LWTL space at Louisiana Tech, has been revised in several ways. First, a more open floor design with larger tables and chairs on wheels provided more flexibility in room design and usage of the space. For example, this afforded the opportunity to add more work areas and storage inside the classlab. Louisiana Tech utilizes separate small but connected storage areas and offers non-dedicated work areas inside the classlab.

Large monitors with both wired HDMI and wireless connections replaced LCD projectors in the classlab and classrooms. The rationale for this selection was based on the expense of replacing LCD projector bulbs in classrooms that use the projectors heavily, as well as the decision by university IT personnel to discontinue all use of LCD projectors on campus in favor of monitors.

Large magnetic glass whiteboards were used in place of standard whiteboards in the classlab and classrooms. Several alternatives to standard whiteboards were considered (such as smart boards, whiteboard paint and whiteboard walls, in addition to the magnetic glass whiteboards). Smart boards are expensive and provide a variety of usage options, but faculty did not anticipate using most of these features frequently enough to justify the cost. Smart board size options were also much more limited than for the other types of whiteboards under consideration. Previous experience on campus with whiteboard walls suggested that they were considerably less durable than the other whiteboard options. Whiteboard paint was ruled out due to the cinder block walls throughout the building which would have necessitated additional remodeling and expense for the classlab space. Positive on-campus experience with glass whiteboards in terms of their durability and the range of size options, as well as cost (versus smart boards), resulted in the selection. One issue noted with the glass whiteboards is glare from windows and ceiling lights. Adjustable shades were added to windows in all rooms with glass whiteboards to minimize this issue.

In addition to the magnetic whiteboards at the front of the classlab, a portable whiteboard for each student table was also added to the design of the classlab. These boards can facilitate learning in teams as work written on the boards can easily be seen by all members of the student team, in comparison to a single sheet of paper or typing on a single computer monitor. These student-use whiteboards also allow faculty to easily see what a team is working on from a distance to determine where to intervene or redirect student efforts.

Power is provided from ceiling mounted, pull-down cords placed around the room, versus the model of in-floor power accessed via the tables (which forces the tables to be stationary) used at Louisiana Tech. In addition, it was decided to build the space for a class of 24 (versus 40 for most of the space at Louisiana Tech) to provide increased student-faculty interaction and hopefully increased student retention.

**Use and Scheduling of First-Year Classlab Space**

The classlab arrangement allows the instructor to integrate the “lecture” and “lab” portions of the course together in a more coherent whole. It facilitates switching from lecture to lab and back, incorporating lab-based demos, and permitting students to work either by themselves or in teams to complete mini-project or assignment activities. The first-year engineering courses taught in the space comprise a year-long sequence introducing circuits, sensors, robotics, programming,
basic use of hand and machine tools, mathematical modeling, mass and energy accounting, and statics, among other topics. Class sizes are limited to 24 students (the standard class size for engineering at Campbell University) and students are often assigned work in pairs or teams of 4.

A typical class period will see extended periods of student work on different problems or projects punctuated by small portions of lecture or classwide discussion. It is expected that students or teams completing the current assignment will assist other students in the class until all students are done. It is common to see students walking around the room to help other students, which is facilitated by the open layout of the space. With longer class periods and small class sizes along with this peer-teaching ethic, it is typical that all students in each section fully complete all in-class tasks in a given day, creating a norm of all students keeping up with the pace of the class. Each of the six tables features a ‘go / no-go’ block that is red on one side and green on the other, with green indicating that all students at that table have completed the task(s) and are ready to move on. These blocks allow the instructor and any students who have completed the task to easily identify students who may need assistance.

To accommodate this type of instructional arrangement, classes meet for longer periods of time (equal to the combined total of lecture plus lab hours allotted per week when those are taught as separate classes in different rooms on different days and usually taught by different people). These longer class periods are assembled to align with university standard start and stop times and are not more difficult to fit into most students’ schedules than a typical course with laboratory component. Scheduling classlab courses can be more convenient than scheduling standard courses with a laboratory component, as there is no need to match larger lecture sessions with a large number of small laboratory sections.

While lecturing for this extended time might be exhausting, the classes implemented change activities and modes of instruction frequently enough that faculty find it readily achievable to maintain positive engagement throughout the class period.

In the first year, the first-year engineering classlab space was only used for first-year engineering classes (three sections of up to 24 students in the first semester and four sections of up to 24 students in the second semester). However, the first-year classlab space could be used to support other classes, including conventional classes, if this were administratively desirable. Inclusion of the large monitor, whiteboards, and in-room sound system would enable the space to be used for traditional or active instructional practices. Scheduling an additional combined laboratory course in the same space would require careful work to integrate any additional equipment side-by-side with equipment already present – but given sufficient storage space and preparation time, it would be possible to base multiple classlab courses in the same classlab. This is planned for some classlab spaces discussed later. One limitation of the first year classlab space for traditional classroom use would be seating, with only 24 seats. Given other classroom space currently available, it is anticipated that first-year engineering courses will remain the primary users of the first year classlab space.

**First-Year Supporting Spaces Configuration**

The LWTL philosophy encourages student exploration and investigation of tools and projects outside of the scheduled class meeting times. This type of project-based approach to instruction
encourages students to study and work in teams (while maintaining the integrity of individual content mastery) and begs for supporting spaces dedicated to collaboration and, at times, access to lab equipment outside of class hours.

Campbell University faculty and staff devoted significant time to designing outside-of-class spaces to enable students to take that exploration and investigation to a new level. The university library offers a limited number of collaborative study spaces, but not only are they challenging to secure, they do not necessarily support the space and electrical power needs of student teams with laptops, robots, notebooks and tool bags. The new engineering collaboration spaces provide, as the research suggests, access to tutors and faculty (all co-located nearby in the building); table space that supports a team of students with books, laptops, tool bags, projects; ample portable and fixed whiteboard for shared communication; as well as flexibility (all furniture is movable), comfort (including a variety of soft seating, footstools, etc.), sensory stimulation via a vibrant paint palette and eye-catching posters, and a decenteredness which organizes the spaces into multiple small group workspaces versus an identifiable front, primary seating, etc.

Two outside-of-class collaboration spaces were developed, along with one complimentary space designed for individual, quiet study. Two of these spaces support the team-based projects often assigned in the classlab-based courses. Spaces such as these are not generally available at Louisiana Tech and extend the design and intent of the classlab spaces beyond specific engineering classlabs. One of these spaces (the largest, see Pictures 4, 5 and 6) supports large teams of 6-8 students with power and proximity to faculty offices and laboratory space (the classlab as well as the metal and woodworking fabrication facility and makerspace with seven 3D printers, vinyl cutter and embroidery machine). It also has some small group spaces for 1 – 3 students, as well as soft seating. Lab facilities are generally not open for student use in the evenings or on weekends, except for specific times when it is necessary to support project completion. Faculty often have evening office hours or review sessions and the large team space features ample whiteboard space. Supplemental instruction classes for math and chemistry are also held in the building.

A second study space (see Pictures 7 and 8) supports smaller four-person teams and individual students, with some smaller tables, small couches and individual seats with footstools. This space also has some portable white board access but less access to electrical power.
The third space (see Picture 9) is a designated quiet study zone, designed to support individual students when they need to study in such an environment. It features large private lounge chairs with electrical outlets, footstools, lighting and privacy screens. It also contains some individual chairs with footstools and one small table. Student response to these spaces has been positive. Use of all of these spaces has been heavy. At the request of students, building hours have been expanded three times, with the building now open from 7 am – 2 am during the week and until midnight on weekends.

Students additionally pursue engineering work and learning outside of the engineering building. While students may choose to work on engineering assignments or projects in a variety of locations with diverse features, one consistent element is the ‘lab’ that students bring with them. The LWTL curriculum requires students to purchase a tool bag in lieu of a textbook, and the contents of this bag along with the required laptop comprise a small portable laboratory. This portable ‘lab’ allows for many hands-on assignments to continue outside of class time. The contents of the student portable laboratory for the first year of study are shown in Table 2. Classes after the first year can require students to add tools or software to their personal laboratory, extending the capabilities of the tool bag (and thereby the student) to pursue engineering work whether it is used in an engineering classroom, study space, or some other location. Additions to the bag beyond the first year have not yet been finalized. Faculty can be sure that students have all of these items and can therefore assign out-of-class work employing any tool or item in the bag required by a prerequisite course. It is expected that the ownership and use of these personal lab tool bags over time will increase students’ sense of ownership and
agency in their laboratory work, but this has not yet been assessed. Consistent use of the laboratory tool bags beyond the first year represents an extension of Louisiana Tech’s use of the bags for the first year coursework only.

<table>
<thead>
<tr>
<th>Parallax Boe-Bot Kit</th>
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<tbody>
<tr>
<td>Arduino Uno Microcontroller</td>
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<tr>
<td>Dial Calipers</td>
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<tr>
<td>Folding Multi-Tool</td>
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<tr>
<td>Auto-Range Multimeter</td>
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<tr>
<td>7-in-1 Screwdriver</td>
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<tr>
<td>Combination Wire Stripper / Cutter</td>
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<tr>
<td>Soldering Supplies</td>
</tr>
<tr>
<td>Pocket Ruler</td>
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<tr>
<td>Safety Goggles</td>
</tr>
<tr>
<td>Assorted Circuit Components (resistors, transistors, relays, LED’s, piezoelectric buzzer, switches, photoresistors, etc.)</td>
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</tbody>
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Table 2-Student Portable Laboratory (‘tool bag’) First-Year Classes Content Only

Campbell University initially worked with the campus bookstore to supply the tool bags. The campus is located in a rural area and not all students have transportation. Repeated delays and unexpectedly high costs have led to a revision of that policy. While the bookstore will continue to carry a limited number of tool bags for students who need to utilize scholarship funds to purchase the tool bags or for students who arrive on campus unprepared, all students will be given the list of tool bag items, as well as potential online vendors. Students generally turned to Amazon Prime to order and quickly receive replacement parts during the first semester. Faculty and staff remain interested in stocking a limited number of key replacement parts since parts that fail the night before a project is due cannot be ordered and replaced in time for students to complete their assignment. The first semester we have relied on the bookstore to stay open extended hours to sell such parts. We are purchasing a vending machine to be housed in our building and stocked/maintained by the bookstore, which students can use to purchase key replacement parts using either cash, credit cards or their campus bucks card. Most of these replacement parts are very inexpensive (under $2), although some (breadboards, Arduino Uno microcontrollers, etc.) can cost more. This arrangement will allow the bookstore to close and students to purchase key replacement parts almost 24 hours a day.

Second Through Fourth Year Teaching and Learning Spaces
While it is very early in the recruitment year for our second cohort of entering students, to-date application, acceptance and deposits have all been running between even and +20% over the same date last year. A large number of students do not make deposits (the most reliable indication of their intention to attend the university) until late spring/summer before their entering fall term. For our first cohort, the percentage of deposited students who enrolled and attended in the fall was high, approximately 95%.
A metal building housing new engineering spaces, including classlabs, a new specialized equipment space, and a student collaboration area is under design, to be constructed over the summer and ready for sophomore classes by fall 2017. Second through fourth year classes have been grouped into four themed content areas, placing courses using identical or similar equipment together. A specific classlab will be allocated to support each of the four themed content areas, with adequate space for equipment and storage to support all classes slated to utilize the space. Classlabs will be flexible enough to support courses with both lecture and laboratory content, courses with outside projects and lecture courses that utilize hands-on demos to enhance instruction. An additional space will support senior design needs for project space and supporting equipment. A final sixth area will support specialized equipment needs. This temporary space will be used for five to six years, until a new engineering building is constructed. Classlabs and collaboration space will be similar to that in the first-year courses, with the caveat that classlabs will support multiple courses and therefore include a larger range of free-standing or dedicated equipment. Initial floor plans have been prepared for some second year classlab spaces including the Mechanics and Materials Classlab (see Figure 2) and the Chemical Operations Classlab (see Figure 3). The Mechanics and Materials classlab is 40 x 37.5 feet, and the Chemical Operations Classlab is 44 x 37.5 feet.

Significant effort and design has been devoted to thinking about how to fit the learning spaces for the sophomore through senior year curricula into the classlab format. Louisiana Tech does not use a classlab approach past the sophomore year. Three different arrangements and ways of grouping courses into common classlab areas were considered before the current thematic concept was selected. Considerations included use of similar equipment and semesters in which courses are slated to be taught (so that a single classlab will not be over-subscribed one semester and not utilized at all another semester). The planned rollout of the curriculum one year at a time also factored into how courses were grouped under each theme. The desire was to only outfit a pair of classlabs for the sophomore curriculum, with rollout of the remaining classlabs to occur in the junior year. This approach will allow for proof of concept and some redesign of subsequent classlab spaces, based on experience with the sophomore classlabs, one of which will accommodate two separate courses during the same semester. One small dedicated lab connected to a specific classlab was added to the initial design to address issues of safety and accommodation of specialized equipment space needs.

Potential concerns with the temporary metal shell building include 1) a less open floor plan which will result in less flexibility in how space is used, 2) an increase in the number of cabinets which are stationary which will decrease our ability to rearrange space to follow actual usage in subsequent semesters, 3) less dedicated collaboration space than in the first-year building, and 4) a significant distance between the temporary sophomore through senior year building and the first-year building which may decrease opportunities for faculty and student interaction (since faculty offices will not be housed in the temporary building) and will make it more challenging to oversee both spaces. Some of these concerns are based on decisions made by the administration which overruled faculty requests and some were made from a standpoint of practicality given that the building is temporary and will used for other activities after our departure.
Figure 2-Mechanics and Materials Classlab Initial Floorplan Concept
Response and Recommendations

Students have used the classlab as anticipated. It is open for use during scheduled class times, with limited after hours supervised usage during specific projects which require outside of class access to accommodate all 24 students in each section of the two-sequence first-year design course. Usage of collaboration spaces has been largely as anticipated as well. Students use both the large tables for groups and the smaller café-style tables. Both the whiteboard wall and portable whiteboards see heavy usage (as assessed by faculty whose offices are co-located around the collaboration spaces and who walk past the whiteboards multiple times a day and observe the changing content). Students do rearrange furniture in all three collaboration spaces on a regular basis to accommodate the number of people in their study group and the activities in which they are engaging (test review, working homework problems, brainstorming for projects, etc.).

Students have begun to utilize classrooms with their large whiteboard walls for after hours studying, as well. Some non-engineering students use our space in the evenings (which is not prohibited), particularly pharmacy students whose building is located next door and which has essentially no dedicated student study areas. Non-engineering student organizations and groups have requested to use space in the first-year building. Some of those groups failed to put the
space back as they found it and moved significant amounts of furnishings around in the building, resulting in some small damage to items. A new building usage form has been developed which clearly spells out permitted activities and space usage and all external request must now be approved by engineering administration prior to granting of such requests. This system seems to be working well.

While the new temporary building will have some collaboration space, it will not be open after hours initially, given its location on the edge of campus which makes oversight more challenging and safety concerns greater. This will likely provide greater demand for the existing collaboration spaces in the first-year building. It appears that the existing collaboration spaces will be able to accommodate demand next year but it is unclear if they will be sufficient during years three and four as new students are added each year.

Informal solicited and unsolicited feedback from current students, prospective students, campus admissions/recruiting/development personnel, university alumni and external visitors (faculty, employers, alumni, K12 teachers and students) regarding the first-year space has been overwhelmingly positive. Two different open house events were held to accommodate requests from the on-campus audiences cited above for formal building tours. In addition, over 50 individual requests for tours of the building from university alumni, trustees, friends of the university, prospective students, K12 schools and on-campus groups were accommodated in the first six months. Faculty have been invited to speak at workshops on developing innovative higher education spaces. Current students have submitted formal requests for extension of building hours in the evenings and weekends on three separate occasions, citing the suitability of the student and collaboration spaces for their needs, the challenge of finding available study spaces elsewhere on campus, and the lack of functionality (access to power, floor space, table size) found in other common collaboration areas on campus. As a result, the building closing time was moved from 10 PM to midnight and finally 2 AM during the week (with midnight remaining the closing time on weekends) and extended hours have been implemented during final exams and prior to major project deadlines.

Recommendations for programs seeking to implement supporting spaces for other hands-on curricula include designing for flexibility. First, do not fix in place any furniture or equipment that absolutely does not have to be fixed. It is impossible to foresee how items will need to be arranged until you have lived in the space for a while. Another way to build in flexibility is to configure similar spaces differently, with somewhat different emphases in mind. For example, one classroom can be equipped with individual rollable desks, another with long, narrow tables and a third with large, wide tables (versus deciding on one classroom layout and using it everywhere). These strategies provide the flexibility to utilize spaces for activities and in ways that were not initially envisioned and to accommodate different sized groups of people.

In addition to designing for flexibility, a second recommendation is to pay attention to how students utilize your current space. They will often force fit existing space to their needs (sitting in the hallway to work on projects when there are no spaces big enough to accommodate project and/or team work, taking over traditional classrooms for group study spaces in the evenings or to utilize the whiteboard for group problem-solving, etc.). Watching how they use existing space
can provide ideas on how to design new spaces to support the ways in which they want to study and learn.

Lastly, learn about new or innovative spaces from external entities, such as other institutions (either through formal visits to review space usage, prior experiences of faculty, or opportunities to view space in conjunction with campus visits made for other purposes), from companies who make higher education furniture and equipment, etc. Given that this curriculum was modeled after the LWTL Program at Louisiana Tech, that institution was the primary model referenced in space development (and it, in turn, has been informed and revised over the last two decades by visits to innovative programs on other campuses). However, faculty have visited and taught in other innovative spaces in the last few years (prior to joining the faculty at Campbell University), such as Olin College, UC Berkley, Purdue, Clemson, and NC State University, in addition to innovative corporate spaces at Microsoft, Medtronic, Boeing, IBM, Lenovo, Citrix, ExxonMobil, Thompson Reuters and Siemens which also informed our thinking about innovative spaces. Travel to other institutions to see novel space design and usage. It can be difficult to envision how to create spaces that stray from the common and ordinary. Dream. Even if final plans end up a step or two back from the “dream”, it is more likely that core innovations can be retained.

**Conclusion**

Campbell University welcomed its inaugural class of first-year students in Fall 2016. The emphasis on an innovative, hands-on approach to engineering education required developing a classlab concept and supporting spaces dedicated to collaboration and access to equipment outside of class hours. Given that the curriculum requires student exploration and investigation of tools and projects outside of the scheduled class meeting times, these collaboration spaces are particularly important to student success. Initial response has been positive and the spaces have proven to be functional and popular with faculty, staff and students. Plans are underway to construct similar classlab spaces for the sophomore through senior year courses, in addition to a fourth collaboration space, utilizing the same integration of lecture and lab, flexibility and student support.

**References**


