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(February 2013)

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1. Executive Summary

Princeton University has nearly 400 classrooms — a significant number. The Classroom Design Committee convened for the express purpose of examining the effectiveness of the design of these classrooms for teaching needs in both traditional and emerging modalities of learning on campus.

Through 14 Committee meetings (during the periods from February through June 2013 and September through November 2013), two walking tours of Princeton classrooms, and a workshop with peer institutions, we as a Committee (names listed in Appendix A1) listened to and questioned a wide range of users, experts, and decision makers (names listed in Appendix A2), reviewed research literature (Appendix B), and consolidated the key themes for this report. Our goal was to learn from both global best practices and local expertise, and to provide long shelf-life recommendations on principles and process.

We began our investigation with the shared assumption that classrooms impact the character and sometimes the quality of teaching and learning. We concluded our work with the shared belief that Princeton should let teaching drive classroom design. The faculty needs audio-visual (A/V) technologies to be as robust, universal, and user-friendly as possible. Classroom design should prioritize function alongside form and should intelligently leverage the spaces adjacent to and outside of classrooms. In light of emerging trends in active learning, Princeton should enable nimble experiments, both large and small. The University, which has an exceptional range of quality classrooms and an active record of new designs, should build on its own successes and learn from its mistakes. Princeton should involve all stakeholders before, during, and after the design or renovation process. The Committee also identified challenges — as well as strategies — for overcoming anticipated obstacles.

Realizing that there are no one-size-fits-all solutions, we make the following recommendations, focusing on creating a technology baseline, reforming the design process, and conducting experimentation in active learning spaces:

1. Equip classrooms with user-friendly digital technology and rapid-response technical support. These features, which at minimum should include connection and projection, must be universally available and easy to use across all A/V classrooms in tier 1 and above. We endorse the “watch list” for new technology, but ultimately believe that classroom technology is faculty-driven.

2. Involve all significant stakeholders in the design of functional and attractive classrooms, starting in the early stages of renovation/construction. Faculty and students, including community or alumni auditors, should be involved in these planning discussions, along with representatives from the Vice Provost’s Office, Office of the Registrar, Office of Information Technology, Media Services, McGraw Center for Teaching and Learning, Facilities, and Office of Design and Construction. The standing Committee on Classroom Design should become more proactive and, together with McGraw Center, collect faculty and student input.

3. Develop centralized, web-based, social-media-enabled, searchable sites for: (1) An inventory of classrooms; (2) a user-friendly scheduling system; and (3) a classroom feedback mechanism. These
sites should clearly denote the features of each classroom, including whether it is reconfigurable and active learning friendly.

4. **Convert underutilized classrooms into more flexible, easily configurable spaces, as part of pilot learning programs.** In these classrooms, encourage additional experiments in active learning, soliciting input and feedback from faculty and students.

5. **Create more “classrooms outside of classrooms.”** Develop and design adjacent learning environments, outdoor classrooms, and other alternative learning spaces.

### 2. Teaching at Princeton: Traditional Approaches and New Trends

Teaching, of course, is an integral part of the University’s scholarly mission:

> “Princeton is distinctive among research universities in its commitment to undergraduate teaching.”

By far the most common form of teaching at Princeton would fall into the category of “traditional” style of instruction and learning. Accordingly, most professors require classrooms that support variations on seminar/discussion formats, and lecture/discussion formats. While the former generally take place in smaller classrooms, the latter make use of both small and large lecture halls. Princeton encompasses world-class examples of such traditional classrooms, which have adapted over the decades (even centuries) to new pedagogies and historical trends. Nonetheless, they require a purposeful plan for their continuous improvement and adaptation.

In the 21st century, the pressures placed upon today’s traditional classrooms have intensified because of recent developments in teaching technologies and innovations in classroom design. This report addresses the challenges/opportunities faced by both Princeton’s traditional classrooms and the teaching facilities that will maximize and reflect the newest teaching trends. In the last few years, Princeton has responded to innovative teaching approaches. The University has efficiently updated classrooms and has taken steps to accommodate these new approaches. Some examples:

- Flexible teaching space (which is essential, for instance, for language teaching, but also increasingly relevant for active learning)
- High volumes of multi-media use (clickers, personal computers, audio/video/image projection)
- Opening the classroom space to the outside world (teleconferencing guest speakers, virtual meeting spaces)

Innovation in pedagogy will continue to undergo rounds of experiments, not all of which will be successful. However, to foster that innovation, Princeton’s involvement should go beyond simply accommodating change. By experimenting with classroom space, Princeton holds a rare opportunity to lead in the design, development, and testing of new teaching styles: The recent wave of new building construction, together with the renovation of historical buildings, offers the University an opportunity to start a conversation on campus about the new pedagogical practices transforming higher education.

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For example, active learning is becoming a significant driver of classroom design innovation. In its simplest definition, active learning seeks to amplify student participation and involvement in his or her own learning experience. Since the 1980s, an extensive body of research on college teaching has convincingly demonstrated that students are more creative, engage more, and retain that learning longer when faculty deploy more learner-centered teaching methods. These strategies often include team-based activities, small group work, collaborative exercises, case study approaches, and other forms of interactive teaching techniques based on students working together (both inside and outside the classroom) to discover, problem solve, test, and create. How one delivers the curriculum, in other words, is just as important as the curriculum itself. As educational pedagogy changes, our campus classroom design process can further these goals.

Other distinctive trends — such as online learning (including Massive Open Online Courses MOOCs), blended learning, and international collaborative learning — often require special classrooms. The development of online course materials has the potential to enhance teaching and learning for distance learners, and, no less importantly, for students here on campus. Some faculty members, for example, currently use online course materials to experiment with a teaching method widely known as “flipping” the lecture. Under this model, students listen to the week’s online lecture(s) in advance so that face-to-face class time is used for group discussions, problem solving, and other interactive exercises that deepen students’ command of the course material.

Several of Princeton’s centers and initiatives promote student-centered learning, despite the lack of suitable classrooms to host such classes (please note: these collaborative classes are often interdisciplinary). Some examples of student-centered learning:

- The campus-wide “Engineering and the Arts” initiative encourages and facilitates teaching and research across these particular boundaries.
- The Keller Center provides both undergraduate and graduate students with a broad range of interdisciplinary courses and co-curricular activities in engineering.
- The McGraw Center for Teaching and Learning sponsors a flip classroom within the center for active learning teacher-training sessions.
- The Digital Humanities Group combs the campus for active learning spaces equipped with new digital media.

Individual faculty members have long experimented with active learning exercises in the Princeton precept. In theory, the precept is an ideal forum for creative and collaborative active learning activities. In practice, however, many faculty members have discovered that the physical limitations of Princeton’s typical precept room, filled with heavy furniture in an inflexible layout, inhibits (some would say prohibits) engaged and dynamic student interaction. Active learning teachers find themselves teaching not so much in the classroom as against it.

A classroom design literature review (see Appendix B) identified five macro-level trends in classroom design for the 21st century: (1) Learner-centered pedagogy; (2) natural systems (ambiance); (3) spaces outside of the classroom; (4) flexibility; and (5) technology. In the next section this report, we evaluate
the current state of classrooms at Princeton, and describe specific needs and guidelines for the University’s future classrooms. We draw inspiration from both traditional teaching methods and new trends in pedagogy.

3. Current State of Classrooms

“Traditional” classrooms
Princeton has excellent examples of classrooms for traditional instruction, particularly among those used for medium-to-large lecture formats. Common features of such classrooms include:

- Ample blackboard space (including multiple, movable boards) and display screens, with the capability of using both simultaneously.\(^2\)
- Comfortable seating, often movable/adjustable.
- Good line-of-sight: Students can easily see the instructor, boards, and screens and can comfortably move their focus as needed. Instructors can clearly see all students in their seats, easily make eye contact, and freely move around.
- Ample space for writing/taking notes and using laptop/tablet computers.
- An easy-to-use, functional controlled lighting system (which has the capability to light the subject matter on the blackboard and dim lighting elsewhere in order to project images on the display screen, simultaneously).

Successful examples of traditional classrooms include: Burr Hall, Room 219; McCormick Hall, Room 106; Friend Hall, Room 108; Lewis Hall, Room 23; Jadwin Hall, Room A10; Wallace Hall, Room 300; and Betts Auditorium.

The general design principles described above also apply to smaller seminar classrooms, but the Committee recognizes the descriptions of a successful seminar to be more varied and flexible. The characterization of Chancellor Green Hall, Room 103, for example, emphasizes the inspirational quality of the historic architecture. Departmental seminar rooms, such as Dickinson Hall, Room 211 (Department of History), derive their value most significantly from their flexibility to accommodate small and large discussions, their generally well-maintained quality, and their ownership by the local program. Evaluating Dickinson 211 by the general design principles described above would raise the questions of whether the chairs should have folding arms for note taking, and whether the tables can be rearranged.

Unfortunately, Princeton has many classrooms in beloved and historic buildings that face distinctive problems. The University has many heavily used classrooms that substantially lack one or more of the features described above; and each of the following examples illustrates a different design problem:

- *Fine Hall, Rooms 214, 314, and 322:* The rooms in Fine have poor access to lighting controls, worn-out blackboards, and fixed seating. In Fine 322, the temperature control is also an issue because it is connected to the temperature control in the server room.

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\(^2\) This does not apply to all large lecture halls on Princeton’s campus. For example, the fact that McCosh Hall, Room 50, the University’s largest lecture hall, does not have this capability shows a significant defect.
• *McDonnell Hall, Rooms 101, 102, and 103:* The McDonnell rooms offer an example of rooms that function well for a single purpose, namely, physics demonstrations. This creates less than ideal sightlines for traditional lecturing. The fact that these are the only large lecture rooms in that part of campus exacerbates these problems.

• *McCosh Hall, Rooms 10 and 50:* The lecture rooms in McCosh prevent one from using the blackboard and display screen simultaneously. These will require a particular upgrading policy, encompassing historic preservation, rather than a straightforward “modernization” plan. The University might develop guidelines for this special category of classroom.

• *McCormick Hall, Room 101:* The stage in McCormick acts as a barrier that disconnects the professor from the students.

Inventory imbalance
Princeton has an adequate classroom inventory in quantity and quality. Generally, the number of classroom spaces outpaces the number of courses taught, allowing classes to be taught geographically near the host department. Overall, there is satisfaction with the location, size, furnishings, and technology of the rooms in which teaching takes place. The current inventory accommodates a wide variety of teaching styles, with different levels of technology and interaction capabilities in the class. However, satisfaction is not universal and constant. The Committee has identified many areas for improvement. Managing the current resources in a coordinated and responsive way should remain a high priority and a crucial aspect of the work of the Office of the Registrar and Space Programming & Planning.

Classroom utilization at Princeton is governed by several factors, including the time and place preference of faculty and students and the abundance of classrooms in the desired “neighborhood.” The confluence of these factors leads to intensive utilization of classrooms in the desirable 10 a.m. to 2 p.m., Monday to Thursday time slots.

Table 1 below shows the size distribution of classrooms presently in use at Princeton. Type A and Type B are Registrar scheduled classroom spaces: Type A rooms are solely scheduled by the Office of the Registrar and Type B scheduling is shared with the departments. Type C rooms are classrooms and meeting rooms located in the various departments and scheduled by each department. Registrar scheduled classroom spaces total 220—only 54 percent of potential classroom spaces.

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3 The information in this section is mostly based on anecdotal information, data from the Office of the Registrar, and room data supplied by the Facilities Organization. In addition, information has been culled from the draft classroom report prepared by Biddison Hier Ltd., Consultants to Higher Education in 2009. Although this report is dated and incomplete, it used data analysis of classroom utilization at Princeton based on data from the 2006-2007 academic year.
There tends to be a mismatch in the size distribution of classroom spaces vs. enrollment. During peak scheduling, Princeton has about 25 percent fewer classrooms than needed for classes with enrollments of less than 25, leading to scheduling of classes in rooms larger than necessary.

In addition, only a handful of classrooms currently have configurable furniture on a flat floor, limiting the capability to experiment with active learning space. Out of the 220 Type A and Type B classrooms, only two have easily movable chairs and tables, and 25 have movable tablet armchairs, which are primarily used for language classes.

**Compressed and variable scheduling**

Although classroom inventory is more than adequate, scheduling problems still arise. One factor is the concentration of teaching at mid-day (10 a.m. to 2 p.m.) and early- to mid-week (Monday through Thursday). This problem could be alleviated with a cultural change in scheduling habits on campus. For example, changing “acceptable class times” to be more inclusive may help ease the pressure on classroom inventory more efficiently than adding rooms to that inventory. In order to tackle this issue, which is beyond the core mandate of this Committee, we suggest initiating a conversation about broadening teaching times among stakeholders in the scheduling process (Office of the Dean of the College, University Registrar, Chairs, and Departmental Representatives).

As mentioned previously, the maintenance and scheduling of most classrooms is the responsibility of the departments. This leads to a high degree of variability in scheduling protocols and lack of transparency regarding room inventory and availability. Adding to the complexity, departments do not always synchronize calendars with the Registrar controlled rooms in their neighborhoods, resulting in double-bookings of desirable classroom spaces.

**Inflexible layout**

The re-configurability of furniture (which ensures a versatile teaching space) and a dynamic use of instructional time rank high among the priorities of classroom users. However, one issue with current inventory is that several rooms were designed with fixed seating charts. The furniture is either:

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4 Biddison Hier Ltd., Consultants to Higher Education *Princeton University Teaching Space Master Plan (2009).*
Bolted down to the floor (e.g., row seating in McCosh Hall); (2) unmovable because it is hardwired for computer access (e.g., donut tables in Friends Hall); (3) too heavy and massive to be moved (e.g., seminar tables in East Pyne Hall); or (4) constrained by tiered floors (e.g., Lewis Library). Where these factors are not in play, the reconfiguration of furniture and technology in several rooms on campus (e.g., Wallace Hall, which is a pilot for a language instruction cluster, and Frist Campus Center, which is used generally for interactive instruction of large courses) became a first response to the need for classroom versatility.

**Complex and non-user-friendly A/V**

The current A/V equipment in the standard media module (which is issued to the overwhelming majority of classrooms) is oversized, overspecialized, and overcomplicated for average instructional needs. Generally, faculty and students need very simple functions, such as connecting a MacBook to a projector (in order to project onto a display screen), and they need these functions to be extremely simple to access and always available.

Having many specialized devices in a classroom is costly and potentially a source for disruption while teaching. Multiplying platforms and devices creates more opportunities for each of them to fail. Most, if not all, of the A/V material played on devices in current media modules can be managed by a personal computer. An efficient way to reduce the hardware in heavily used classrooms is to encourage the use of digitized A/V material in class as an alternative to tape and DVDs. We anticipate the impact of the A/V capability reduction to be minimal. Princeton already has in place a network of centers (such as the Andlinger Center for the Humanities or the McGraw Center for Teaching and Learning) that handle digitization and distribution of A/V material through Blackboard. In addition, a loan program for instructional laptops is already in effect.

Finally, the current A/V technology interfaces with PC based computers; however, a significant proportion of faculty members have Apple computers, such as MacBooks, requiring specialized dongles to be able to use the A/V technology. One solution is to have a ready supply of dongles in each room to fit the range of Apple computers used on campus. Another alternative is to have wireless capabilities for A/V presentations.

**Variable maintenance and support**

The maintenance level of rooms varies because of inconsistencies in surveillance, ownership, and feedback mechanisms. The upkeep problem will likely become exacerbated, as classrooms become more flexible, leading to possible disarray. We advocate a better feedback mechanism, including a web-based site to report classroom maintenance problems. Additionally, users must return the room to the standard configuration after class, and staff in each neighborhood must be instructed on how to return the rooms to baseline each day. For this reason, we strongly encourage the purchase of lightweight, movable furniture for flexible classrooms in order to reduce the time required to reconfigure.

A common complaint threading through this report is the need for uniformity of flexible A/V equipment across classrooms. We also advocate a mechanism for rapid-response A/V support, which could be in the form of posted phone numbers, or a button on the A/V screen to contact support staff, as needed.
4. Technology Needs

Technology is a vital part of the design of the future Princeton classroom. Both traditional teaching and new trends (e.g. active learning) need reliable and user-friendly technology. This section outlines some basic recommendations related to technology that are essential for enabling effective teaching.

Keep it simple

We do not need classrooms loaded up with hard-to-use technology, just technology that works for those who need it. All classrooms should have an identical minimum technology package (projector, speakers, etc.) that only requires the physical connection of a device and the capability to turn on the projector. Faculty should be able to walk into any classroom on Princeton’s campus and connect standard portable devices to a projector and a sound system with very little effort.

This “minimum-feature, ultra easy-to-use, always-on” list consists only of:

- A ready supply of connectors to PC laptops and MacBooks in every classroom
- One button/switch (after possibly entering a security code) that projects the laptop screen onto the display screen

In classrooms outfitted with more advanced technology such as video conferencing, there should be clear instructions on how to use the equipment for the essential functionality of projection onto a display screen.

The next priority should be reliable and robust wireless Internet connection in all classrooms, especially as more wireless technology becomes available (e.g., wireless projection).

Digital, not analog

For using projection in the long-term, converting classrooms to more modern technology, such as digital HDMI, is a priority. The current standard at the University is VGA analog, which is outdated and requires adapters for many of the devices used by the faculty. The A/V and IT worlds are evolving rapidly. As analog begins to fade, digital is taking the lead. Therefore, the new flex rooms should be equipped with a digital connection and, wherever possible, designed with new media in mind. Granted, many challenges lie ahead:

- It is difficult to predict which technologies will last and which will not.
- Not all faculty members need or desire media equipment for their classes.
- Some faculty members still prefer analog equipment like DVD players.
- Digital systems are more costly than analog ones.

However, while the initial upfront cost of going digital is more expensive than analog, once digital systems are installed, their cost over time is considerably less. Currently, many of our media-equipped classrooms have both analog and digital connections, and this is even more expensive and takes up valuable classroom space in the process.
Faculty-driven
We are enthusiastic about maintaining a “watch list” for new technology, but ultimately we endorse the idea that classroom technology should be faculty-driven and rooted in the needs of teaching and learning. Therefore, there are two elements to consider: First, faculty members should be able to project, easily and reliably, any content onto a screen and through speakers that they can see and hear on their own devices. Second, since faculty are the prime innovators with technology and give new technologies their utility, there should be a system whereby University technology planners canvas the faculty members, on a regular basis, about emerging ideas in classroom technology.

Strategic screen placement
The poorly planned placement of the display screen in many classrooms makes it impossible to use a projector and a board simultaneously. Since many classes at Princeton are still partly or fully taught using blackboards or whiteboards, larger classrooms should be designed with multiple screens. In addition, there should be more focus in the design of the placement of the screens relative to the boards and the resulting architectural challenges in terms of sightlines and lighting.

Clear procedures for on-site technology support
Princeton’s classroom technology strategy should include a set of universal procedures for whom to contact for immediate support. For example, each room could have clearly posted contact information (name, office, phone number, etc.) when an immediate response is required for technological problems.

5. Enhanced Teaching and Learning through Classroom Design

Function should not be sacrificed for form
While Princeton classrooms should be characterized by both form and function, the main driver of classroom design should be how instructors actually use classroom spaces. Ignoring pedagogical practice has resulted in some poor instructional spaces on the Princeton campus. A case in point is Sherrerd Hall, Room 001, which is an unfortunate example of form trumping function: In this fishbowl design, students feel exposed and uncomfortable. The room’s furniture – intended to be reconfigurable – is heavy and awkward to move, thereby restricting use of the room.

Some of the functional classroom requirements should include predictability of layout, appropriate location of windows and lighting source, easy aisle accessibility, proper arrangement of viewing angle and podium-row distance, adequate knee space and desk space, and proper choice of blackboard size and projection screen location.

Furniture, ambiance, and technology are needed to meet the needs of classrooms. Table 2 below lists examples of some core classroom elements (chairs, tables, props, technology, and décor) that can be mixed and matched to fit different spatial environments (lectures, labs, precepts, seminars). This illustrated list of elements and spaces is not comprehensive but demonstrates the various combinations of elements that are possible for different class types and sizes. Students learn differently and our learning spaces should accommodate that diversity.
Table 2: Spaces Spectrum

<table>
<thead>
<tr>
<th>Elements</th>
<th>LECTURE (normal or flipped)</th>
<th>LABS (science or design)</th>
<th>PRECEPT/SEMINAR</th>
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<tr>
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<td>Large</td>
<td>Med.</td>
<td>Small</td>
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<tr>
<td>CHAIRS:</td>
<td>hard</td>
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<td></td>
<td>soft (sofa/beanbag) wheels</td>
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<tr>
<td>TABLES:</td>
<td>circular</td>
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<tr>
<td></td>
<td>rectangular</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>reconfigurable paper top</td>
<td></td>
<td></td>
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<tr>
<td>PROPS:</td>
<td>chalk board</td>
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<td></td>
<td>white board</td>
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<td></td>
<td>pin-up boards</td>
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<td></td>
<td>flip charts</td>
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<td>markers</td>
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</table>

Flexibility in the space

Reconfigurable furniture in an open, flat space may be the most important requirement for the “flex” room. We need more layouts with modular furniture (that can be easily and quickly rearranged) to accommodate different size groups and different teaching styles. Many faculty members employ many pedagogical methods, often within a single class hour. For example, an instructor might begin with a brief lecture to the large group, segue into small group activities, and conclude with a full group discussion. Classroom spaces need to be flexible and adaptable enough to accommodate these quick changes in tactics and tempo, as the learning environment shifts from large groups to small groups, and then back again. Researchers refer to the different classroom configurations made possible by flex rooms as linear (lecture, presentation, video), horizontal (class discussion), cluster (small group discussion and activities), and network (decentralized instruction).
Ambiance for enhanced learning
Ambiance is another, perhaps too often neglected, component of good classroom design. A classroom space starts from outside of the room. Studies show that there are enhanced learning outcomes in classrooms that integrate the dynamic learning experience with the patterns and processes of the natural world (daylight, outdoor views of trees and the sky, natural building materials like stone and wood, etc.). The following recent design ideas (that link the physical properties of the classroom to active learning methods) also strike us as especially promising:

- Classrooms with upholstered furniture that look more like living rooms
- Classrooms that encourage writing and erasing on walls or tables
- Classrooms with lockers, cubbies, bookshelves, or other storage silos
- Classrooms with moveable or “soft walls”
- Classrooms with different zones for contemplation, brainstorming, or creating
- “Dinner theater” classrooms with curved tables on tiers

A classroom environment can be versatile or playful and, at the same time, highly productive.

“Classrooms” outside of the classroom
We endorse the value of suitable spaces for discussion near classrooms. These spaces typically feature wide hallways, comfortable seating, blackboards, and table surfaces, which provide students an inspiring venue to be able to sit and talk with each other and with instructors, often working together on a problem or plan.

However, Princeton, with its beautiful campus, has a scarcity of outdoor areas designed to facilitate learning. For example, The Lewis Library and the Icahn Laboratory are outstanding new buildings in most respects, but they lack outside spaces designed for people to meet and work. In some places (e.g., outside the Chancellor Green Café and the area in front of the Art Museum), the simple addition of tables, chairs, and benches has transformed empty spots into vibrant venues for meetings, collaboration, and small precepts.

We recommend more attention to the outdoor spaces on Princeton’s campus and their possible uses in the construction of new facilities, and suggest that several existing open areas (e.g., near Lewis Library, outside Icahn Laboratory and the new Neuroscience Building, and Frist Lawn) be re-imagined to facilitate meeting and discussion outdoors. Besides tables and chairs, these spaces could also include blackboards, walls for projection, electrical outlets, etc. (e.g., the inclusion of a blackboard as part of the outdoor installation in front of Simonyi and Wolfensohn Halls at the Institute for Advanced Study, just across town, is conducive to learning). A more complicated and expensive design would be the amphitheater outdoor seating incorporated into the Arts and Transit Complex, which is currently under construction.

In the fall and spring seasons, we also propose experimenting with pop-up outdoor tent classrooms, similar to the tents that pop up for special events. There could be an online sign-up system for precepts to meet outdoors during the semester. This would be an alternative outdoor space for the traditional
At a minimum, should include connection and projection, must be universally available and easy to use.

Equip classrooms with user-friendly A/V technology. These features, which at minimum should include connection and projection, must be universally available and easy to use.
across all A/V classrooms, tier 1 or above. We endorse the “watch list” for new technology, but ultimately believe that classroom technology is faculty-driven.

This recommendation has two elements: First, faculty should be able to easily and reliably project onto a screen and through speakers anything they can see and hear on their own devices. Second, since faculty members are the prime innovators for technology and give new technologies their utility, there should be a system whereby University technology planners canvas faculty members, on a regular basis, about emerging ideas in classroom technology. Again, the particularities of the diverse, innovative, and flexible Princeton classroom should be balanced with universal minimum technology. Faculty members should be able to walk into any classroom on Princeton’s campus and connect standard portable devices to a projector and a sound system with very little effort. The recommendations range from implementing digital projection standards to a universal system for securing urgent on-site technological support in the classroom.

**Recommendation 2: Involve users in the early stages of classroom design**

For the design of functional and attractive classrooms, involve all significant stakeholders in the early stages of renovation/construction. Faculty and students, including community and alumni auditors, should be involved in planning discussions, along with representatives from the Vice Provost’s Office, Office of the Registrar, Office of Information Technology, Media Services, McGraw Center for Teaching and Learning, Facilities, and Office of Design and Construction. The standing Committee on Classroom Design should become more proactive and, together with McGraw Center, collect faculty and student input.

We encourage Princeton to design classrooms that meet the pedagogical needs of the 21st century while creating attractive and comfortable spaces for learning. To accomplish this endeavor, we advocate that the design of each renovation or new classroom should involve all stakeholders, including faculty, architects, students, and the administration.

At Princeton, there is no dearth of distinctive and inspiring classrooms. Some of these rooms, however, are not ideally suited for the many forms that teaching may take. The involvement of users in early phases of classroom design will help to achieve a balance between form and function in the classroom inventory. Also, and perhaps more importantly, this involvement will ensure that the teaching that takes place in the various neighborhoods will not need to adjust to the available rooms, but rather that rooms may accommodate the different and evolving teaching styles. We recommend that this decisive aspect of the design process be developed in conjunction with initiatives promoting campus-wide and cross-constituency reflection on and experimentation with the pedagogical use of space. In particular, a system should be put in place that enables faculty involvement in the design process. One form that such involvement may take is the targeted recruitment to and participation in standing committees of faculty involved with pedagogical thinking; another possible incentive may come from the inclusion of space-specific language (or the creation of a specific sub-category) in the existing structure of grants designed to foster innovation in teaching.
Recommendation 3: Develop a database of inventory, scheduling, feedback

To prevent classroom-scheduling conflicts, develop centralized, web-based, social-media-enabled, searchable sites for: (1) An inventory of classrooms, (2) a user-friendly scheduling system, and (3) a classroom feedback mechanism. These sites should clearly denote the features of each classroom, including whether it is reconfigurable and active learning friendly.

There is a high degree of variability in scheduling protocols and a lack of transparency about room inventory and availability because maintenance and scheduling of most classrooms is in the hands of the departments. Adding to the complexity, departments do not always synchronize calendars with the Registrar controlled rooms in their neighborhoods, resulting in double-bookings of desirable classroom spaces. We recommend development of a web-based, social media-enabled searchable inventory of classrooms, which would include such information as class size, layout, furniture configuration, and scheduling protocol. Additionally, calendars should be centralized, web-based, and modifiable throughout the year. The feedback to be collected into this database should be done through convenient interfaces with faculty and students, based on real-time experience without having to wait for the Classroom Condition Survey email at the end of each semester, and should be broad enough to cover the impact of classroom design on faculty’s choice of pedagogical style and experiments.

Recommendation 4: Experiment with classroom spaces

Convert underutilized classrooms into more flexible, easily configurable spaces, as part of pilot learning programs. In these classrooms, encourage additional experiments in active learning, soliciting input and feedback from faculty and students.

The Committee feels that creating and maintaining a designated space to experiment with and demonstrate new classroom designs may play an important role in raising awareness of new teaching methodologies on campus. If centrally located, properly promoted, and easily booked, such a space (similar to Frist Campus Center, Room 309, which is in high demand) could be used to display new layouts, furniture, and technologies to faculty, students, and the campus community in general. Beyond being a showcase for classroom setups, this space may bring together all stakeholders in classroom design around a concrete project and involve them in a sustained and long-term conversation.

Recommendation 5: Locate “classrooms” with the larger campus plan in mind

Create more “classrooms outside of classrooms.” Develop and design adjacent learning environments, outdoor classrooms, and other alternative learning spaces.

Aside from traditional classroom space, learning also takes place in informal spaces, such as adjacent corridors, common rooms, and outdoors. Therefore, campus planning needs to integrate these “classrooms” in all neighborhoods on campus and included within academic buildings, administrative buildings, residential colleges, libraries, and athletic facilities. There should be no academic buildings constructed without classroom space (both formal and informal). Recent construction has sometimes failed on this principle. Both the new Frick Chemistry Laboratory and the new Neuroscience Institute buildings include very few classrooms suited for instruction.

A balanced classroom distribution is also the key to achieving and maintaining Princeton’s commitment to a walk-able campus with viable campus neighborhoods, such as exists in the natural science,
humanities, social science, and arts neighborhoods. The classroom spaces in these neighborhoods possess the intrinsic requirements (furniture, A/V, and other resources), as well as the extrinsic requirements, since a key element of a classroom’s success is the environmental context in which it is located. It is important for the University to understand these twin requirements, and recognize how the physical spaces of the campus might enhance or support new teaching methodologies and learning environments.

Therefore, a strategic classroom plan should be coupled with a larger planning initiative — namely, the new Campus Plan that is being developed by the Office of the University Architect. This Campus Plan, contemplated in conjunction with the next Capital Plan, should include an examination of the classroom requirements (both intrinsic and extrinsic) and how they impact the overall plan. Integrating the classroom planning effort within the larger context of the overall Campus Plan will lead to a more efficient and effective process in achieving a match of our classroom inventory to the needs of the faculty and students well into the next decade.

In the planning of renovations and new spaces, these are some key elements to consider:

- Geographic and room size distributions
- Exploitation of opportunities for viable spaces just outside classrooms (adjacent spaces)
- Augmentation or right-sizing the inventory

Spaces adjacent to classrooms should become an important element when planning classroom space. Currently, hallways (that have been properly designed and furnished) are used by students as spaces for informal conversation and course-related interaction, before and after class time. Spaces conducive to developing interpersonal relations also foster the essential collaborative interactions at the core of contemporary pedagogy.

7. Implementing the Recommendations and Anticipating Challenges

The Committee recognizes that implementing the above recommendations will face challenges, and concludes this report with a discussion of some of such challenges and possible solutions.

Streamlining and upgrading A/V technology

Upgrading A/V technology is a challenge, not only in terms of implementing a campus-wide upgrade of the A/V equipment, but also in terms of physical support. Media Services only has a staff of five to maintain, service, replace, and monitor nearly 220 media classrooms, while simultaneously responding to increasing faculty and staff requests for training and assistance. This will not be sufficient, especially as spaces are flipped to enable new teaching practices that require more technology in the classrooms.

Preserving the architectural element of Princeton’s beautiful buildings

While updating Princeton’s historical buildings to modern teaching styles will be a difficult balance. We need to be mindful not to destroy the style of our historic structures while trying to upgrade.
Creating learning and teaching spaces outside of the classroom

Due to space limitations in some existing buildings, creating space outside of the classrooms will be a challenge. Their narrow corridors cannot accommodate typical pedestrian traffic with chairs and sofas obstructing the walkway. In addition, weather presents limitations during the period when outdoor teaching can take place.

Scheduling of classes to accommodate time for rearrangement of furniture

Rearrangement of furniture may require increased transition times between classes. One solution is scheduling of classes during non-standard times, which itself presents other challenges. A simpler solution is to purchase lightweight, easily reconfigurable furniture. Perhaps classroom surveillance, upkeep, and a return to baseline can be centralized with dedicated staff. In addition, the scheduling of classes requires balancing the distribution of classrooms in terms of size, and location across campus.

Incentivizing stakeholders to become involved in the design process

Incentivizing faculty and students to become involved in the design process in the early stages (by providing information and presentations to design planning committees) is a challenge — most do not have spare time for such activities. However, there are some stakeholders who have a vested interest and would be willing to make themselves available.

Establishing active learning spaces

Active learning spaces have significant benefits (chief among them student comprehension and retention), as well as challenges (e.g. discovering and quantifying hidden demand). Universities like Cornell University and University of Michigan (these institutions moved quickly to embrace active learning) have reported these two main challenges:

- *Flipping the spaces* poses several problems. First, it is costly. Flex rooms require an investment in furniture, technology, and even buildings to create workable active learning spaces; the amount of rooms that can be “flipped” inevitably depends on budgetary constraints. Second, the short time period between classes (at Princeton, just 10 minutes) leaves little time for reconfiguring classrooms from one class to the next. Third, flex rooms often put more demands on teaching assistants, who are typically the ones charged with rearranging the classroom furniture, possibly following instructions on default furniture arrangement (which is clearly marked on the wall). Security standards must be maintained, given the mobility of the furniture. Some of these problems can be readily resolved (students, for example, can quickly learn to rearrange the furniture themselves at the start of the class period). But the cost of creating these more innovative learning environments (by some estimates, between $50,000 and $100,000 per room) remains a significant challenge, as does the scarcity of square footage to accommodate the greater space needs of flex rooms.
• *Flipping the instructors* also presents difficulties. Not all faculty members are interested in new pedagogies (often because their current methods are successful). These faculty members, however, will not likely feel inconvenienced by an increase in the number of special classrooms, since most flex rooms are designed precisely to accommodate both traditional and active learning pedagogies. A larger problem may be training or incentivizing faculty members who are eager to learn new teaching methods but who need time, and sometimes resources, to readjust their curriculum. (Grants from the McGraw Center for Teaching and Learning might be one way to address this issue.) During this transition period, student evaluations may temporarily dip as faculty experiment with the many new pedagogical possibilities that special classrooms make possible. We might bear in mind, however, a familiar theory that proved successful at the University of Michigan: If you build it, they will come. The more special classrooms become available, the more faculty and students demand them.
Appendices

Appendix A: Background of the Classroom Design Committee

Appendix A1: Classroom Design Committee Members
Mung Chiang (Electrical Engineering): Chair
Paul LaMarche (Vice Provost)
Diana Fuss (English)
Alison Gammie (Molecular Biology)
Maria Garlock (Civil and Environment Engineering)
Bo Honoré (Economics)
Alison Isenberg (History)
Simone Marchesi (French and Italian)
Chris Skinner (Mathematics)

Appendix A2: Active Participants
- Internal Participants
  - Faculty/visitors: Brian Herrera, Mike Littman, John Danner, Derek Lidow
  - Undergraduates: Ankit Buddhiraju, Sara Kushma, Misha Semenov, Christina Bott, Jessica Brooks
  - Graduate TAs: Chris Brinton, Christian vom Lehn
  - Classroom committee
  - Office of the Registrar, especially Polly Griffin
  - Office of Information Technology
  - Office of Design And Construction
  - Office of University Architect
  - McGraw Center for Teaching and Learning
  - Council on Science and Technology
- External Participants
  - Architectural/design firms: KPMB Architects, Herman Miller, Steelcase
  - Researchers in classroom design, especially Lawson Wulsin
  - Clare Van Den Blink, Cornell University
  - Frances Mueller, University of Michigan
  - Donna Matteson, SUNY Oswego

Appendix A3: Charge Statement to the Committee from the Dean of Faculty (February 2013)
Princeton regularly designs and renovates classrooms. Yet, although these spaces are critical to our mission, we have no clear planning standards to govern them. As one might expect, the results are hit-or-miss: we build many classrooms in which faculty members love to teach but also others that they avoid. Moreover, even when faculty members like the physical configuration of the rooms, they sometimes express dissatisfaction—ranging from mild to profound—with the IT equipment
and support for the classroom.

The design challenges for classrooms are increasing. Students and faculty members are using a wide and expanding range of information technology in their classrooms, and their use of information technology is opening up new possibilities for teaching. So, for example, if professors choose to “flip” large classrooms by putting lectures online and using class time for discussion, they will require interactive spaces for large classes that previously took place in lecture halls. At the same time, professors in some fields are exploring new forms of pedagogy. At some universities, for example, language instruction takes place in specially designed classrooms configured differently from those used for many other subjects.

In response to faculty expressions of concern about the IT fit-out in our classrooms, we brought to campus last fall a group of IT leaders from Stanford, Carnegie Mellon, Yale, and Harvard. They confirmed that we lacked, and needed, a set of guidelines to shape the IT capacities of our classrooms. They insisted, however, that they could not tell us what those guidelines should look like: there is no agreed-upon “industry standard.” Instead, they said, the right guidelines depend upon faculty teaching practices. The universities that have succeeded at solving this problem have convened faculty groups to formulate standards for their teaching spaces.

We have convened this committee to assist us with meeting this challenge, and we are grateful to all of you on the committee for agreeing to participate. We have decided to broaden the Committee’s mandate beyond questions limited to IT. In order to create classrooms effectively for the decades ahead, Princeton needs a set of faculty-driven standards to guide design. These standards need not be—indeed, obviously cannot be—“one-size-fits-all”: Princeton will obviously require a portfolio of classrooms for groups of different sizes and teaching of different kinds. The University’s administration will have to use good judgment and seek departmental input about classrooms each time that it designs a new building. Nevertheless, this process will go much better if we have some general guidelines to structure the process. Developing these standards is especially important in light of the significant building projects—such as the renovation of the old chemistry building at 20 Washington Road—now in progress on our campus.

The Offices of the University Architect, Information Technology, the Provost, and the Registrar all stand ready to assist you with relevant information. We would also propose to put you in touch with a design firm that can support you by, for example, providing background about the range of available options for classroom planning and the kinds of standards that would most assist architects as they planned projects.

We ask that you address the following questions (along with any others that you deem relevant in the course of your work):

1. What principles should govern the basic physical configuration of lecture halls, classrooms, and seminars?
2. How should Princeton provide the flexibility necessary to accommodate “flipped classrooms” and other novel forms of instruction?
3. Are there gaps in the portfolio of classrooms available at Princeton?
4. What are the standard IT packages that Princeton should provide for “ordinary” classrooms?
5. What sorts of technologically “special” classrooms (for example, telepresence rooms) should Princeton provide?

Appendix B: Research Literature and State-of-the-Art Survey

(Please see enclosed report by Lawson Wulsin)