Blurring Boundaries: A Description and Assessment of the High Performance Learning Spaces in Wallenberg Hall, Stanford University

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1. Introduction

The goal of this report is to describe and assess the uses that faculty, students, and others are making of the high performance learning spaces (HPLS) in Wallenberg Hall at Stanford University. Wallenberg Hall is a unique facility at Stanford, and few similar classroom buildings exist anywhere. In particular, Wallenberg Hall is distinctive in its focus on small and medium-size classes (four of the five classrooms are best suited for classes of twenty students or fewer, and the fifth can accommodate fifty), and in its status as a University resource, as opposed to a teaching facility attached to a particular department or school. Other advanced technology classroom buildings tend to be focused on larger classes, and to be associated with particular (usually technical or scientific) disciplines. These distinctive features make the learning spaces in Wallenberg Hall of interest beyond the Stanford community.

In examining the use of Wallenberg Hall classrooms, the project team quickly identified a key underlying theme: the use of technology (ranging from “low-tech” items such as small portable whiteboards to large Web-enabled display screens) to enable a richer and more flexible learning environment for faculty and students than is typically possible in university classrooms. The title of this report, “Blurring the Boundaries,” is intended to call attention to this theme, and to link it to a more general trend, perhaps particularly evident at Stanford, of increasingly indistinct boundaries among universities, industry, and public policy.

Wallenberg Hall (also known as Building 160), is located at the front of Stanford University’s Main Quad. The interior of this historic building was completely renovated in 2002 to prepare it to be the home of the Stanford Center for Innovations in Learning (SCIL). The renovation of the building was the product of a partnership between the Wallenberg Foundations of Sweden and Stanford University. Wallenberg Hall also serves as host for a broad-based research initiative on interactive technology and people at Stanford known as Media-X as well as the Stanford Humanities Lab and the Wallenberg Global Learning Network, a SCIL research collaborative including major Swedish and German universities. In this introductory section, we provide background about the building, including a brief history and description of the high performance learning spaces.

1.1 History of Wallenberg Hall

The idea of creating advanced resource classrooms1 for experimental purposes on Stanford’s campus dates back at least to early 1998. In a proposal to the Knute and Alice

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1 Advanced resource classroom (ARC) means a classroom outfitted with leading edge technology such as large interactive computer displays, collaborative workstations, readily available laptop computers, interactive whiteboards, and wired and wireless high-speed networking facilities. An advance resource classroom could become a “high performance learning space” (HPLS). We characterize an HPLS as an ARC or any other space where interactions within the physical space are enhanced so that users feel that they are operating at a higher level of performance than they do elsewhere. Further, an HPLS should be an environment that facilitates and enhances meaning-making. Typically, an HPLS would meet the following
Wallenberg Foundation in Sweden, the co-directors of the Stanford Learning Lab highlighted the need for advanced “spaces for learning,” as follows:

**Spaces for Learning**

Guiding Question: What are the design requirements for physical spaces that optimize learning performance, and how do these spaces best serve virtual learning communities?

To answer this question the Learning Lab plans to design and construct a new type of learning space. We have found that common classroom configurations do not support innovative pedagogy and pedagogically informed technologies. Similarly, the typical lab suffers serious design deficiencies for integrating current technology and promoting active student learning. We have already addressed some of these issues with a new type of classroom design that allows learners and instructors to control the configuration of their environment. Next we propose to integrate this type of room with other learning spaces to form “flexible agenda spaces” designed to adapt, moment-to-moment to the activity requirements of the user community.

Such spaces serve as a collection of studios for project-based courses. They are instrumented to document meetings and decisions. They may contain many large writing surfaces for planning and brainstorming. They allow for informal discussion; private study and communication. Each of these functions must have physical as well as virtual embodiment. In this regard, there is no precedence for what we must create. Learners will share times, spaces and information with other sites. Flexible agenda spaces must adapt to different activities, different size groups, different levels of public access and privacy. They must accommodate image projection, sound management, lighting, and computer input and output devices. (bold-type added)

The animating vision for Wallenberg Hall was thus not simply one of applying technology to education, but a more fundamental break with pedagogies of information transfer in favor of supporting the capacity of work/learning groups. In practice, the range of courses that have been taught in Wallenberg Hall has been even broader than this vision, and has included lecture and seminar classes in addition to project-based classes.

In late 1998, after the Learning Lab’s proposal was approved by both the Wallenberg Foundation and the University’s President’s office, the design phase of Wallenberg Hall began. Beginning in 2000, demolition and then a complete renovation of the building began. In August 2002, the building was completed and its new occupants moved in.

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educational communication requirements: 1) artifacts are easily accessible, 2) artifacts can be easily shared, 3) a rich history of representational work practices (versions) are available, and 4) “layering” of media (e.g., drawing on top of web page screen shots) is easily accomplished.
1.b Focus of this Report

The purpose of this report is to answer the following questions:
(1) How are the users of Wallenberg Hall making use of its facilities? What differences do teachers and students perceive in using Wallenberg Hall as opposed to other facilities at Stanford?
(2) What learning goals are actually being addressed in Wallenberg Hall? What subjects and pedagogies do teachers and students see as being particularly appropriate for Wallenberg Hall?
(3) Do users believe that their learning goals are being achieved better or differently in Wallenberg Hall as opposed to other facilities at Stanford?
(4) What are the key factors, including the organization of space, the hardware and software, and the support activities, that are either promoting or impeding the success of teachers and students in Wallenberg Hall?

As our last question suggests, we have found it useful to attempt to understand Wallenberg Hall as what might be called a ‘sociotechnical system’. That is, the high performance learning spaces that are our subject are not limited to the assemblages of hardware and software, but include also the technical, pedagogical and administrative support staff associated with the building, and the teachers and students themselves. The purpose of this insight is to avoid ascribing any effects that we see directly to the physical technology in the classrooms. Instead, we attempt to see the technology and the people as engaged in a dynamic and interconnected pattern of activity that results in particular teaching and learning experiences. Thus we ask, in addition to questions such as “Do the large-scale displays seem to provide an effective method of stimulating class participation?” others such as “How does the presence of dedicated pedagogical support staff affect the flow of teaching ideas among faculty members?” and “How do Wallenberg Hall teachers and students differ in their experience of technology in ways that affect teaching and learning activities?”

A key question that we will not address is, “Based on independent assessment of learning outcomes, do students learn better or more in Wallenberg Hall than in other facilities at Stanford?” We have chosen not to pursue this question for several reasons. First, we already have in the teaching faculty extremely sophisticated and sensitive assessors of student learning. Relying on faculty judgments about student learning will likely yield assessments with a high degree of validity – after all, the validity of these judgments is relied upon by the University in constructing its records of student performance. Second, we lack the resources in this project to undertake a full-scale subject-specific analysis of learning outcomes for each class, and then to produce instruments to measure those outcomes. We have as an alternative adopted a more generic lightweight assessment tool focused on student judgments of their own learning that has proved effective in other settings. Third, it is extremely difficult, given the number of classes that have been taught in Wallenberg Hall, to identify and study sufficient numbers of similar classes taught elsewhere at Stanford to isolate the “Wallenberg Hall effect.”
1.c Description of the Learning Spaces in Wallenberg Hall

Wallenberg Hall was designed to provide learning spaces for university classes and state-of-the-art facilities for research in learning and education, both locally and in collaboration with international partners. The five advanced resource classrooms on which our research study focuses occupy the first floor: four classrooms with capacities of 20 to 22 students, and the Peter Wallenberg Learning Theater, which is suitable for larger classes (up to 50 students) and small performances. These spaces can be used individually or in varying combinations to support a myriad of learning activities. None of the rooms has raised flooring. All of the classrooms contain lightweight, easily foldable tables and lightweight chairs on casters that can be rearranged to move quickly between whole class and small group settings and provide support for a wide range of traditional as well as emerging modes of teaching.

Following is a detailed description of each classroom:

Room 120 offers meeting space for up to 22 students. With soundproof glass windows and retractable blinds on one side, the room can also serve as an observation space for Wallenberg Hall visitors. The technology in Room 120 includes a SmartPanel, two Webster wall displays running Microsoft Windows, iSpace software, video conference capability, and video cameras and microphones.

Rooms 123 and 125 are identical. Each offers meeting space for up to 20 students. In addition, they each include a SmartPanel, two Webster wall displays running Microsoft Windows, networked laptops running Microsoft Windows, iSpace software, collaboration stations, and video cameras and microphones.

Room 127 offers class meeting space for up to 22 students. Room 127 features a SmartPanel, two Webster wall displays running Apple Macintosh OS X, iSpace software, networked Macintosh iBooks, collaboration stations, videoconference capability, and video cameras and microphones.

The Peter Wallenberg Learning Theater is designed to support innovative presentations, performances, and learning activities. The Learning Theater has flexible seating for up to 49 people; with alternate configurations of Wallenberg Hall's other spaces, the Learning Theater can accommodate up to 150 occupants. There are three large screens in the learning theater with accompanying projectors. In addition, the Learning Theatre features a SmartPanel, iSpace software, video conference capability, and video cameras and microphones.

1.d Wallenberg Hall infrastructure

The classrooms and learning spaces in Wallenberg Hall are supported by an integrated building technology infrastructure providing network connectivity, centralized audio and

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2 Detailed descriptions of the various technologies are included in Appendix 1 below.
video capture, and mass storage and room configuration “sandboxes” for each class taught in the Hall. Each classroom has its own dedicated wireless network. Video cameras and microphones in each classroom record directly to hard drives located in a server room in the basement of Wallenberg Hall, supporting on-demand recording of classes and other activities in the classrooms. A software application, Conductor, provides each instructor with a dedicated hard drive and classroom configuration settings to ensure that instructors can rely on a known state of the room for each class period, no matter how other instructors modify the room settings.

1.e Description of Method

The analysis that we present in this report is based upon a wide variety of sources of evidence, which we describe in more detail below, including systematic survey data collection, interview data, the experience of staff members, and communications from faculty and students on subjects of their own choosing. The main obstacle that we have faced in conducting our analysis is not the availability of evidence, but the complexity of the object of our evaluation: as our discussion above of Wallenberg Hall as a sociotechnical system indicates, teaching and learning in Wallenberg Hall comprises a variety of physical spaces; technological affordances; course disciplines, subjects, pedagogies, and levels; and faculty and student backgrounds. In order to deal with this complexity, we have identified a number of analytical dimensions of variation that we have used to organize our thinking and investigation, and that also provide points of access for users of our report:

(1) **User types.** Wallenberg Hall is used by people who have a variety of different roles that are relevant to their activities in the Hall: faculty members (both tenured and untenured), instructors and lecturers, undergraduates, graduate students, technology and pedagogy support staff, etc.

(2) **Disciplines.** Wallenberg Hall hosts classes from a wide variety of disciplines, from engineering to foreign language to social science.

(3) **Pedagogical organization.** Classes in Wallenberg Hall have ranged from seminars to project-based courses to lectures.

(4) **Technological affordances.** The ARCs in Wallenberg Hall contain a wide range of technologies, including large-scale displays, small portable whiteboards (“huddleboards”), flexible furniture, and videoconferencing facilities.
2. Wallenberg Hall in Use: Teaching Hebrew in the HPLS

Understanding Wallenberg Hall as a sociotechnical system requires seeing it in use in the concrete practice of teaching and learning. In this section, we present an extended description of the use of Wallenberg Hall’s learning spaces in a Hebrew language class. This description makes clear a point that an analytic decomposition of the teaching activity could not: that the overall effect of teaching and learning in Wallenberg Hall results from the simultaneous presence of a variety of technical and human resources, all available to be incorporated into the activity of faculty and students.

Throughout the academic year, Dr. Vered Shemtov used Wallenberg Hall’s space and technologies to simulate everyday situations in which students use the language skills they are learning. In one class, she set up the breakout space outside of her room to resemble a movie theater box office. As students were coming to class, they “bought” tickets, popcorn, and drinks; to get into the classroom students had to give their tickets to an usher. Once inside the class they found 3 rows of chairs all facing the large display screens in the front of the class. The lights were turned down low. After all of the students had taken their seats, Dr. Shemtov turned out the lights and played the opening scenes of an Israeli movie. After fifteen minutes, she stopped the film and students rearranged their chairs into a circle to discuss what they had just seen. Their homework for the night was to watch the rest of the film, which Dr. Shemtov had posted on the class website, and to write a review.

In another class, Dr. Shemtov asked her students to use their new vocabulary to work together to design the ideal classroom. Students broke into teams, with each team using a Huddleboard™ -- a small, portable whiteboard stored in racks of five -- to sketch out their design. The teams took their Huddleboard racks and spread out throughout the class and the breakout space so that each could have room to work. Dr. Shemtov and her teaching assistant circulated among the groups, helping them when necessary. After fifteen minutes, the teams came back together in class and presented their work. As is often the case, time ran out before one team could present their full work. So, they hung their Huddleboard™ on a rail attached to a larger whiteboard and then used the Copycam™ -- a digital camera integrated with the larger whiteboard -- to take a picture of their design and save it to the class website. That same group kicked off the next class by pulling up an electronic version of their work in front of the class and finishing their presentation. In a traditional classroom, that group might have been forced to cut their presentation short, or to hurriedly recreate their work before class in order to share it.

Dr. Shemtov also taught her Hebrew Land and Literature class in the Peter Wallenberg Learning Theater, a large central space with three very large projector screens, each controllable by computer. The topic for one day was a Hebrew poem about a specific place in Jerusalem. On one screen she showed an English translation of the poem. On a second screen, she showed photos from the neighborhood that was referenced in the poem, and on the third screen she showed artists’ paintings of the same scene. Students were thus able to see, simultaneously, three different representations (text, photo, and painting) of a specific place in Jerusalem. Dr. Shemtov guided her students through a
discussion of the poem, and the room’s technologies allowed her to create a layered context for their discussion.

One of Dr. Shemtov’s students, a sophomore majoring in religious studies, commented:

I’m a religious studies major and I’m probably never going to build something or do something with computers but what I thought was amazing as I was sitting in this class learning an ancient language that I’m going to use read texts and do all those other kinds of things but doing it with technology in a very modern way, and that they were compatible. And so I thought that was really exciting and I would encourage you that the humanities people can also be open to technology. And, if anything, I think... I learned the language, probably better than I would have normally just because there were so many media with which I could interact with to learn language – it wasn’t just like a textbook. And the fact is, you know, it’s a living language and I got to experience that in the class.”

This comment nicely encapsulates a trajectory of experience that recurred frequently in discussions with faculty and students: the first impression is of the technology itself, an effect that is probably accentuated by the white walls and neutral tones of the room furnishings; and over time the technology moves into a supporting role as the classroom activities move into the foreground.
3. Pedagogy and Technology in Wallenberg Hall

The key to understanding the educational effects of the technology in Wallenberg Hall is to focus our attention not on the technology itself but on the kinds of capacities for teaching and learning that it brings to the classroom. We found that these capacities are quite general in nature in the case of Wallenberg Hall, perhaps because the classes taught in the HPLSs span a much wider set of disciplines than is typical of advanced technology classrooms. While this generality has obvious benefits – for example, in supporting the kind of transformation of the classroom space that Professor Shemtov achieved in her Hebrew class – it may also have drawbacks in ruling out classes that require more specialized technology than is consistent with the classroom design. While these tradeoffs are not a focus of our report, as we are not adopting a fully comparative methodology, they would be at the forefront of an effort to design advanced technology classrooms.

We have identified three general capacities, defined in educational rather than technical terms, that flow from various technologies in Wallenberg Hall. These include:

- **Expanding the Social World of the Classroom.** Videoconferencing over high speed data networks opens up the classroom to outside participants, including students and experts located elsewhere.
- **Supporting Segmented and Distributed Work.** Modularizing key classroom technologies, from furniture to computing resources, supports flexible organizing of classroom interaction and attention into small or large groups.
- **Enabling Complex Information Retrieval, Display, and Inscripton.** A suite of technologies, including large-scale displays and electronic whiteboards, enables rich and flexible display and capture of information.

3.a Expanding the Social World of the Classroom

Traditionally the classroom has been a closed space, with participation and discussion limited to those who could be physically present. In fact, classrooms have remained curiously cut off from interactive technologies, even those as simple as the telephone. The Wallenberg Hall HPLSs use videoconferencing technology, in concert with large displays, to open up the classroom to other participants. In Wallenberg Hall’s first floor classrooms, two distinct kinds of activities have emerged using the videoconferencing tools. In many cases, professors at Stanford have invited remote experts to lead a single class. These classes have often been lectures but on several occasions the remote guest has served more as a resource for student project teams. Videoconferencing has also allowed groups of students to participate regularly in classes to and from remote locations.\(^3\)

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3 Classes use one of two Polycom Viewstation FX Videoconferencing Systems. These shoebox-sized units include a small pan, tilt, zoom, camera and run over IP using the H.323 standard. Remote participants need an IP based videoconference system to join a class in Wallenberg. In room 127 there is a single camera on a mobile table; in room 120, there are two fixed cameras, one in the front of the room and one in the rear. In both rooms, the videoconference units plug into a built-in audio system with microphones and speakers.
In faculty interviews, those who discussed videoconferencing felt it to be a positive addition to their class. All mentioned the benefit of bringing people into the classroom, whether experts or other students, that could not otherwise have attended. One professor, who taught a class that always had a videoconferencing connection to another classroom, described a number of limitations in teaching a class where some students were always remote. Other teachers, who used videoconferencing on only one or two occasions, emphasized the success of their efforts. Some said they would like to expand the use of videoconferencing in their classes.

3.a.1 Guest Lectures Support Student Project Teams and Student Readings

In a typical university class, students have only one personal contact with an expert in the field of instruction: their teacher. Other experts are represented only indirectly, via readings in the class. Classes that involve multiple instructors (e.g., graduate seminars) are very often surveys of areas within a field, because a typical university department contains only one or two experts in any one subfield. Bringing in guest lecturers or participants from another institution is one way of exposing students to more than one expert in a field, but this is so expensive and cumbersome that it is, in practice, rarely done.

Videoconferencing offers another alternative. Faculty members can invite experts located elsewhere to participate in a class without the outside expert having to travel at all, except to a videoconferencing facility located at their home institution. Since the time and expense is orders of magnitude lower, the frequency and flexibility of guest experts can be dramatically increased. For example, a guest located across the country can join a class for 20 minutes to discuss an article that he or she wrote, allowing the instructor to incorporate outside experts into the flow of the class without devoting an entire session to the visit. In addition to the pedagogical value of including more expertise in the class, the presence of outside experts can give life to debates within the field, perhaps causing them to see their instructor as occupying just one of a set of possible perspectives.

In Professor Shelley Goldman’s Participatory Design and Research of Technology Integrated Curriculum class, Suzanne Alejandre an expert from Drexel University joined the class for a guest lecture about developing computer-based math exercises at the beginning of the quarter. At the end of the quarter, the same expert returned to class via videoconference to review and discuss the students’ final projects.

In one of Russ Altman’s Bioinformatics classes, Dr. Phil Bourne of UCSD joined class via videoconference in Wallenberg Hall to discuss protein databases. As Dr. Bourne mentioned specific websites, Professor Altman pulled them up on the second large screen in Room 127 to share with the class. “I loved it…I knew him pretty well so it makes it easy to get a rapport.” said Dr. Altman The main thing is there was no way he was going to fly up here. “This is the number one protein database guy and they talked to him for an hour.” Prasahant Ranganathan, a student in the class
whose team project concerned protein databases, commented, “Its amazing that we could get him…we couldn’t get him in a regular class.”

In Richard Martin’s Horace class, the students read an article by Professor Lowell Edmunds, a Classics scholar at Rutgers. As the class was discussing the piece, Professor Martin asked, “I wonder what Lowell Edmunds would say about this.” In Wallenberg Hall, this question quickly turned from curiosity into reality when Professor Edmunds videoconferenced into a later class so that students could ask him directly about his work. As he was speaking, Prof. Edmunds referenced other works by Horace; Professor Martin was able to show those works quickly to the class on the second screen. In this case and in the Bioinformatics case, the local professor enabled a far richer discussion by being able to show supporting materials quickly on the rooms second screen; the remote guest wasn’t just a talking head; instead his comments were in a deeper context that the local expert was able to create.

As these anecdotes suggest, there is a synergy in the HPLSs between the videoconferencing facilities and the presence of multiple large display screens. Typically, one display screen is allocated to showing the remote expert. The “local” instructor is able to use another display to show materials that are relevant to the discussion between the students and the remote expert. This ability also invites interaction between the remote and local experts, allowing students to see experts in a field discussing mutually relevant material.

The ability to involve outside experts in Stanford classes obviously requires that there be videoconferencing facilities located at the remote site. Now, videoconferencing still requires special arrangements and probably travel (if only to another building on campus) for remote experts. In the future, as videoconferencing moves further into the mainstream and even becomes a standard part of a laptop computer, we should expect to see remote participation in classes become more frequent and more spontaneous.

3.a.2 Using videoconference for distance education and remote collaboration

Faculty members also use the HPLS videoconference facilities for what is probably a more ‘traditional’ purpose than involving remote experts: bringing in remote students and perhaps instructors.

Using a three-way video-conference, Professor Rich Shavelson and Dr. Susan Shultz led a group of students from Stanford, UC Berkeley and UCLA in a graduate level seminar on science education assessment. Throughout the quarter, students from all three sites collaborated inside and outside of class time on projects, readings, and designing activities. The remote collaboration was complemented by several site visits that the students and the professors made to build face-to-face relationships.
Environmental Engineering Professor Stephen Monismith and History Professor Tim Lenoir both conducted videoconference classes in Wallenberg Hall Room 120. In both cases, the professors used one big screen for videoconferencing and the other big screen for presentations and class workspace. Professor Monismith used the SmartPanel to switch between the videoconference and a digital whiteboard on one screen while using the second screen to display his lecture notes and movies. His students at Hopkins Marine Station in Monterey watched the class unfold while he wrote on the digital whiteboard; when he finished writing, he switched back to the view of the students. The side-by-side displays allowed Prof. Monismith and his students to use one of the screens as a presentation space and the other as a workspace where they can interact with remote colleagues.

During his History of Silicon Valley course which is co-taught via videoconference with Professor Steve Usselman at Georgia Tech, Professor Tim Lenoir makes active use of the course website. Having two side by side large screen displays means that he and his students can interact with their colleagues at Georgia Tech through the videoconference and access the class website where presentations, readings, and discussions have been posted throughout the week. In both classes, students and faculty have access to the work that they have done over the quarter as well as the opportunity to discuss the subject matter with each other in real time.

3.b Supporting Segmented and Distributed Work

Traditional lecture classes have an extremely simple and stable structure of work and attention: a single person, almost always the teacher, has the “floor” and manages all aspects of interaction, information display, scheduling, etc.; and some number of students, ranging from a handful to hundreds, work individually in attending to the teacher. Equipping a classroom to support this structure of work is straightforward, since the locations and equipment requirements of each participant can be reliably predicted in advance.

Project-based classes, which drove the design of the classrooms in Wallenberg Hall, have a much more complex structure of roles and interactions. Project-based classes typically involve subgroups of students working together independently of other subgroups. These subgroups may vary in number, require access to their own information resources, and may well need to maintain their identity across class periods. If a lecture-based classroom is a tightly coupled system, a project-based class is necessarily loosely coupled: not only are the activities of one group distinct from those of another group, this independence has to be maintained in order to facilitate the success of each work group. At the same time, a project-based class must also support the possibility of orienting the class simultaneously to a single focus of attention, for example when the teacher is providing instruction or when classmates are demonstrating their projects.
The general design approach to these demands in Wallenberg Hall is to modularize key resources so that they can be flexibly reconfigured to accommodate both small group work and whole class use. To take a simple example, the furniture in the classrooms is small, lightweight, and easily moved around or pushed to the side. Both chairs and tables are on wheels and tabletops flip up in order to minimize storage space so that they can be pushed against the wall to create open space. In a similar way, the classrooms include racks of laptops and Tablet PCs to allow individual or group work, but also include large-scale displays addressable by the mobile devices to provide a way for groups to give demonstrations of their work to the entire class. In another example, Huddleboards (small hangable white boards) provide white board space for small groups of students to brainstorm and work out ideas, but can also be made visible to the entire class.

In interviews with faculty members, the furniture in the rooms was frequently mentioned as a positive aspect of the rooms. Many instructors mentioned that they enjoyed being able to easily reconfigure the space and appreciated that the furniture was comfortable as well. As mentioned above, at least one professor felt the flexibility of the physical space, and in particular the furniture, helped create a collegial atmosphere. There was minor disagreement over whether there was too much, not enough, or just the right amount of furniture in the rooms.

3.b.1 Small Groups and Modularized Work

A direction from a teacher to “break into groups” initiates a complex social process of sorting, matching, and occupying a workspace. A successful technology support for breaking into groups is one that provides obvious places for groups to occupy and work, and that provides the tool and information resources that the groups need in order to do their work.

In Larry Leifer’s Introduction to Design Seminar (ME 013N), five student teams gave five completely different presentations in the Peter Wallenberg Learning Theater to demonstrate their design projects. Just before class, the students arranged the tables and chairs to create distinct spaces within the hall. Each group gave their presentations including brief enactments in a different corner of the room. The transitions between presentations were not only smooth, but also transporting as one corner of the Learning Theater felt like a “dorm room” while another corner felt like a “library”. One key result of reconfiguring the room was that each of presentation seemed fresh, keeping the entire class engaged as opposed to the more traditional and often less-engaging scenario where student teams give 5 PowerPoint presentations one after another.

Prof. Roy Pea and his Online Learning Communities class (ED 298) use the student breakout space and the in-class laptop computers to move between class activities seamlessly. In most classes, Prof. Pea begins with an introduction to the class material and then students break out into small
groups – usually with two inside the classroom and two in the breakout space -- to discuss various aspects of the week’s reading. After about forty minutes of small group time, the class reassembles in Room 127 to share their comments and findings. When they are done, the TA uploads the presentations to the class website to create an archive of all of the work done throughout the quarter. Wallenberg Hall’s classrooms and breakout areas provide the physical spaces and the technology for groups to create work and then share it with their classmates.

Most of the courses that have been taught in Wallenberg Hall have varied the furniture configurations based on their plans for each class. For example, just before one class, Professor Bill Verplank pushed all of the tables and chairs to the center of the room and had students tape their projects to the walls. Because the furniture was in the middle of the room, it was very easy for students to circulate around the room and study each other's work. After 45 minutes, the class formed the tables into a large square so that they could discuss the projects as a whole. In a subsequent class, 5 tables were set up directly against the walls, each table abutting its own whiteboard. Students, sitting in their final project groups, used the whiteboards to brainstorm for 20 minutes before presenting to the rest of the class.

Stan Christensen’s Negotiations class often began with the entire class meeting together for lecture, discussion, and occasionally a video. During class, the students paired up and spread out throughout the whole building to work through a negotiation scenario. In other buildings, they would be confined to the same room or limited to sitting on hallway floors or stairs. In Wallenberg Hall, they took advantage of the student lounges, the benches, and the nooks on the second-floor so that each group could create some private space in a comfortable setting. After working through their scenario, they reconvened in the Learning Theater to debrief in large group setting.

In Momoyo Kubo’s Japanese class students broke into pairs and discussed the day’s topic, taking notes on HuddleBoards that they later used to present to the entire class. By spreading activity around the building students maximized their time speaking, listening, and authoring documents in Japanese. Professor Kubo glided around class to coach individual teams when needed and offer feedback throughout the lesson.

In a Mechanical Engineering design class, a guest speaker visited to discuss the importance of prototyping and collaborating while working on design projects. As a component of his project he had student groups push the furniture into four different corners of the room and gave the students several minutes to develop a paper prototype and then a few minutes to present their first iteration. They repeated this cycle two more times in
about twenty minutes to reinforce the lesson on the importance of iteration. To support this activity, the speaker had the students move the tables and chairs away from the center of the room where a single presentation table had been placed. This configuration allowed groups to prototype in workspace and move quickly to a presentation space in the center and then back again to their group work space.

3.b.2 Using Huddleboards™ and CopyCams™ for effective group work

Throughout Wallenberg Hall’s first floor, students and instructors have access to 2’ x 3’ lightweight portable whiteboards that can be used to generate and present ideas. Complementing the Huddleboards are two CopyCams, wall mounted scanners that can save work done on boards to a website or floppy disk, or print out a hard copy. The Huddleboards sit in groups of five on mobile racks that have also been used as props and hanging space for posters.

The Huddleboards, whether used in connection with the CopyCams or not, are a useful example of a technology that does not involve advanced computing or display technologies, but that can be quite critical in augmenting an HPLS. The key characteristic of the Huddleboard is its portability, the value of which is realized most clearly in combination with other portable technologies: e.g., movable tables and chairs, mobile computing devices (discussed below), and so on. The Huddleboard’s portability enables students to use it as a resource in a small group setting, and then to transport it back into the setting of the whole class if necessary. This ability to complete a “round-trip” between large and small groups is a key feature of the modular classroom, as it makes it possible for the teacher and students to organize themselves according to the work arrangements that are most likely to be effective (in fact, we can imagine a series of round-trips, as students bring the products of their group work back into the setting of the whole class for critique and feedback, recorded on the Huddleboard, and then return to the small group for another iteration).

Huddleboards appeared as a popular item for small-group work in interviews with faculty members, one of whom described them as a “big hit” with students. CopyCams, by contrast, evoked a split in opinions. Three teachers mentioned this tool as somewhat of a disappointment, citing in particular the inconvenience of retrieving images later. Two teachers described the tool as a valuable addition to their class.

Professor Gayle Curtis held his HCI Design Studio Class in the Peter Wallenberg Learning Theater – a room that does not have any permanently mounted whiteboards. Instead of using whiteboards, the small groups of students used Huddleboards for their work. The groups broke out, worked on their ideas and then returned to the group with their Huddleboard. By using the Huddleboards, the student teams were free to set themselves up however they liked within the space of the Learning
Theater instead of being constrained to standing next to each other at one large whiteboard as happens in more traditional classrooms.

Dr. Vered Shemtov used Huddleboards to help her create opportunities for different level students in her Beginning Hebrew language course. In one class, six higher-level students went to the breakout space and worked on their own project reading materials that had been posted on the class website. These students wrote introductions on the HuddleBoards, and saved them to the web using the CopyCam. In the meantime, the lower level students continued their class. Later that night Dr. Shemtov reviewed the advanced students’ work that had been saved to the web, then gave them feedback at the beginning of the next class.

In another one of Dr. Shemtov’s classes, the students used vocabulary that they had just learned to design the ideal classroom. Students broke into teams, with each team using a Huddleboard™ to sketch out their design. The teams quickly spread out throughout the class and the breakout space so that each could have privacy. Dr. Shemtov and her teaching assistant circulated among the groups, helping them when necessary. After fifteen minutes, the teams came back together in class and presented their work. As is often the case, time ran out before one team could present their full work. So, they hung their Huddleboard™ on a rail and then used the CopyCam™ to take a picture of their design and save it to the class website. That same group kicked off the subsequent class by pulling up an electronic version of their work in front of the class and finished their presentation. In a traditional classroom, that group might have been forced to cut their presentation short, or to recreate their work first thing in the morning to share it. In the Wallenberg classrooms, not only did they not have to recreate their work, their presentation made for a smoother transition to the next lesson: it was a clear reminder of what they had studied the day before.

In Paulla Ebron’s Introduction to Cultural Studies class, students used Huddleboards to form splinter groups from their original teams. The students broke into teams to create models that represented how particular terms and concepts were connected. In one group, a single student’s opinion diverged with his group members, so he picked up a Huddleboard and created his own model. Just after this same group presented their model, this single student presented his splinter group model by hanging the Huddeleboard in front of the larger whiteboard. Keeping the two models physically together helped reinforce the conceptual differences he was highlighting with his splinter group.

In Professor Larry Leifer’s class, students used CopyCams to capture their brainstorming sessions and document the first steps of their design process. Later, the students retrieved the images from the web and used
them as starting points for further work that they did in their dorm rooms. Finally, they inserted the images in their project presentations that were given to the entire class. For Professor Leifer, this tool was valuable as a way to reinforce his emphasis on the design process itself. A team of students from Prof. Bill Verplank’s Human Computer Interaction Design Studio used the Copycam to capture the first stages of their final design project of the quarter. Students brainstormed ideas, sketched first concepts, and created a working plan on the Huddleboards. They then saved the images from the boards to a website so that they could continue working from their dorm rooms or other locations; they did not have to write “save” on the boards, and did not have to hold their second meeting in the same place as the first.

3.b.3 Sharing Small Group Work Quickly with In-Class Laptops and iRoom Software

The four small seminar rooms on Wallenberg Hall’s first floor all have a mobile cart of 20 laptop computers to complement the other display technologies in the room. In two of the rooms, these computers are running the experimental iRoom software that enables individuals to share their work quickly with small and large groups. The software also allows groups of students to share control over the two computers projected in the room. These mobile computers have characteristics that are precisely analogous to those of the low-technology Huddleboards: they can be used to support the work of small groups, but can also bridge the gap back to the class as a whole, allowing small groups to immediately share their work with the entire class. All of the faculty members interviewed who mentioned the laptops felt that they were a useful addition to their class. One particularly positive teacher said, “It was really wonderful to have portable technologies that students could just go to the cart, get out computers. We could actually use class time as to do your time and laboratory time for actually working on projects.” One concern that was mentioned (for room 127) was students’ potential unfamiliarity with the Apple platform.

In Professor Roy Pea’s Online Learning Communities (ED 298) students do small group work and use the classroom set of wirelessly-networked laptops to research, record, and collaborate. Typically, each group takes several laptops; one is usually dedicated for the group recorder to take notes; others are used to do web research. As the groups wrap-up, they assemble their notes into PowerPoint slides. Next, they use the iRoom software to push their work from their laptops to the big screens – without any cables or wires -- so that they can present their findings to class. Two groups push their work to one screen and two groups push their work to another so that as one group wraps up their presentation on the right-hand

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4 The iRoom software was developed as part of iSpaces, a research project led by Professors Terry Winograd and Armando Fox in Stanford’s Computer Science Department.
screen, the other group is ready to go on the left-hand screen wasting hardly any time between presentations.

In a BioInformatics Project class, taught by Russ Altman, Teri Klein, and Betty Chang, students quickly shared alternative models of complex structures and relationships. As Dr. Altman was explaining one representation on the right hand screen, the student used one of the classroom’s laptops to search the Web for an alternative model. The student then used the iRoom software to send this second model to the left hand screen. Dr. Altman didn’t skip a beat and then talked about the differences between the two models in depth.

In Doug Brutlag’s Genomics class students used iRoom software to share their research quickly in class. As class was beginning, each student used an in-class laptop to load several web pages with information on the specific disease that he or she was researching. In turn, they then sent their local web pages up to the large screen displays to share their findings with the entire class. As Professor Brutlag and classmates asked questions, each presenter slid her mouse up to the large screen and navigated the site and explained more about the subject.

3.c. Multiple Surfaces for Public Writing, Sharing, Saving, and Retrieving

Inscribing and displaying information are fundamental activities in classrooms, whether these activities are accomplished using a simple blackboard or through large-scale displays and electronic whiteboards, as in Wallenberg Hall. This is the area of functionality in which the ARCs have shown both the greatest promise and also the greatest difficulty, perhaps because of the centrality of these activities to the teaching and learning process. On the one hand, the availability of technologies – particularly large-scale displays linked to the Internet, and small portable whiteboards – for managing information contributed to the learning process. On the other hand, faculty in some ARCs found the lack of a simple way to write on a whiteboard frustrating, and the large-scale displays could be distracting as well as enabling.

Large displays are typically used in high technology classrooms as a response to the large number of students in a lecture course. In a lecture setting, with dozens to hundreds of students, the major work that the display does is to make it possible for all students to see the material simultaneously. In extremely large spaces, this may involve multiple large displays all showing the same material, or smaller, “local” displays that provide an alternative display for students.

In the Wallenberg Hall HPLSs, by contrast, the large displays function to broaden the range of interactions that faculty and students are able to have with course material, by supporting a range of operations beyond simple display. These include writing “on top of” digital material, capturing screen shots and whiteboards for later use, interacting with software applications in a public setting, and so on.
Teachers interviewed mentioned that these displays were great for making presentations, and some mentioned the ability to bring in high-resolution images to show to students. One professor felt the screens could be a distraction to the class when they were on and not in use. The Webster tools associated with the screens were not mentioned frequently in interviews, but those that did mention them seemed to feel that they were potentially useful, but somehow not an ideal match for the activities in their class.

3.c.1 Recording and Sharing Diagrams, Images, and Texts with Webster™ Digital Whiteboards

Each of the four seminar rooms in Wallenberg Hall has 2 large screen displays that can project an in-room computer, a laptop, a DVD/VCR player, or a videoconference. These screens are known as Websters™, a commercially available product that can function as a digital whiteboard. Instructors and students can interact directly with the screen using a special stylus to click through websites. They can also use the stylus as a “marker” to take notes on a digital whiteboard or to mark-up web pages, documents, diagrams, or any other file that can be shown on a computer.

Professor Stephen Monismith used Wallenberg Hall’s digital whiteboards for writing complex equations, sketching diagrams, and explaining the content of his course, Introduction to Physical Oceanography (CEE 164). At the end of each class, he saved the whiteboards and posted them to the course website where students referenced the equations and diagrams in more depth or printed them out. Because the work on the board was being saved, students could pay more attention to Professor Monismith while he explained the content, and pay less attention to reproducing the diagrams into their own notebooks. As the end of the quarter, students reviewed all of the work that Professor Monismith had done on the whiteboard to help prepare for the final exam.

In Richard Martin’s Horace class, students shared control of large screen displays to translate and analyze texts together. Just before class began, Professor Martin downloaded ancient Latin texts in Microsoft Word™ files to both of the Websters at the front of the room. On one screen, one team of students used a digital marker to annotate a poem. On the other screen a second team of students parsed the poem by sharing control over the editing and reorganizing processes. Professor Martin led the entire class through a comparison of how the two teams analyzed the same material.

3.c.2 Displaying Multiple Media Simultaneously

The displays in each of Wallenberg Hall’s rooms have been used to show multiple media simultaneously during lessons. In the best cases, instructors have used two or three screens to facilitate comparisons and to deepen the context of particular lessons.
Professors Brigid Barron and DeeDee Perez-Granados have been able to pack more activities into a single class by taking advantage of both large screen displays and the accompanying SmartPanels. In one class for example, they used the SmartPanels to switch between showing VHS movies, movies on the internet, pre-loaded powerpoints, student presentations, and finally a guest speaker’s presentation from his laptop. The faculty and students in this class can do more activities in a fixed period of time because the transitions between technologies are smooth. In another class, the professors were able to show video from a research project on one screen while displaying a PowerPoint presentation on the other screen. Because there are two screens in the room, faculty and students could compare the findings and theories shown in the presentation side by side with the evidence that was presented on videotape.

Dr. Shemtov also taught her Hebrew Land and Literature class in the Peter Wallenberg Learning Theater. In this course, she took advantage off the three screens to On one screen she had the poem translated into English. On a second screen, she showed the class photos from the neighborhood that was referenced in the poem, and on the third screen she had artists paintings of that same scene. In this activity students were able to see, simultaneously, three different representations (text, photo, painting) of a specific place in Jerusalem. Dr. Shemtov guided her students through a discussion of the poem; the room’s technologies allowed her to create a layered context for their discussion.

In Professor Harry Elam’s Sophomore College Course, Social Protest Drama, Students produced a ten-scene play that highlighted social justice issues on Stanford’s campus and throughout society. They used the three large screens to play a complex montage of revolutionaries that had been authored specifically for a three-screen presentation. They also created “sets” for each scene: images of neighborhoods and people, or videos that all played from Wallenberg Hall’s computers. The performers were able to change the sets by simply clicking a mouse to bring up a set of images on the screens behind their stage.
4. The Experience of Teaching and Learning in Wallenberg Hall

In this section of the report, we will consider the experience of teaching and learning in Wallenberg Hall, drawing largely on 14 interviews with 15 professors and lectures who taught in Wallenberg Hall (two people who co-taught a course were interviewed simultaneously). The interviews were conducted shortly after they finished teaching their class. The interviews were transcribed and coded by topic.

4.a Overall impressions of Wallenberg Hall

Teachers strongly prefer Wallenberg Hall to alternative spaces elsewhere at Stanford. All 31 passages (from 11 interviews) that were coded as making an explicit comparison between teaching spaces in Wallenberg Hall and other teaching spaces indicated that Wallenberg Hall was preferred to the alternative learning space. This unanimity is surprising because interviewees freely discussed the shortcomings of the learning spaces in Wallenberg Hall (see below). This result may be an artifact of the interviewing process, but it is nonetheless an encouraging result. One teacher said, “It is such a leap ahead just to have... just consistency, just cleanliness and, you know, relatively recent upgrades.” Another described the experience of trying something new: “I would have never been able to do it in another room and I did it only because I was sitting here and the machines were sitting here and I said, let's see what I can do with this.” Yet another contrasted her experience with support in other spaces, “I mean everybody here has actually been really helpful. I mean that—that's been a big plus actually because a lot of other places they are reluctant, ‘Oh, you want projector?’”

This is not to say that instructors found no fault with Wallenberg Hall. The aspects that faculty criticized are quite diverse. Most of the problems mentioned fall into other categories as well. A arbitrary sample gives a flavor of these comments: lack of storage space, “everybody comes in with backpacks full of stuff and they plunk it down on the floor or they put it on the table and then there is no place to work”; difficulty hearing in the Wallenberg Learning Theater, “the downside of the space is that the acoustics aren't—you don't have an intimate feeling when you're in here... because the sound just goes away”; the look of the rooms, “I would like to see the classrooms be less white on white”; placement of outlets, “that box in the hole in the floor shouldn't be the only place to get your IP and your projector connection”; and lack of printers in the room, “many times during class, we did things and we needed to print and we couldn't print! As it was, we had to run up to the fourth floor, find some way to get into the fourth floor and get a printer.” Some of the complaints are justified, while others are based on unrealistic expectations. Some identify real inadequacies of the learning spaces, while others reflect a professor's incomplete or inaccurate knowledge of the space and its capabilities. Regardless, each is worth considering, as it represents an area in which teachers felt their needs were not being met.

A number of interviewees mentioned that they feel that the rooms are particularly well designed for group work, discussion, and project based classes. Some saw this as a
positive, noting that such rooms are severely lacking on campus. At least one saw this as a potential mismatch to her lecture-oriented class.

Surprisingly, explicit mention of learning as an outcome was infrequent, occurring in only three interviews. This more likely reflects the interview and coding process then anything about Wallenberg Hall itself. Among those few who did mention learning, the opinion was split about whether or not the learning spaces themselves could be credited with enhancing student learning outcomes.

Ten interviews contained explicit mention of the idea of flexibility of the spaces. Some teachers appreciated the ease with which the rooms can be reconfigured, primarily because different configurations are believed to lend themselves to different activities. At least one professor believed the flexible space helped create a more collegial atmosphere in her class. Another mentioned that the dynamic nature of the room encouraged him to break out of established patterns and try something new. Another felt that the fact that the room was not always in the same configuration at the start of class was a challenge to students, preventing them from having their own “spot” in the room. With this exception in mind, the general view seemed to be that flexibility was valuable, perhaps in part because it could be leveraged or ignored as desired.

4.b Affective dimensions of teaching and learning in Wallenberg Hall

Learning is an activity that engages the emotions as well as the intellect. The “feeling” of being in a space can play a powerful role in facilitating learning, and in particular the experience of what Mihaly Csikszentmihalyi calls “flow.” In terms of the architecture and room fittings, the Wallenberg Hall HPLSs can be described as cool and subdued, though the presence of substantial amounts of wood (particularly in the Peter Wallenberg Learning theater) serve to add warmth. The Swedish connection, through the funding by the Wallenberg Foundations and other contacts, can be discerned in a restrained, simple aesthetic in the selection of colors for walls (off-white) and carpeting (mottled grey). There were mixed feelings expressed directly about the appearance of the rooms. Five instructors had positive comments, saying that the room appeared to be a “special place,” and that students appreciated that. Three people commented that their room had somewhat of a “clinical,” perhaps sterile feel to it.

In addition to these features of the space, it is important to consider the possibility that teaching and learning in Wallenberg Hall is experienced as a special privilege, and that this may itself affect the emotional state of teachers and students – and in particular, that it may lead to greater feelings of motivation, excitement, and so on. While these reactions are not necessarily inauthentic, they do depend on aspects of the Wallenberg Hall experience that are not attributable to the substance of the technology, and hence may be transitory.

A number of teachers referred to the space in terms of intimacy. Some enjoyed the spatial feel of the classroom they taught in. As one teacher said, “as a teacher, we fall in love with the actual smaller classroom area. It's a little tighter. You're closer to your
folks—your students, and it is so functional.” The majority of comments on intimacy were positive, but some expressed ambivalence. One teacher, for example, felt that the presence of laptops interfered with intimacy, saying, “it's somewhat hard to build a sense of intimacy where you are using your eyes to connect with your students ... everybody is playing, probably looking at their email for all I know.”

Another theme mentioned by a few interviewees was discussion of inhibition or intimidation. There was no consensus on this matter. One worried their students would be intimidated by the space, but another explicitly denied anything inhibiting about the space. One felt students did not “feel free enough” to participate in reconfiguring the space, and thus felt like they never knew where to sit, while another mentioned a cooperative atmosphere that lent students a certain ownership over the space. Quite a few teachers mentioned that they felt that the prototypical teacher in their department, namely one who is not tech-savvy, is likely to be intimidated by the technology in the rooms.

Six interviewees mentioned student motivation as a possible outcome of holding their class in Wallenberg Hall. Everyone who mentioned motivation did so in a positive light. One said, “I think that one of the great things about the space is that it, again, disrupts the assumption, the formal assumptions that students have... about the relationship to a classroom space, and it really makes them much more engaged that and, I think, the ‘do’ part of learning is so critical and you can't help but do here.” Another, referring to the Wallenberg Learning Theater, said “the central hall is a relatively formal place compared to [our previous classroom], and I thought the students really sharpened up their presentations, maybe because of the room itself.” In general, there was a suggestion that the learning spaces were exciting, both to students and to faculty, and that this excitement led to motivation.

4.c Teaching in Wallenberg Hall

Teaching in Wallenberg Hall presents challenges and opportunities. In general, faculty members find Wallenberg Hall conducive to teaching, especially for what might be called active learning. One said, “You have to let them learn. If you're teaching all the time they don't get much time to learn. So that’s something this space helps you do. Let them do things in there.” Asked about the advice they would give to the university, one teacher replied this way, “My advice to the university is that if you want better teaching, make these teaching tools ubiquitous.” Describing his class, one teacher said, “I would divide them up and configure them and, you know, I've taught in traditional classrooms and that's hard to do.”

A common sentiment among the seven interviewees who mentioned teaching preparation was that teaching effectively in these technology-enhanced classrooms requires extra preparation. Estimates on how much preparation was necessary varied greatly. One teacher went so far as to say, “I think to use it properly you need a year of preparation and planning to try it,” while another, at least with regard to the technology itself, said “I think anyone who is going to use it … should probably plan on spending a couple of
hours beforehand, learning how to, you know, try different things.” Most likely, these differences reflect a varying focus on revising curricula versus learning to use technology, as well as differences in beliefs about the amount of change necessary. There was not complete consensus on the need for more preparation. One professor said, “I'll cite the use of this room as having afforded me the luxury—help afford the luxury of minimum preparation.”

Three teachers described how they felt the technology allowed them to be more spontaneous in their teaching. One professor summed up her experience nicely: “It’s funny because I thought I prepared for my class but then I came in the room and all of this stuff is sitting here and as I discovered it, I started using it. So the night before class I say, oh, we can really use those computers to do a writing activity, side by side writing activity and then have people read each other’s writing, kind of like they do in the writing program but that’s not something I planned in the course beforehand but when I got here and I saw that, that’s something someone did, suddenly, I found a way to make it really useful in my own class.” Other claims of spontaneity were more modest, if still notable, such as the impromptu access of a web site to answer a question that arose during class.

Five teachers mentioned their desire to learn about and learn from other teachers' experiences teaching in Wallenberg Hall. They had many ideas about ways to do this, and several of these have been implemented in the time since the interviews occurred. There was also a generally expressed understanding that the scarcity of professors' time presents a challenge to efforts to share examples of pedagogy. While the desire for sharing was not unanimous, the relative frequency with which it was mentioned suggests a worthwhile avenue for future development.

5. Conclusions

5.1 Factors Affecting the Success of Wallenberg Hall

In assessing the degree to which Wallenberg Hall is successful in facilitating teaching and learning, it is helpful to think of the HPLS learning spaces as, in software terms, a platform rather than an application. By “platform,” we mean that the HPLSs provide a set of general capacities that teachers and students rely upon, in combination with more specialized resources, to construct courses. The success of Wallenberg Hall depends on whether the general capacities that Wallenberg Hall provides are the right ones – that is, whether they help teachers and students achieve their learning goals – and whether those capacities are expressed in a reliable and user-accessible way. Based on the limited evaluation we have undertaken to this point, it seems that Wallenberg Hall has been successful in serving as a platform for teaching and learning. In this section, we attempt to identify some of the factors, beyond the initial design of the classrooms, that may have contributed to this success, and to suggest the implications of this report’s finding for Wallenberg Hall, for Stanford, and for the use of technology to enhance classroom learning in higher education generally.
5.1.a Peopleware

One of our key findings is the central importance to Wallenberg Hall of what might be termed “peopleware” – that is, the pedagogical, technical, and administrative services provided by staff members associated with Wallenberg Hall. As discussed above, we have elected to treat Wallenberg Hall as a sociotechnical system in order to capture the interdependence of technology and human beings in constituting the HPLS platform. In particular, the “peopleware” component of Wallenberg Hall seems to play three functions: (1) as an alternative interface to the technology itself, (2) as a means of adapting the technical resources of the HPLS to class needs through incremental changes, and (3) as a knowledge capture and transfer vehicle for teachers.

In rough terms, the peopleware component of the HPLS in Wallenberg Hall consists of approximately 3 FTEs: a fulltime academic technology specialist (ATS), who is the primary point of contact for teachers and is most intimately involved with classroom support; a portion of the work time of 3 technologists, including a systems manager, desktop and network support specialist, and a technology manager; and a portion of the work time of a building manager, who handles scheduling and other building issues. In addition, the Stanford Center for Innovations in Learning, which runs Wallenberg Hall and has responsibility for the HPLS, devotes management time to planning, support, and supervision of staff members involved in supporting the HPLS.

Of the 12 interviews mentioning the technical and pedagogical support provided to them during their time teaching in Wallenberg Hall, all stressed its importance and all assessed the support they received positively. Interestingly, they did not seem to distinguish between technical and pedagogical support, but rather spoke of the two dimensions interchangeably. Several people mentioned the relief they felt at being confident that the technology would function properly and that able-bodied professionals were available on site, both to fix problems as they happened and to try to prevent problems before they occurred. Many emphasized their belief that Wallenberg Hall could not function without the support staff, and several mentioned explicitly that they did not believe that they could have successfully integrated technology into their teaching without the support that they received. One interviewee summed these views up simply, saying, “It’s been actually really nice having—the staff here has been real supportive and proactive in making things work and wanting to solve problems.”

The most critical, and probably most expensive, use of peopleware is as an alternative user interface to that presented by the technology itself. This role is largely fulfilled by the ATS (Dan Gilbert). Gilbert meets with faculty members who are scheduled to teach in Wallenberg Hall for a preliminary meeting before their class begins in order to brief them on Wallenberg Hall’s facilities and to suggest, based on the content and teaching style of the class, how the HPLS facilities might best be used. Once the course has started, Gilbert sits in on nearly every class, providing instantly available support to the faculty member. This means that the teacher rarely has the experience of an unmediated interaction with the technology, which certainly contributes to its ease of use.
The second role of peopleware is to facilitate incremental changes in the technical capabilities of the classrooms in order to meet specific course needs. In a typical instance, a faculty member will request functionality that is “in the neighborhood” of what is possible with the deployed technology, but is not actually available. At this point, the availability of technical resources, including both system configuration and software programming, often makes it possible to bridge the gap and to develop at least some version of what the teacher requested. This capacity (which is also expensive, in the form of labor costs) contributes to an experience of the technical environment as flexible and enabling.

The third role of peopleware is to serve as an intermediary between faculty members to reduce the knowledge gulf that is otherwise produced by the individualistic organization of teaching in large research universities. Faculty members teaching in Wallenberg Hall have few naturally-occurring opportunities to observe each others’ teaching, and to learn from the experience of others. Wallenberg Hall staff members who work across courses can serve a kind of pollinating function, carrying innovations and adaptations from one course into others. This improves the chances of success of subsequent teachers, since they are able to benefit from the experience of earlier ones, and probably also improves the effectiveness of Wallenberg Hall staff, who are able to encourage repetition of successful practices and hence the overall reliability of the system.

5.1.b Wallenberg Hall in the Context of Stanford

Wallenberg Hall’s HPLS classrooms are unique among classrooms at Stanford (and in fact have few analogues at other universities). This raises the question of how the HPLS classrooms fit as part of Stanford’s “teaching stock” of classroom facilities. This question has two dimensions that we address here: the nature of faculty “demand” for teaching in Wallenberg Hall versus the supply of classroom teaching time slots; and the potential status of Wallenberg Hall as a model for innovation in other classrooms at Stanford.

Faculty members who teach in Wallenberg Hall are almost always eager to return, creating a growing demand for a fixed resource (classroom teaching time slots – of course, this resource could be increased by scheduling classes in unused times, but there is a limit to how possible this is in the overall context of University course scheduling). In addition to a general sense that teaching in Wallenberg Hall contributes to learning, faculty members face the practical imperative of wishing to draw again on the work that they have performed in preparing for class, given our finding that teachers almost always substantially modify their courses in teaching them in Wallenberg Hall. This factor contributes to the urgency of the demand for classroom space for faculty who have already taught in Wallenberg Hall, at the same time as it may also play a dampening effect for prospective faculty, who may be reluctant to teach in Wallenberg Hall without a commitment that they can repeat their courses. This issue will have to be carefully managed in order to avoid creating a closed group of Wallenberg Hall teachers.

Alternatively, this demand could be focused outwards, in the form of pressure to replicate, to some extent at least, the HPLS functionality in other classroom spaces at
Faculty pressure is the most likely stimulus for innovations in other areas at Stanford. However, it is not clear that the Wallenberg Hall model, with its strong emphasis on what we have called peopleware, can easily be replicated across the university, or in other institutions. It may be necessary to treat Wallenberg Hall as a more flexible incubator for teaching ideas and technical innovations that can then be exported to more fixed, less fully staffed locations.
Appendix 1: Descriptions of Classroom Technology

Flexible Furniture

Each Wallenberg Hall room contains lightweight, flexible, tables and chairs that facilitate multiple modes of working together in a quickly configurable environment.

Webster Wall Displays

Each room has two rear-projection Websters - big screen displays that can project an in-class computer, an individual laptop, video, and videoconferences. Webster includes digital whiteboard software that allows users to 'write' directly on documents and images or on a whiteboard. Rooms 120, 123, and 125 with computers running Microsoft Windows software; Room 127 has Apple Macintosh computers.

Networked Laptops

Depending on the room, 16-20 laptops are available for in-class use. Each laptop is wirelessly networked and configured with software that allow users to drag and drop files from one computer to another. Macintosh iBooks and Dell Laptops are kept in racks in the WH rooms. In Winter 2004, 20 Compaq Tablet computers will be available in the Learning Theater and Room 120.

Collaboration Stations

Rooms 123, 125, and the Room 127 will have flat screen displays on carts that students can use to work on projects in small groups. Students will be able to drag files from their laptops on to the collaboration "desktop" to create, edit, and review work together.

SmartPanel

All of the Wallenberg Rooms will feature a SmartPanel that includes simple on/off switches, volume controls, and a technology selector. The SmartPanels, found in many other rooms across Stanford, will also feature a DVD and VHS player.

iSpace Software

Each computer will have software that allow users to push files from one computer to another, share control of the big screen computers, and give synchronized multi-screen presentations. New applications are being developed continually by the Computer Science Department and the SCIL technology team.

Class Disk Space
Each class will have its own space to save files that are created during class. The entire room will automatically reboot just prior to each class and bring up the files and applications just as they were left them from the previous class.

**Video Cameras and Microphones**

Every class in WH can be automatically recorded and uploaded to the class Coursework site. For students who miss class or want to review lecture or discussions can log in to the class Coursework site and experience class.

**Video conference capability**

The Peter Wallenberg Learning Theater, the Room 127, and Room 120 support IP videoconferences using a Polycom Viewstation.

**Huddleboards**

Huddleboards are lightweight portable whiteboards that can be used for small group collaboration or presentations. The ideas generated on huddleboards can be converted to digital images using the CopyCam (see below).

**Copy Cam**

The Copy Cam takes high resolution digital photos of huddleboards and converts them to images that can be saved and printed. Students and professors who do work on the huddleboards will be able to save their activities with one touch.