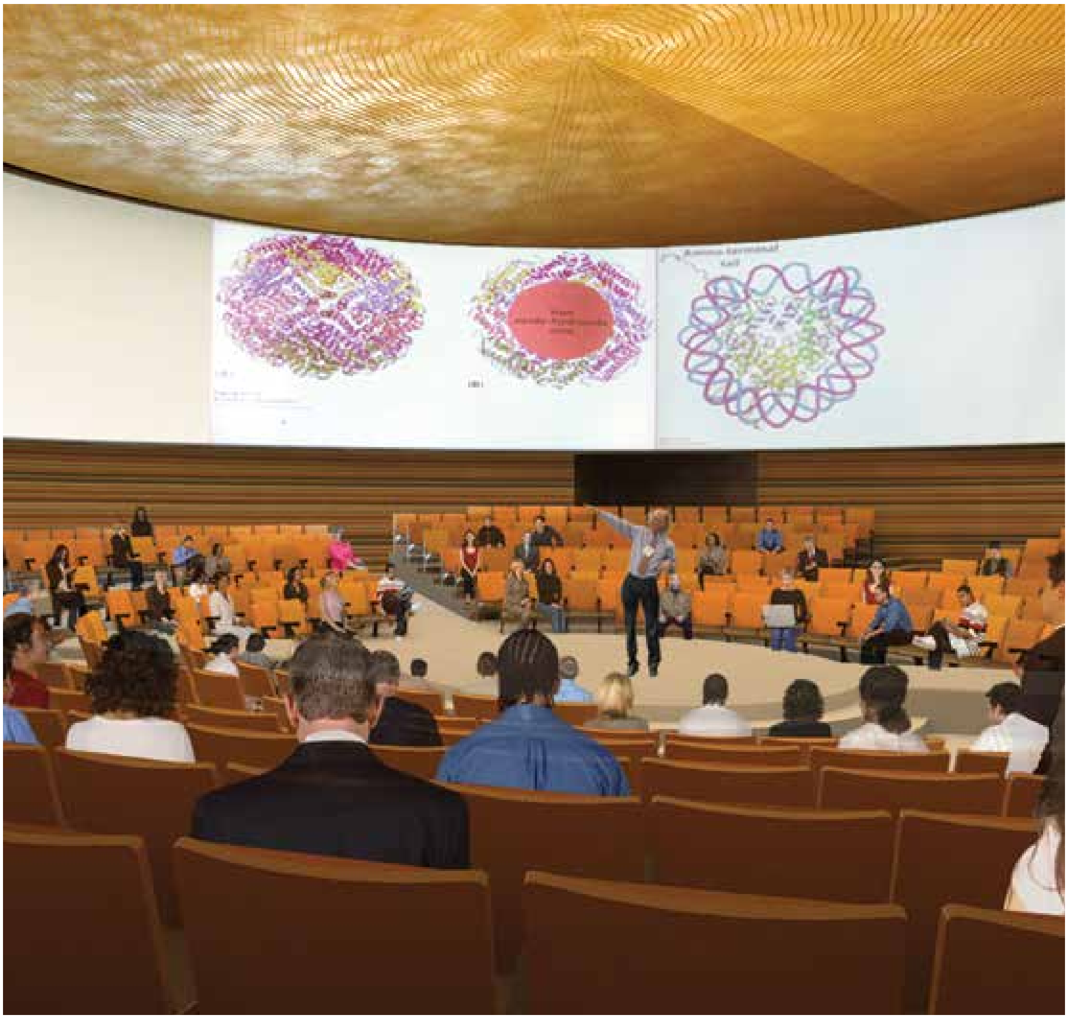


Photos courtesy of Boora Architects

The round configuration of the arena classroom shrinks the distance typically separating teacher and student. Facial modeling and the direction of light are especially important for teacher-student engagement, while the surrounding screens must be visible from all vantage points.

Designing for the Active Classroom

As teaching methods change in higher education, the architectural and lighting approaches for learning spaces should follow suit. Oregon State University provides examples

BY ANDREA WILKERSON, AMY DONOHUE & BOB DAVIS

Higher education is undergoing renewed scrutiny and change. As the duration and costs of earning a degree continue to increase, learning outcomes appear to be on the decline. Recent studies have shown that undergraduates are not making appreciable gains in critical thinking skills in the first two years of college [1].

In response, universities are working to increase student engagement and learning outcomes. Faculty are focusing on moving students beyond passive lower order thinking skills, such as remembering and understanding information, to active higher order thinking skills, such as analyzing, critiquing and creating. The "active learning classroom" has emerged as a space to foster this new direction in pedagogy.

Many institutions of higher education are experimenting with this kind of teaching at a variety of scales, borrowing from other spatial models such as theatrical spaces and architectural design studios. Whether sized to accommodate 24 or 240, active learning spaces share common traits such as fostering student-faculty engagement, maximizing time for learning and anticipating change.

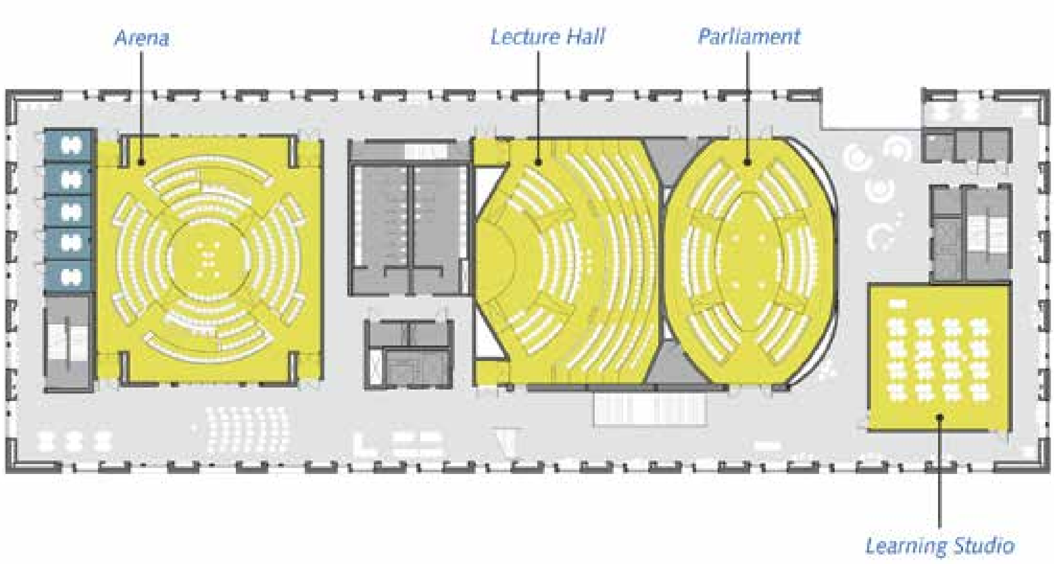
In this article, we will explain how new architectural approaches that embody these three traits are being implemented in the new Oregon State University (OSU) Learning Innovation Center (LINC). The focus will be on the 600-seat arena classroom and the 72-seat active learning studio at OSU.

FOSTER STUDENT-FACULTY ENGAGEMENT

Architectural approach. Proximity and visibility are leading factors in student engagement. At a distance of 15 ft, an instructor has an increased chance of making direct eye contact with the audience, holding attention throughout the discussion and perceiving visual cues that reveal whether students understand the material [2]. Removing physical barriers, such as large table surfaces or expansive podiums, fosters a learning-centered environment, one that supports dynamic discourse both with the instructor and among students. The recent shift to a more discussion-based pedagogy has made visibility between students equally as important. Just as spaces are designed to meet standards for physical accessibility, teaching environments must be designed to maximize visual access for enhanced student-to-faculty and student-to-student relationships.

Recent advances in control technology have provided much greater mobility within the teaching space as well, untethering the instructor from a single fixed position in the classroom. This ability to move throughout the audience eliminates the "back row" aspect of a typical learning space, where reluctant learners often sit. The freedom to communicate from a variety of positions also encourages both faculty and students to explore the most effective ways of presenting information given the material and the audience.

In the 600-seat arena classroom at OSU, a round configuration collapses the distance typically separating student from instructor in a large lecture hall. In this teaching space, one is never more than eight rows or 30 ft from the professor, trumping Laurence Olivier's classic rule of acting within 65 ft of the last row of the audience. Four aisles extend from the center of the room, enabling faculty to reach the 15-ft visual access zone of every student in the space. Multiple projection screens surround the audience, ensuring simultaneous viewing of



Different classroom scenarios at OSU. Note that the lecture hall setup is being phased out in favor of the other three options. The parliament classroom is a version of the arena scenario discussed here.

the speaker as well as important course material from anywhere in the space.

Lighting approach. Facial modeling and the direction of light are critical factors for faculty-student engagement, and accomplishing this in the 600-seat arena classroom where students are looking at a speaker from every direction elevates the difficulty. Dynamic lighting that tracks the presenter can facilitate student focus and engagement, making barely perceptible adjustments as the speaker moves around the room. Adequate vertical illuminance on the face of a student who raises a hand to ask a question helps the presenter quickly notice the student and more easily read the facial expressions and gestures of the student. This supplemental lighting for facial modeling may be remotely controlled by the professor using a mobile device, or may occur automatically based on emerging positioning technologies or adaptations of motion-tracking technology such as that used for video gaming. The lighting and the design of the space can work together so that the student who wants to avoid participation can no longer sit in the dark, back corner to avoid engagement; now the teacher can get closer and the lighting can better support visibility.

Ideally, the desired lighting conditions would be set before class or even before the semester begins so that the lighting is automatically responding as the instructor wishes. These advanced features would require an initial investment of time as the professor understands and adapts to the new technology. This is similar to the learning curve required for new presentation technology and classroom layouts such as the arena classroom. In fact, the arena classroom at OSU will not be used for classes during the first semester so that the Instructional Resource Center can train professors how to effectively use the new space. For future classrooms, training on the operation of lighting systems can be included with training on other instructional technologies.

Ensuring that student engagement is supported while keeping the presentation screens visible is especially challenging if the screens surround the audience, as is the case in the arena classroom. The arena classroom requires clear visibility of the screen from over 600 positions, so what is the best way to keep light off the screen? One option is a variety of optical lens choices based on desired distribution, with asymmetrical options. Although current outdoor luminaires often have many different optical distributions available, a designer usually does not have many choices for different optical distributions or form factors for interior luminaires such as downlights or troffers. A variety of optical distributions may be needed in a single building in order to get light where needed in the most efficient manner.

Taking this one step further, perhaps the distributions for all recessed luminaires, regardless of form factor, are standardized as Type A, Type K and everything in-between, similar to the IES classification for outdoor luminaires. Another option is the LEDs within a luminaire that are aimed toward the screens could also be dimmed

15 ft **At this distance, an instructor has an increased chance of making direct eye contact with the audience and perceiving visual cues that reveal whether students understand the material**

Classroom To-Do List

To encourage engagement and learning, consider providing the ability to change:

✓ *Aiming* of luminaires as the presenter moves around the room

✓ *Intensity* of light on an audience member when a question is raised

✓ Color of light as the day progresses

✓ *Lighting cues* to facilitate transitions between class activities or class periods

✓ *Distribution* of light exiting a luminaire when video screens are turned on

or turned off, while the others remain on. Or, perhaps the arena ceiling will be comprised of curved OLED panels, and the OLED panels directing light toward the screens can be turned off.

To fully support faculty-student engagement and alertness, the color and intensity of the light may also need to change depending upon the time of day. As we continue to gain a more complete understanding of the psychophysical and physiological effects of light, the lighting in classroom spaces can be tuned to meet the needs of the occupants throughout the day (and evening). In the past, designers attempted to reduce the variety of fixtures and lamps based on maintenance concerns, which may not be relevant if LED systems ultimately achieve their expected lifetimes. If this limitation is removed, will the lighting market respond with an increase in unique form factors and optical choices? The ongoing development of solid-state lighting technology provides almost limitless opportunities for new approaches to these problems.

MAXIMIZE TIME FOR LEARNING

Architectural approach. Transitions between scheduled classes often consume valuable teaching time at the start of the class period. In order to reduce this time pressure, the architect should locate multiple entries and exits, as well as circulation space in hallways, to allow students to leave the class quickly as the next class is entering. The space should enable an easy transition for instructors to "exit" the technology when class changes occur, so that the next instructor can move into the room and set up quickly for the following class to begin.

In addition, the architecture should extend the opportunities for learning by locating informal and group study areas immediately adjacent to classrooms. In these nearby spaces, the conversation can continue after the formal class time, allowing faculty to answer questions about the group discussion. White boards and flat screens are helpful for referencing materials presented.

Lighting approach. Many instructors have pondered, "Are the students packing their bags because class time is over, because they are particularly antsy today, or because I was particularly boring?" A lighting cue in the classroom and the adjacent corridors could help transition classes just like in a theater, helping to maximize time for learning. The instructor could also preprogram the lighting before entering the space, so that when entering the classroom, the lighting is adjusted to his or her preferences for the day.

ANTICIPATE AND EMBRACE CHANGE

Architectural approach. The one constant in teaching and learning is change. Integrating flexible infrastructure systems into active learning spaces allows classrooms to evolve as pedagogy does, adapting the physical characteristics of the room to the needs of the learning community. Including extra conduit, cable raceways, or an under-floor plenum for cabling will enable technology to be converted at a reasonable cost. Tiered classrooms can be built using a raised platform system, allowing the room to be renovated in the future to a flexible flat-floor classroom with less effort and expense.

In addition to anticipating long-term changes over coming months and years, the flexibility of active learning environments also supports a wide range of pedagogical instruction throughout the day. To improve a larger classroom's flexibility, fixed auditorium-style seats arranged for lecture format can be swapped out for seats that swivel. This allows small group breakout sessions to occur within a class period. Technology should be fully integrated throughout the room. In smaller classrooms, instructors can easily rearrange chairs, tables and whiteboards on wheels multiple times within one class period or from one class to another as an instructor's teaching methods change.

Where physical movement of equipment is not practical based on setup time, technology and room configuration provide a great deal of flexibility. The learning studio at Oregon State University supports a class of 72 students in a wide array of coursework, often working in groups of three or nine. The instructor has a home base but often moves about the room working with small groups on problem solving. Like an architecture studio, the lecture time is minimized while individual or small group discussion is the focus. Interactive boards surround the room, connected to each round table of nine students. Results from small group efforts can be broadcast to the room, enabling students to learn from one another while guided by the instructor.

Lighting approach. The lighting systems installed now need to be both flexible for daily use and adaptable to future changes. This is particularly important in the learning studio, where the lighting needs to react during each class session to the mobile furniture and the multiple writing surfaces in various locations. The lighting during a lecture should enable good visibility and attention in the lecture area, while minimizing energy use for lighting in unused areas. As student group work begins, lighting throughout the room needs to adapt to the separate team task areas, always providing the vertical levels needed for effective faculty-student and student-student interactions. Students reading detailed printed reference material have different needs than those streaming a tutorial to an adjacent interactive surface, and lighting needs to adapt to support these various activities.

In terms of anticipating future changes, lighting systems in the classroom need to advance at the pace that other technology advances—a marked increase in pace for our industry. In the future classroom, we expect that all luminaires will be smart. NanoMarkets estimates that the market for smart lighting chips is around $67 million in 2014 and will be about $530 million by 2018, growing to $1.3 billion by 2020. The lighting system will know the positions of students, mobile furniture and interactive surfaces, and will be able to track changes in the positions. The mobile furniture and interactive boards will be smart too, so that the lighting system not only knows the location but the direction a chair and the interactive surface is facing. As a result, the amount of light directed toward the interactive surface can decrease if it is being used to watch a video, or can increase if it is being written on.

These seamless changes could also occur based on occupant density and noise. Lighting systems that allow for modified output levels and altered light distribution through variable optics are needed in order to enable lighting adaptations that match the other changes in the space. To be successful in tomorrow's applications, lighting manufacturers should be considering smart, flexible luminaires that can provide directional or diffuse light of the desired spectrum where it is needed, when it is needed.

Teaching environments with these spatial characteristics support the goal of increased learning, better preparing students for upper level coursework and eventual careers. The expected future of solid-state lighting systems combined with "smart" lighting means that we may not have too long to wait for dynamic, responsive lighting that keeps pace with other advancements and supports the changing nature of education. ☐

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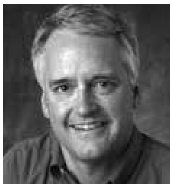

Robert Davis, Ph.D., Fellow IES (Member 1983), joined Pacific Northwest National Lab in 2013 as senior staff lighting engineer. In addition to his work on the manufacturing side, Dr. Davis taught and conducted research in lighting as a faculty member at RPI's Research Center and at the University of Colorado at Boulder.

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