

Specificity in Context: Selected Studies in Architecture and Technology for Education

Part 2 of a two-part report

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While an intern at the Milwaukee, WI, firm of Kahler Slater Architects in the summer of 2000, David Foxe researched the architecture of higher education institutions for health-care programs. This diverse and highly specialized niche within architectural design encompasses a wide variety of aesthetic, educational, technological, and logistical issues relating to the individual's roles as learner, teacher, facilitator, and administrator, as well as patient and doctor. Permeating these architectural ideas is the concept of specificity in context; this specific design niche is valuable within the larger context of how architecture influences and reflects business, educational, and planning trends. By understanding these trends within the framework of higher education, one can translate them into specific, meaningful, technology-enhanced health- and education-related spaces.

Part 1 of this article (published in the Fall 2000 issue of MURJ) included sections on:

- Business and Education at the Turn of the 21st Century
- Learning Trends: Constructivism, Technology, and Health Care
- Planning Makes Perfect (campus architecture, facility management, etc.)
- Pedagogical Architecture: Spaces and Technologies, such as presentation technologies, auditoriums, conference rooms, and distance learning spaces.

Part 2 of the article, published below, will begin with the laboratory section and continue with libraries, classrooms, and information technology. The conclusion brings all of the aforementioned spaces and technologies into a larger context and is followed by the notes and bibliography for the research.

Laboratories

There is less than clear demarcation between laboratories, classrooms, offices and public spaces in science teaching facilities, as science does not occur only within a laboratory. "Therefore, consider the building as a whole...If the laboratory is in fact a place conducive to experimentation, investigation, and observation, then the whole building can now indeed become the laboratory."¹⁸ Every square foot in a laboratory must be considered for its potential contribution to the laboratory; traditional "net" and "gross" area measurements must metamorphose into "learning

environments,” “transitional or contributing spaces,” and “utility space.”

The location of offices should encourage interdisciplinary collaboration and research, and offices need to be in a different space in relation to laboratories and classrooms. Avoid a sense of “my office” or “my lab,” especially when the building isn’t big enough, by bringing together dispersed faculty and/or consolidating disciplines and agencies. Having zones of offices and labs linked by atrium spaces can also bring together people who otherwise would not interact. Use of outdoor site arrangements and indoor “streets” faced with visible laboratories and interactive displays can also facilitate interaction between engineering and science students and students from the humanities.

Create a utility and material distribution corridor internal to the labs, separate from public corridors, and consider the need for off-site support and direct exterior access to lab spaces. Since support and repairs are expensive, design labs for both low cost of maintenance and low technological level of maintenance through simplicity and access. Access to utilities can be handled by overhead or underfloor grids rather than attachments to fixed furniture, so that labs are not forced into a preset modular bay system or pattern and so that some labs can be open while others are subdivided (hot rooms, cold rooms, clean rooms, etc.), with specialized equipment.

As research becomes more team-oriented, industries demand new collaborative skills in workers. In addition, expensive equipment must often be used continuously by more than one team, so cooperation is necessary for the very existence of the research. Support spaces for preparation rooms and access to major stored equipment need to reflect this collaboration. With respect to equipment, laboratories include myriad technical concerns relating to physical equipment and utilities as well as information technology networks. Consider ring stands and future equipment when planning hood sizes, and allow equipment to be connected to future computer networks. Indoor Air Quality (IAQ) is especially important within and between laboratory settings for environmental precision as well as human health. The abundance of natural light is good for a learning environment and for some biology experiments. However, real control over light is required for labs that need to be completely darkened for video presentations and experiments.

Consider opportunities for multiple seating and options within flexible academic spaces, which can include differentiated spaces for lec-

ture, teaching, research, and other specialized spaces within the larger “laboratory” context. Laboratories for undergraduates fulfilling general requirements need to have larger academic spaces; those for declared majors need smaller, more defined spaces.

Today’s science graduates are expected to use a creative trial and error approach, yet science is often taught in a structured way that does not reflect how it is practiced. Serendipity, the chance discovery of an idea, is common in the daily practice of science and mathematics, and facilities should support it. Simulation through the use of computer equipment is increasing and will allow safe replication of experiments for trial and error, so less toxic, more flexible laboratories can be multidisciplinary. Shared laboratories allow for much greater space utilization when compared to single-discipline facilities that are only used for a small part of the day.

Facility flexibility will be more important than in the past because the learning environments must now support collaboration. Traditionally, designers have simply inferred space needs from enrollment projections and space formulas that are now obsolete. The configuration of the laboratories in which traditional teaching has taken place for the past 50 years prohibits collaborative methodologies because they discourage group interaction. However, we must not only consider the configuration of individual environments, but also design the whole building as a place to learn science. The teacher today should be close to the students, able to circulate among students, and effectively present to the class. Students should have defined sight lines to demonstration and display areas. This way, students can work flexibly between individual and collaborative work in a “studiolike” format in which they learn skills and concepts through experience. Communication is key toward building community; faculty don’t often have a clear consensus as to what buzzwords such as “shared laboratories” mean in practice.

Rapidly innovative disciplines such as biomedical research are developing needs for laboratory facilities that are inherently inter-/multidisciplinary and flexible to changing technological and scientific guidelines. There has been a shift in the past 10 years from a traditionally isolated research environment to one of sharing, particularly through partnerships with the business world. A facility is no longer a mere “biology building,” but now a “Center for the Advancement of Biological Sciences,” often with individual or corporate sponsorship. Trends of biotechnology in the business world will continue to

shape research environments, and the demand for undergraduates involved with research grants will cause a greater demand for new, expanded, more specialized, yet flexible facilities.

Libraries

In spite of competition from computers, books still constitute the most agreeable resource for research, while electronic storage and retrieval of information increase alongside. Libraries constitute a primary adaptable space for technology and interdisciplinary education. The library, which has merely shifted roles from information storage to information accessibility, should be a centrally located space available for information and research. A library may be considered as a “head end room” for disseminating information, data, media, and technology. Thus storage spaces and technology infrastructure support spaces may need to be located nearby. Libraries can also be a central network access site for the school’s online resources and for the Internet at large. Within library spaces, provide for plenty of individual student spaces for storage, study, and discussion for project-based or team-oriented group work. One difficulty is that a large variety of scale in spaces and the use of both task-specific lighting and natural lighting may conflict and cause glare on computer monitors. While improving this situation, a diagonal layout of ceiling lights can also add flexibility by relocating shelving stacks, information appliances, and furniture.

Classrooms

In addition to the aforementioned specialized learning spaces, we must also examine the role of the classroom as the central pedagogical space. The formal definition of a classroom in the learning environment is expanding to encompass a greater realm of possibilities. The learning environment can now be defined as the place of connection between all of the various media, data, and other resources, and it can become something other than traditional classroom spaces: Collaborative group work settings can occur in open public spaces with tables, informal meeting places, and other nonclassroom spaces.

Classroom spaces are only a part of the architecture of an educational environment, and “quality school environments enhance—even improve—programs, attitudes, and achievement...It is our belief that curriculum and the educational environment cannot be separated.” Besides the pedagogical implications, classrooms need to have quality ergonomics and value, because dingy classrooms suggest that classroom

teaching has less importance than departments such as athletics and administration, if those facilities are more handsome. Strong educational facilities can improve morale, school and community pride, and other effects beyond the built environment, whereas uninviting school facilities can detract from otherwise quality programs. The physical setting is not just an institutional backdrop; it has a real impact on academic performance.

Emphasize flexibility and simplicity of technology in classrooms so that it does not intimidate, but rather inspires presenters who rely on improvisation, spontaneity, and audience participation. Allowing for “self-service” classrooms can reduce costs, and technology can be incorporated in classrooms directly (housed in cabinetry) rather than isolated in a separate projection booth. In other situations, use a small lectern with AC power, data and display connections for a laptop rather than a large “bunker” that creates a psychological barrier between students and teacher. These technology-rich classrooms need to be created around the campus, and not just as one expensive island of technology to impress VIPs. A majority of faculty prefer chalkboards to whiteboards; it is essential to note the important persistent use of “chalk and talk” along with additional media. Technology is supplementing rather than replacing traditional means.

There are inherent difficulties when designing spaces with one type of teaching style in mind. The 1960s “pit classroom,” which fit educational trends popular at the time of construction, has since had difficulties adapting to new technologies and learning strategies, such as large presentations alongside small-group cooperative learning. Fixed seating arrangements are not as efficient as movable furniture for unpredictably and constantly changing room uses and capacities. For hands-on teaching and learning spaces, consider student workstations that can be organized in concentric rings instead of a rectangular grid. Another working environment could be a module that includes movable table and chair areas around a central meeting space. Spaces need to be conducive to small- and medium-size group work, discussion, and instruction, and a classroom needs space to experiment with innovative equipment and curriculum.

New collaborative learning strategies place the student at the center of learning, with the teacher being a facilitator, a situation that often works for realistic “project-based learning” situations. These newer learning strategies require consideration of interior spaces’ internal relations and furniture and will bring up issues of adaptability

with the “traditional” classroom paradigms. There will be fewer “standard” 30-person classrooms, with more small-group spaces modeled on conference rooms and more large-group spaces modeled on auditoriums. Within each of these teaching spaces, students need comfortable, semiprivate, personal spaces, especially to humanize the scale of large-group areas.

Furthermore, the integration of lecture and laboratory has pedagogical and spatial implications, based on how “old” research and teaching styles have developed into more hands-on and IT-based approaches in the classroom. Finite lab and teaching areas have evolved into zones that can be shared and used more often and effectively, and this contributes to the devolution of the computer lab. Although it is important to retain areas of more concentrated technology, the larger computer laboratory contains the entire learning environment. (This parallels the ideas delineated in the earlier description of laboratories.)

Technology usage and linkage affects the formal definition of what a learning environment is and what it can become. Technology should be curriculum based and instructionally valid so that it can support multiple learning and teaching styles and adapt to changes without being stuck with one vendor or platform. Three instructional uses of computers include (1) learning about computers with theory, literacy, computer science, and programming; (2) the use of the computer as a tool for word processing, instruction, and aiding problem solving, and (3) learning through computers via interactive learning and navigating for knowledge, e.g., Internet, Intranet. Computers in the classroom need to maximize the quality of the presentation and accommodate last-minute changes, the diversity of preparations for different courses, and different interactive opportunities. For flexibility in room planning, there are cost-saving opportunities with mobile computer boards and AV equipment on coordinated (perhaps modular and/or rolling) furniture. If the seating faces a corner, it can be diagonally truncated to enclose cabinetry with presentation technology and storage space.

The classroom will not disappear, but its usage patterns will be more varied, and even the most specialized parts of the learning environment will need to be adaptable and responsive to differences in learners’ needs. Even the fixtures and spaces that are assumed to be only for science facilities can often prove serendipitously functional for a different program. For example, science lab space can also work as art lab space. Expanded corridors to connect additions to existing structures can serve as informal discus-

sion and study spaces, requiring balance between noisy corridor spaces and alcoves for study. Each of these iterations of the larger learning environment should enhance informal learning through interaction.

One new model for classroom space by Bruce Jilk, AIA, shows an archetype for a new classroom facility based on personal workstations for groups of five students with modular furniture and computer network connection. These are grouped to form a 100-student “family” around a central space for instruction, demonstration, display, laboratory, etc. Four “families” are grouped with commons for dining, studying, and socializing, and these are grouped into larger communities. The system of units creates a symmetric learning community that is repeated despite the change in scale. This has been implemented in the School of Environmental Studies in Apple Valley, MN, sited near a zoo, which provides an interdisciplinary curriculum to 11th–12th grades. This concept can be easily repeated near other community resources for education facilities with emphases on health science, technical skills, or the performing arts. Multiple, large, lecture-style classrooms, with clusters of smaller Internet-connected workstations and study spaces, are used in the Georgia State University classroom building. At Rensselaer Polytechnic Institute in Troy, NY, traditional classrooms for science-related courses’ lecture, recitation, and laboratory functions have been combined into one facility, the studio, where the faculty conducts hands-on interactive learning sessions.

A related option for the evolution of the classroom is locating smaller learning “enterprises” in a community with individual workstations around a central “social hearth,” with common library spaces, social spaces, and other shared/subservient resources. On a larger scale, community colleges could reclaim a sense of community. Parks, medical facilities, professional and municipal offices, and different socioeconomic and age groups could be grouped around facilities that offer lifelong community training partnerships. At the Horizonte Instruction and Training Center in Salt Lake City, Utah, for example, an office building has been renovated into a flexible training center for several age groups. With such education, workplace and vocational training facilities need to take into account individual differences in knowledge acquisition for technical skills training, just as classrooms need to adapt to different teaching strategies.

Information Technology

Information technology is becoming a univer-

sal link, from university classrooms to vocational training centers. Networked technology has macroscopic design implications for the entire campus, which needs a network backbone that connects every zone and building on campus, as well as attends to small details such as distributing connections to every desktop and space within individual buildings. For network computing, computer nooks with standing-height tables can become e-mail "post offices." These and other small nooks and crannies should be creatively designed, informal, inviting, cozy, distributed, and wired.

The idea of a network as merely an Internet/Intranet connection for data is also expanding to include video and other media as part of larger trends toward convergence. Current video conferencing technologies make use of a wide-area network with high-speed Ethernet or ATM (asynchronous transfer mode) between campus buildings, fiber optics between main locations, and local-area networks within buildings. The new H.323 standard allows for distance learning possibilities using Ethernet. Small portable computing devices are leading the way toward convergence with cellular technologies that will contribute to ubiquitous wireless networking. Wireless connectivity is already possible within limited range, and while wireless technology will improve, wired connections are still needed to have sufficient uninterrupted speed for intense tasks such as distance learning video.

Telecommunication closets are among the new flexible support spaces acting as adaptable places for technology infrastructure. At least one closet is needed per 10,000 square feet, each of which consider pathways in three dimensions for cable tray routing, riser conduits, and other wiring. For safety, no plumbing should be located above these closets, and sprinkler heads should be protected from accidental activation. HVAC systems should have one air exchange per hour. Consider lighting and space to work, as well as having equipment rack access from the front and back.

New technology-enhanced spaces serviced by network connections may include on- and off-campus small-group conference facilities, scattered individual workstations, faculty office clusters that include space for meeting with small groups of students, and new production/distribution facilities for course software. While educational technology can sometimes imply a narrow definition of distance learning, technology-enabled education needs to be inclusive of on-campus and distance education programs, because technology for existing on-campus

courses is generally a higher priority than developing online delivery. Furthermore, technology is enabling courses and training for a wide audience, so "antiquated terminology" that separates distance learning, continuing education, and extension programs "imprisons our thinking in old paradigms."¹⁹ As part of new technology paradigms, look to innovative businesses, including worldwide scientific enterprises, communication organizations such as AOL/Time Warner, and information technology companies such as those in Silicon Valley, rather than schools, as benchmarks for future technologies.

Instructors need ways to become comfortable with technology, and they need extensive support to use technology as an effective tool for learning. Human productivity improves with use of better tools, and educational institutions need support and communication for new technologies that can make learning environments more productive. It is also essential to recognize the distinction between technology and science in current education; the gadgets and information technology appliances used are merely tools in the pursuit of scientific research or study for fields such as medicine and biochemistry. The user's research and study require educational architecture specifically designed for the needs and use of technology, and yet adaptable to changing pedagogy and trends.

In a world of technology, a world increasingly infused with images and "places" in cyberspace, real spaces are ever more important, especially for educational institutions. Students want high-tech activities to occur in warm, soft, sophisticated spaces, within buildings that are comfortable with the rest of campus architecture; the technology should be subservient to the humanity, whether it is in the classroom or the workplace. "We no longer have to design workplaces around the needs of computers, and we should not. We should aim to create people-centered workspaces, with natural light and air where possible, and fit the computers into those."²⁰

Conclusion: Interdisciplinary and Interpersonal Connections

Just as technologies are heading toward convergence, the most exciting research developments are occurring on the boundaries between different disciplines and require many capabilities. Interdisciplinary fields, including biomedical technology, the health sciences, and other technical enterprises require educational facilities that match their goals and can facilitate technological innovation as well as focus on personal communication between fields. For higher education



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institutions, the technology aspect may be part of business partnerships, and the interpersonal relationships may include locations within a community that partner with existing high schools, community colleges, or other public facilities.

In order for interpersonal and interdisciplinary connections to occur in facilities that house separate, specific disciplines, circulation spaces need to allow students to interact informally and spontaneously with each other and faculty. Single-loaded circulation spaces (doors on one side) allow for social spaces and views of the surrounding indoor and outdoor environment. People are more likely to walk through and socialize in a long corridor than visit places that are physically closer but require stairs. Create indoor and outdoor gathering spaces (drawing the inside out, and vice versa) at major traffic/circulation areas, locating services nearby to generate activity. Furnishings, finishes, and changes in vertical scale can give people a sense of personal space within a larger public campus. Give consideration to public and transitional spaces for collaborative learning opportunities; wherever students can connect to the Internet and campus Intranet, there is an ad hoc laboratory or potential learning environment.

Educational facilities will increasingly require “clustered” classrooms or other spaces. These clusters of space, giving order and human scale within a larger campus, may be organized along a central axis, or they may focus different aspects of a facility toward a central outdoor space. On a practical level, if a technology or media center space is the source for technology infrastructure, the building’s hierarchy can grow out of that central focus. Architecture for interdisciplinary education can also be organized using a “World Wide Web” approach, which, while linking spaces and technology in a hierarchy, allows disciplines to be easily traversed. All of these organizational ideas corroborate with the aforementioned learning theories, with resources and spaces for large groups surrounded by interstitial small-group and informal areas.

The image of the college is becoming that of an interpersonal learning community, with connections to other secondary, post-secondary, and community resources. The college campus will remain a community asset, a physical destination and a home for those who are thoroughly immersed in their educational experience. Higher education institutions’ organizational structure will likely depart from the traditional models of lasting four years, where students have a single focus and faculties are divided into distinct departments. Interdisciplinary interaction within institutions will also expand so that institutions do not “stand alone,” but rather share resources through partnerships of similar program. An example would be the La Crosse (WI) Medical Health Science Consortium, comprised of public and private educational institutions and regional healthcare providers; this consortium was the client for a multidisciplinary facility by Kahler Slater, which opened in September 2000.

Higher education is developing needs for multiprogram buildings in which technology is an assumed inclusion. Architects and users should think of schools “not just as single-purpose buildings, but as environments, each of which should reflect the specific needs, interests, and aspirations of the community it serves...Nowhere is it written that schools should not include day care centers or medical and dental services. Nowhere is it written that school athletic facilities, fitness centers, libraries, media complexes, theaters, and conference rooms should not be available to the entire community.”²¹ Similar to ideas of recombinant DNA technology in genetics, recombinant facilities create new kinds of buildings through the process of rearranging program functions, forming new combinations that change the interaction of people with their

environment. Integrated health centers can include hospital clinics, pharmacies, offices laboratories, and health stores.²² Education facilities with flexible accommodations for multiple user groups can even model spaces on malls, office buildings, and architecture studios that have structural, HVAC, and electrical systems that allow for periodic rearrangement.

As part of the personal connection, more institutions are viewing student housing as yet another part of the interdisciplinary learning environment. Large common work spaces and large student rooms with myriad technology appliances and upgradable network connections are becoming the norm. In order to replicate and compete with 24-hour-a-day online discussions, debates, and friendships, colleges are ensuring that their facilities for learning and living add the richness of human contact computers can't provide. Thus, the new dorms are "living and learning" centers with adjoining classrooms and quarters for faculty and visiting scholars.

The MIT Educational Technology Council Report is a cohesive, interdisciplinary recommendation for integrating electronic facilities and physical space so that they are mutually supported.²³ This includes rethinking on-campus and remote access points as well as integrating displays and interaction points within public places. A new "architecture" for tomorrow's reinvented campus will include virtual places as well as physical rooms and laboratories, electronic links as well as corridors, so that the vivid images and sense of place is maintained throughout the community. Physical campus landmarks need to be complemented by beautifully designed, shared online environments, and this partly electronic, partly architectural infrastructure must not be an end in itself, but instead a pathway to educational goals. "The most exciting thing about teaching and learning on the Internet is not distance learning, but the possibility to create entirely new learning environments for students."²⁴

Chris Riley, strategic planning director for the advertising firm of Wieden and Kennedy, echoed this when describing an educational "brand" of identity for Marylhurst University in Portland, Oregon. "How do you represent values grounded in the experience of an educational community in the realm of distance-based, isolated learning? Part of the answer is that Internet learners need not be isolated; they are also a community, an extension of the community defined in spatial terms by the Marylhurst campus...If we could create a place on the Internet that had the same values as the place in Oregon, then there would be consistent values across the broad Marylhurst

community." Rather than a flashy advertisement, the online experience needs to be just as sensory and intellectual as the corresponding physical environment. Higher education institutions' processes can and will include elements of the physical campus as well as other technological means, resembling "the proverbial onion: at the core, the traditional kind of real-time, face-to-face instruction, surrounded by rings of other educational experiences" facilitated by technology.²⁵

In a nutshell: Technology makes information accessible, and faculty make it meaningful. The academic mission and pedagogy will drive the technology and the architecture.²⁶

Architecture for education is now filled with meaningful paradoxes:

- Buildings need increasingly specialized program spaces, yet they need to be "social" to maximize the frequency and quality of human interaction through nonprogrammed spaces.
- With all of the centralized specificity required for health science and other fields, universities are challenged as to how many specialties they can have, and how to share general, decentralized resources from virtual scholarly communities.
- Flexibility is essential so facilities can stay functional, but flexibility may not always be appropriate because it achieves the lowest common denominator without tailoring to any best solution.
- The physical adjacencies to classrooms, labs, and libraries will become less important for electronic access, but Web-based planning, production, and presentation are still highly dependent on physical infrastructure and environments designed for effective presentation and learning.
- Physical spaces must make it possible to use virtual spaces and technology tools. Educational technology is wonderful when used with critical thinking, but if used superficially, it may severely undermine the learning it is intended to enhance by not encouraging deeper thought.
- Buildings should express the exploration and discovery that are important in obtaining knowledge, but the new spaces do not fit in existing paradigms; altering the public's image of school facilities may be the single most difficult part of the needed transformation in American education.

References

My role at Kahler Slater was to link all of their diverse ideas with my own thoughts, based on the facts of the resources I have read and evaluated, and this analysis therefore represents a comprehensive synthesis. A more comprehensive bibliography is included in the research files I created and organized, which contain hundreds of articles, books, seminars, and other materials on which much of this text is based.

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- Educational institutions are needing to work with future technologies within aging campuses of the past; in Riley's words, "Education will be both the vanguard and the rear guard; it's up to you which way you look, to the future or the past."
 - In designing effectively for future information technology, architects are no longer limited by the needs of computers, but can instead refocus on creating spaces for people.
- The architecture of higher education institutions for healthcare programs is becoming the

architecture of interdisciplinary and interpersonal connections through the physical and technological environment. By understanding the aforementioned business, education, and planning trends within the context of higher education, these design ideas and suggestions can be applied to the creation of specific, meaningful, technology-enhanced health- and education-related spaces.

It was my pleasure to help Kahler Slater Architects learn and conduct research about architecture. 🏠