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

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The architecture of higher education institutions for health care programs is an example of a diverse and highly specialized niche within the architecture profession. Architectural design in this realm encompasses a wide variety of aesthetic, educational, technological, and logistical issues relating to the person in roles as learner, teacher, facilitator, and administrator, as well as patient, doctor, etc…

For eleven weeks in the summer of 2000, I was an intern with the higher education team of Kahler Slater Architects in Milwaukee, WI, which is a 130-person firm with offices in Milwaukee and Madison, WI. Guided by a list of topics I was assigned to research, I organized the existing information from locations within the office, researched information to be incorporated from external sources, and developed a cohesive way to combine the existing and new information in an eminently expandable organizational system. Although the system can constantly evolve and gain new information, this analysis takes a written "snapshot" of the information as it existed in August, 2000. The analysis was originally directed primarily towards the Kahler Slater higher education team while being as understandable and usable as possible for others within and beyond the firm; the original report has been reformatted and shortened to the present form.

A primary idea that permeates these issues of spaces, technologies, and trends are that the designs are characterized by specificity in context; the research files consist of highly specific information that is shown within the context of individual projects and/or locations, and the organization of the files puts this specificity into a more usable context within the specifics of higher education architecture. Consequently, the three major issues that the research files and this analysis address are: (1) design recommendations for health- and education-related spaces, (2) the architectural implications of various technologies, and (3) the larger architectural, business, and educational trends which have an effect on designs for higher education.

One must first understand the business, educational, and planning trends that have an effect within the context of higher education in order to transfer them into specific, meaningful, technology-enhanced health- and education-related spaces.

Business and Education at the turn of the 21st Century

Educational facilities are increasingly following financially lucrative fields such as biomedical technology, internet startups and networking, and materials science. Areas of the US that do not seem receptive to new business innovations will have a hard time keeping graduates and attracting businesses towards a good economy, and are in danger of being bypassed as locations for new and expanding companies. In the case of Wisconsin, the state needs to build on the intellectual capital of a major research university (UW-Madison), to extend regional and local technical training and distance education to local and rural businesses, and to change the state's perception as an old, blue collar economy.

Business trends indicate that there will be fewer workers in standard full-time jobs and that traditional white-collar professions may likely decline in the future. Business is becoming less interested in specific skills and more interested in talent; one can be trained in job-specific tasks, but not in being a better thinker or a more creative problem-solver. Highly specialized blue-collar skills will become more important, however, as white-collar jobs lessen in a virtual world.[1]

Additionally, as federal funds and taxpayer support decrease, institutions develop partnerships with corporations for applied research, sponsorships, endorsements, and naming rights. As research grants go to teams rather than individuals, spaces must facilitate team research both within the university and for working with businesses. These extensive partnerships are hailed by some as the educational establishment finally coming to terms with the real world, while others insist that institutions should not "sell out" to business. With tuition increasing more than twice as fast as inflation and nearly one third of students transferring between institutions, universities are turning to market economy and tuition-driven models where tuition is the student's investment, and the campus is key to being marketable.

The proper role of a business in an educational institution is not yet consistently well defined, so a variety of public/private/academic partnerships have begun to flourish independently. The Center for Environmental Sciences and Technology Management in Albany, NY is a public/private/academic partnership as a research center and marketing facility of products, including offices of the National Weather Service. The light, circular rotunda is the gathering spot for the partners, with discussion spaces spreading to adjacent conference rooms and circulation spaces. The Michigan Virtual Automotive College (MVAC) is collaboration between higher education, the state, training providers, and the automotive industry that has internet-based courses.

In the business world, the line between services and products is becoming increasingly vague in an information-based economy. Architecture is expanding far beyond the design process because firms make money by staying involved during the entire life of a building. According to Richard Hobbs, FAIA, the vice president of professional practice for the American Institute of Architects (AIA), "What we're seeing is a shift in the role played by some architects from one that's project-oriented to one that's relationship-oriented…The new paradigm is for architects to serve clients as facilitators and integrators." Architects are now in an information business, providing continued expert advice before and after the design process. Businesses and educational institutions are also faced with becoming "information enterprises," with long-term clients, especially for people in technology areas whose skills become obsolete in only a few years. Thanks to the Internet, the college or university that an teenager selects can be viewed as the lifetime provider of educational services.[2] "Education will go from being benefit driven, like a manufactured product, to value driven, where the importance of an institution is its core values as a lifelong learning partner.

Educational "economics" are changing from labor intensive to capital intensive, from local to national, and from small to large scale production and evaluation, due to the expansion of distance learning and other programs. Although internet opportunities have high startup costs, the internet allows for low marginal costs of distributing educational content. Universities could lose a "local monopoly," and become part of a larger group of "degree-granting bodies," like the DeVry Institutes that teach technology and business without including dormitories or tenured faculty, and the distance-education-based University of Phoenix that gives adults advanced training but has no campus.[3] Ted Marchese, vice president of the American Association for Higher Education (AAHE), describes challenges of educational economics for universities to include threats to continuing education programs, questions about whether to replace existing, home-grown courses with nationally produced courseware, and seeing enrolled students appear in the registrar's office with brand-name Web course credits.[4]

Meanwhile, socioeconomic changes are reflected in the widespread dissolution of the nuclear family, the growing number of elderly people (who often need and want access to educational and health facilities), and the predicted growth of the wealthy and poor sectors while the middle class shrinks. Educational institutions are faced with developing facilities and curriculum that coherently address these demographic groups. In order to deal with demographic implications, funding issues, and competition from online resources, educational institutions may adopt a private sector model, where instead of having "selective" application and turning more students away, they try to let all the students come and become learning customers for life. Colleges don't tell students "goodbye" at graduation, and alumni become the market for distance learning and training options.

The aforementioned business trends that emphasize knowledge and talent over isolated skills have dramatic implications on education. Rather than more technically oriented students, we need, "broad-educated problem solvers who can acquire and apply knowledge in a wide range of ever-changing disciplines. In blunt terms, the Information Age may demand the primacy of the broad-based liberal arts education."[5] In this knowledge-based society, colleges and universities now have the central role to fill as the homes of intellect, knowledge creation, research, and lifelong learning.

Learning Trends: Constructivism, Technology, and Health Care

Current learning theories focus on analysis and application of information rather than the traditional teaching/learning model, with extensive implications for educational facilities. Constructivism, a widely acclaimed learning theory, is based on the innate human desire to make sense of the world through experiences and other methods. Constructivism uses contextualized learning in knowledge acquisition and construction, in contrast with the traditional "behavioralist" approach that uses rote learning and external reinforcement. Learners build procedural knowledge (techniques, skills, abilities) and propositional knowledge (facts, concepts, propositions), as well as dispositions (attitudes, values, interests) to decide if something is worth doing. Students construct knowledge with its usefulness, its functional context, and the social context of the student. Part of this social context is that learning is not just about the individual because the community of learners share a common physical—architectural—context. Learning is most effective using a realistic social and physical context as part of the process. By constructivist standards, "experts" organize information based on patterns, and through experience they amass a rich index of cognitive structures to easily recall and use. This structuring of knowledge parallels educational facility design, where the building is based on a fundamental organization of space patterns, so that the learner can experience spaces as part of the educational process.

Another venue for education, the workplace, has strengths as a learning environment because it has real goal-directed activities and problem solving, access to guidance from experts and co-workers, and intrinsic reinforcement, i.e., getting paid. Constructivist educators and businesspeople advocate that vocational education should change to incorporate approaches other than lectures and other situations that don't build experiential knowledge. Vocational education is also paralleling human resource development as both are tending towards a closer integration with applied learning and workplace preparation as the key to competitiveness and economic progress. The importance of "learning while doing" that is essential for occupational education programs is thus applicable to a vast variety of educational programs and paradigms. Vocational education and technology are getting rid of the distinction and inequality "between working with one's hands and working with one's head."[6] Two-year institutions of higher education are reemerging, serving government, community groups and businesses, working families, and other secondary and post-secondary education institutions. Furthermore, as occupations now require, education is becoming seamless and never-ending without strict phases such as elementary school, secondary school, higher education, and continuing education.

Some radical theorists predict that technology will cause content learning to become obsolete, but in order for educated people to focus on the process of applying knowledge, they must first learn content in an integrated manner, so that curriculum can then deal with constructing meaningful patterns, relationships, and other interdisciplinary links. In this manner, learning will move beyond only mastering content and skills, to incorporate lifelong-learning concepts that require continuous engagement in critical thinking, questioning, and contextual problem solving.

Technology is frequently a political panacea for these larger pedagogical and socioeconomic issues. Voters are encouraged to support educational technology over reducing class size or repairing school buildings, because technology is not just an education issue, but part of preparation for the business world. President Clinton proclaimed that national education policy should include technology so that, "A child would be able to stretch a hand across a keyboard and reach every book ever written, every painting ever painted, and every symphony ever composed."[7] The gadgetry and infrastructure of technology is not a panacea for educational needs, nor will it function without human support. The same researchers that proclaimed that "Interactive multimedia will become the new tool of education…the traditional blackboard will be replaced by text, graphics, sound, animation, full-motion video, and other formats," later found that "old-fashioned methods of learning may be more effective than high-tech simulations…the realism of high-tech simulations does not necessarily or consistently translate into more effective learning and retention."[8] Technology can enhance the learning of those on campus and also reach students at a distance, and can better use faculty and student time, but "technology alone does not teach;"[9] the fundamental issue is still the students' motivation and the teachers' effectiveness. Information technology should be about community and conversation, but it is often used as a glorified workbook and a vehicle for submitting tests. Rather than merely repackaging "talking head" or "chalk and talk" styles of pedagogy, these tools should build real distributed learning communities to discuss and share ideas of real substance. According to Canadian educator Dr. Judith M. Newman, "The way we use technology in education is not the real issue; the important questions are really about curriculum and learning strategies."[10] Since software products and curriculum usages of computers have an inherent bias towards certain assumptions about learning, it is better for technology to be only one facet of the learning process, rather than an end in itself.

Health care education is inextricably linked to communication over distance, particularly in rural areas. Places ranging from the Australian Outback to Appalachian areas of West Virginia and elsewhere are pioneering systems to allow health care professionals to provide help and information without geographic impairment. Health care is interdisciplinary within and beyond medical professions to deal with issues of ergonomics, aesthetics, scientific research, etc.. Health care is moving away from acute illness care to health promotion and disease prevention, away from hospital settings to home and community settings with wider responsibilities. Health care reform is changing the way in which health care is provided and altering the role of allied health professionals, especially nurses. According to Purdue University[11], the continued streamlining of the American health care system is creating more demand for advanced practice nurses, and schools of nursing are answering the call by expanding both on campus and via distance education technology.

Health care education is following larger business trends with growing programs with partnerships, internships and "earn-while-you-learn" positions. As a result, educational opportunities and partnerships that are an attraction to technology companies also appeal to health care institutions. Another current interdisciplinary example is biotechnology, which has developments that are an example of science research fused with clinical medicine and business endeavors, and these partnerships are a new and different situation with which medical professionals will need to become educated.

Planning Makes Perfect (or at least better)

Historically, campus planning focused on laying out designs for which a more perfect institution could be created or expanded in a coherent fashion. While this role remains, the realm of planning is now faced with how to deal with an existing physical context, and continually work to adapt it to evolving programs, functions, and technologies.

Planning is not an event, an office, a resource to sit on a shelf, or a singular task, but rather a teaching and learning process that should result in controlled change, rather than lengthy documents, reports, and committee meetings. This process must be simple and unencumbered by excessive forms, committees, computer printouts, and rhetoric, so that time and energy can be concentrated towards the importance of people and data. The planning process should answer questions of what to achieve, how to accomplish it, and what criteria will measure achievement. The planning process should link facilities and capital plans, and should produce planning tools both for day-to-day activities as well as long-range capital projects, and tools for administrators to govern, monitor, and market the progress. This process is not inherently simple or linear; "…planning for higher education does not work with a "cookbook"-type approach; guiding institutions requires flexible leadership that can perpetually learn and grow."[12]

Traditional master plans tend to define the "destination" by giving a "twenty-year snapshot" expressed through a rendered site plan or a pretty picture of proposed construction without giving the path to achieve the plan. Instead, master planning should emphasize connections with current facilities by being both a viable road map towards future plans as well as a practical, valuable guide for daily decision-making. Dealing with the existing overall context is also important, because approximately 80% of existing buildings will still exist in 20 years, and the plans shouldn't only focus on the other 20%.

Campus architecture should always operate within (and be subservient to) the larger context and environment. (In response to out-of-context designs, it has been said that campus architecture is "too important to be left to architects."[13]) Scale, not style, is the essential element in good campus design, so university leaders must insist that architects design campus facilities on a warm, human scale. Campuses should use a land use policy that addresses ecology, open space, buildings, roads, parking, pedestrian circulation, recreation, athletics, and utility infrastructure. The land use and open spaces can both enhance the environment and provide a coherent link between diverse functions. Outdoor spaces can have a sense of destination as an "outdoor room" as well as being circulation space to pass through. An institution's commitment to specific building projects or renovations does not, however, constitute a commitment to a land use policy. Within the land use policy, there should be a hierarchy of widths of circulation that accommodates necessary equipment, pedestrians, and vehicles without conflicts, and these paths should have a legible sense of direction and signage, particularly for impaired individuals. The pedestrian scale, and way of dealing with precedent, influences whether the campus has an image and feeling of an "academic village" with a unified sense of place, or a small "city" with many isolated places.

The campus image and overall massing need to be addressed carefully because visitors and prospective students often judge a campus based on first impressions. "Most high-school students decide if they like a university or not in 15 seconds,"[14] so the campus architecture and student facilities need to demonstrate attention to detail and commitment to student needs. The community environment, the sense of place at the heart of the campus, and whether the campus looks "traditional" with a park-like setting and fine architecture are all part of the overall ambiance. Besides the campus itself, skillfully edited photographs of the campus and its facilities will serve as the dominant marketing materials. The economics of the institution are improved through the appeal of the campus to prospective students. The physical planning can also deal with social aspects of the campus to improve interpersonal relationships and relationship of the campus to its neighbors with issues of housing, business partnerships, and community involvement.

Facility management becomes increasingly important, as the complex operations of university campus can be modeled by coordinating multiple departments, campuses, and standards for furniture, equipment, technology, and spaces. All of these facility management issues are able to become part of the actual strategic planning process so that quality campus maintenance is seen as part of an institution's image as well as for predicting facility expenses. Operational "life cycle" costs in a master plan include not just expenses for the initial building and daily operation, but also routine and preventative maintenance. Issues during the building's life cycle in the short term will deal with software and hardware, but since these structures are intended to last several decades, issues of infrastructure (power circuits, outlets, wiring, cabling), general cleanliness, and the overall spatial layout will become more important. Thus, the technology itself is not the entire issue; the architecture needs to facilitate long-term needs for flexibility. In terms of facility management for a research-oriented or other science building, there needs to be a body that coordinates use of facility, responds to changes in the research environment, and communicates building maintenance so as not to disrupt sensitive experiments.

Technology will impact campus planning in overall master planning, facility planning, and spatial layout, as well as specific spaces. Technology requires increasingly specialized space, with increased space demand for closets, storage, network infrastructure, utilities, and the information appliances themselves. Current interfaces such as the keyboard and mouse are transitory and will likely evolve or be replaced, but it is dangerous to design with fixed assumptions of the future, such as that ubiquitous wireless technology will eliminate all needs for cabling. Future use and demand for spaces and technology cannot be predicted by extrapolating current uses and trends. Building from effective use of the existing campus technology, new hardware/software should be selected using a defined process for supporting operations and maintenance. Ensure campus-wide technology standardization, balancing standards with individual preferences. Technology should address both instructional and non-instructional needs, such as providing for professional development and training and collegial communication. Furthermore, it is incorrect to consider technology as a capital expense; the acquisition and renewal of technology must be integrated into the operating expenses in order for a facility to remain current.

A planner's most difficult challenge with respect to technology is "future proofing" buildings, but how should you plan "for something that you don't even know about?" What if the future arrives ahead of schedule? One answer is that instead of trying to have the latest gadgets in entirely customized areas, make sure that any construction and renovation is such that the building can be changed again in the future. One facet to remodeling and new construction that needs consideration, however, is the sensitivity of alumni with connections to "the old building that you just can't tear down"; the technology changes need to be subservient to the aesthetic physical environment.

When planning for specific structures, there must be great attention to the programming phase, including an analysis of needs with respect to present and future users. Participants in facilities programming meetings have other responsibilities and primary functions, so their participation should be as easy as possible, with easy access to pertinent data without searching through unneeded materials. Organize elements of the facility program in the written program document concisely; every word should have style and purpose that reflects quality architectural design. Make the information accurate and qualitative, and ensure the information is presented in an organized, concise, prioritized fashion. Programming and other planning processes need to be kept as brief as possible to hold faculty interest and improve enthusiasm.

Common errors that occur in programming (with possible solutions) include a lack of support for the program; stakeholders at the institution need to feel it is "their" document rather than "the architect's." Through workshops and presentations, the process should facilitate communication between administrative, instructional, and support services. Get a top-down approval of key administrators who will be stewards to champion and implement the plan, and make sure that all internal objectives and curriculum goals are clear before planning.

While it is good to involve as many users as possible, including community groups, make sure that there is a small core group of decision makers to allow for coherent leadership. Participants in the larger process should include a building user committee, project team, students, key administrators, trustees, and any other ways of involving stakeholders, but keep deans off of committees, making them instead part of an "executive oversight" group. The client team that works in programming should not try to design the building and be too prescriptive; program statements can deal with what, when, why, and how much, but the "how" needs to be left to the architect.

A common problem is insufficient gross area and inconsistent terminology regarding calculations of circulation space within departments; these need to be defined at the beginning so square footage arguments do not compromise the design. People don't understand square footage except when it's not enough. Administrators tend to focus on cost per square foot as an objective measure, but instructors and students perceive and use the educational space in very different ways independent of raw area.

The architect and clients may have different assumptions that cause incompatible quality goals; have key user groups tour comparable facilities in a range of prices, and clarify wants and needs. Part of this quality issue may be determining the value difference between new construction and reuse/renovation of existing facilities. Also, do not make unfounded assumptions of existing utility, subsurface, and building conditions, as well as site access and scheduling.

A primary issue of programming is that each department may be used to being the exclusive owner and user of large numbers of spaces. New campus facilities will be interdisciplinary, owned by the institution not the department, with diverse, collaborative funding and 24-hour access. Before adding space, use current buildings to the best and highest amount of use. When designing, have clear proposals signed off as to what really belongs to a department and what is considered "shared." For optimum efficiency in new designs, non-hazardous lab functions may be consolidated, and classroom space can become a shared, fluid, flexible resource. This can often be seen in existing centrally scheduled rooms, which have a much higher use/utilization rate than those under departmental control. By designing by function rather than academic discipline, disciplines can be combined even though programmatic spaces (classroom, office, lab, etc.) are more separate. In order to make these shared spaces usable, the physical adjacencies and zoning levels of departments are essential, to ensure that the rooms are situated in a practical fashion for all user groups.

Another departmental issue is unrealistic projected departmental expansion, a so-called

"Garrison Keillor Factor"[15] where all programs are "above average" and have 15-20% growth. Look at the history of program developments, departmental accomplishments, and the resulting faculty sizes at peer institutions to gauge what is realistic. Similarly, programs can reflect projected increases in student enrollment, but the program should aim to affect an increase quality of institution rather than mere number of students.

When attempting to convert curriculum and user needs into programming, educators and architects try to program every part of the built environment. By not designing spaces for spontaneous interaction, conversation, and reflection, planners actually compromise the effectiveness of "programmed" spaces. Gathering spaces need to be a priority in how a facility is organized.[16]

In the future, these changes with flexible, mixed-use programs may allow for vastly different functions to be combined into a new facility. For such a project, funding can be combined and mixed-use spaces can allow for technology-rich spaces, new meeting places for the entire institution, and a location for innovative academic programs. Educational facility planning may expand to incorporate public places with fused-use space to accommodate education, entertainment, training, and other functions into what we now see as fixed-use facilities such as malls, office buildings, and government facilities.

The process of master planning is expanding into the virtual realm, but tangible products are still a necessity. Once the master planning process has provided a framework for implementing change, make hard copies and electronic versions, packaging the information in manner suitable for promotional and fundraising purposes. These planning products will help to make the planning process more fluid and have real impact rather than remaining abstract plans.

Pedagogical Architecture: Spaces and Technologies

The realm of architecture for education is no longer one where the built environment is passive. The environment, described above as an integral part of new learning strategies, must now be part of the process as a teaching and learning tool. "No architect should be permitted to build for academe unless he or she fully appreciates that his or her building is an educational tool."[17] The learning environment should be rich in opportunities to discover, display, and demonstrate education, so that learning is a natural occurrence. The building must match and adapt to the user groups' educational preferences, and facilitate the incorporation of new spaces and technologies. A primary example of literally pedagogical architecture is the Lewis Center for Environmental Studies at Oberlin College by William McDonough and Partners, which demonstrates the sustainable technologies and design principles that are in the curriculum. In less extreme examples, buildings such as the Duke University Levine Science Research Center are designed "to encourage interaction among scientists from across the campus." The concept of "laboratory" or "library" can be extended so that the whole building has a larger role, and is filled with specific, concentrated, functional areas. The ideas of "classroom" and "computer lab" are eschewing their traditional form and needing new, practical, spaces.

Infused throughout these spaces are myriad technologies, whose design and implementation can no longer be considered peripheral to the architecture. Concentrated, technology-enhanced spaces are complemented by distributed areas for wired learning opportunities in the rest of the campus facilities. These technology systems, along with the structure and mechanical systems of the architecture, should contribute towards the experience of learning about technology. While the technological specifications change quickly, their design concepts have a more lasting meaning within the larger educational context.

Audiovisual (AV), visual projection, and other presentation technologies are a field that includes rapid changes in "state of the art" specifications for brightness, resolution, and size, and rapid changes with converging media. These technologies, previously limited to auditoriums and corporate boardrooms, are now becoming commonplace in medical imaging, international meeting facilities, and churches. Slides are becoming obsolete (except for art and architecture lecture situations) as slide images can be converted to computer formats. A document camera is preferred over the overhead projector or slides, because it can read a transparency or an opaque image and transmit it to the computerized projector. Presentation technology is loosely defined; to different faculty members it may mean sophisticated AV equipment, seamless computer interfaces, using video instead of slides, using an overhead projector, or using different colored chalk.

In education situations it is important to differentiate between equipment to deal with incorporation of physical demonstration material requiring video camera/display, versus digital presentations from a computer or other source depending on different teaching strategies. Also, digital technologies often need to function along with quality analog means of display such as chalkboards, and whiteboards. The logistics of presentation technologies can become complex depending on the quantity of media being used within a single lecture. (An example is that within a 50-minute lecture at MIT, media may include nine motorized mechanical chalkboards, video close-ups of experiments, document cameras, overhead projectors, computer animations and internet documents.) Besides knowing what media need projecting, which need to be shown concurrently? Switching systems between several computers or computer and video may be cost-prohibitive. Does the presenter need to be videotaped while the projector is showing images, causing conflicting lighting issues? Will video production facilities for students and/or faculty need to occur in similar places? The placement and aesthetics of projection media will determine how interactive the learning environment feels, and these issues differ for lecture facilities and cooperative learning spaces.

For a video/graphics projector, consider image size, the type of input sources, light output, control, weight, power, cables, and ease of access for maintenance. For projectors, the required brightness (luminous intensity in lumens) is affected by the surrounding ambient light requirements; all facilities need to be able to eliminate natural light when necessary. Besides the lumens of a projector and the ambient light, the lumens per square foot, which is proportional to the inverse square of the distance to the screen, will determine the apparent image brightness.

Rear projection, where the image is projected onto the screen from behind, allows a presenter to walk in front of the image without casting a shadow, and the presenter does not have to look into a bright projector light (a health hazard) when addressing the audience. The image brightness is more intense, allowing more ambient light in the room, but the equipment and maintenance are quite expensive. If there isn't enough depth in a rear projection booth to shoot straight, mirrors are used. A typical rear screen projector is smaller, quieter, and lighter than a long-range front projector, and front-projector lamps are expensive and difficult to change, especially with a sloped floor. If front projection is used, especially for large lecture halls, the screen can be above the height of the presenter. For televisions and monitors, which have screen measurements given diagonally, the size should be more than one diagonal inch per foot from the farthest viewer. The farthest a person should be away from the screen is based on the size of the projected image and the amount of detail needed to be seen: for general viewing, image height equals one-eighth to one-sixth the distance from the screen; for highly detailed inspection, image height equals one-fourth the distance from the screen.

With so many technologies interacting, overall acoustic quality for the spoken voice alongside technologies becomes increasingly important. Depending on the space, the technologies may need to be more subservient to comfortable acoustics that allow for collaboration and discussion without difficulty hearing the presenter. Guidelines for audio and acoustics include consideration of analog and digital formats of audio and video, and where the equipment is accessible and controllable. Sound controls need to be located within the open portion of a room to set volume; lighting and projection can be controlled from a booth. Consider possibilities for multiple control options and locations depending on the presenters, lecturers, etc. needs and preferences, but controls such as touch screens or engraved panels need to be readable in low lighting and very user friendly. Microphones in the ceiling do not work well for teleconferencing, so microphone wiring needs to go to fixtures in the room. Use conduits to separate microphone and audio from power, because power cables may induce buzzing in the microphone signal.

Sound barriers, which control sound by absorbing (insulation, etc.) and reflecting (hard surfaces), can be ruined by even a small hole, so a sound barrier wall needs to extend from floor to roof deck. It does not work to place insulation above the ceiling or extend a wall of insulation up to the deck. To control sound between rooms, equalize the noise level heard from either side of a wall or floor, either by masking the sound or adding "white noise," muzak, etc. to create a consistent sound that becomes unnoticeable and forms a distraction from the noise you're trying to cover up.

In general, when monitors, computers, or audiovisual equipment racks are mounted in casework, they need separate mechanical ventilation or at least air circulation with air holes out to the adjacent room. Equipment racks need to be accessed from the front and back, and should be on wheeled or slide-out racks. Wall-mounted equipment is supported by studs and/or brackets between studs, and the same applies for joists supporting ceiling-mounted equipment. For wall- or floor-mounted interface boxes, there needs to be clarity as to the required depth, connections, size and location of plate, and the finish for interior design. Make sure systems are developed in ways that are practically adaptable to changing communication lines such as copper cable, fiber optic, and other video control systems. Fiber optic capacities which currently approach 50 million bits per second will continue to increase, approaching 1 billion bits per second, facilitating enough bandwidth for increasing video and data demand, but the wiring systems will still need functional ways to be replaced. Consider below-floor-level conduit with wires going through furniture to avoid unsightly or dangerous cables dangling. Projection systems are often facility-dedicated, but some applications may require an integrated mobile solution for multiple videoconferencing capabilities; the AV cart may make a comeback after all.

Auditoriums, including lecture halls and performance spaces, are incorporating these presentation technologies as well as access to information technology networks. The physical environments of past lecture facilities are not conducive to more interactive teaching methods and multiple technologies, but the incorporation of technology should not eliminate traditional, spontaneous teaching formats. For example, if lecture halls have an AV booth that is separate and locked, this can cause difficulties with technologies not being accessible to the instructor in front. If there is an AV booth at the back, make sure one does not need to traverse through the large auditorium space to reach the booth. Furthermore, if the space is tiered, there may be difficulties with moving equipment.

From an acoustic and structural standpoint, make auditoriums “rooms within rooms” to isolate them from noise in the rest of the structure. Sound can be blocked by large partitions with mass or smaller, less massive partitions separated by a large air space. When optimizing acoustics, realize that reverberation time and other information depends greatly on how many people are present, since each person is approximately equivalent to 0.8 square meters of acoustically absorbent material. In general, speech sounds best with less reverberation time, and music sounds best with more reverberation time, but this varies greatly depending on the type of music being performed or played through an audio system, and how varied the uses of the space will be.

Aside from the acoustics of sound traveling directly from the source to the listener, the ceiling shape will determine what quality and quantity of reflected sound waves reach the listener. A flat ceiling will reflect sound waves like a mirror will reflect light, whereas a surface with uneven texture and/or with a wavy shape will tend to scatter waves randomly. A convex ceiling will bounce sounds and scatter the sound around evenly. A domed, or concave, ceiling bounces the sound within it, creating places where the sound is focused; these types of ceilings may create problems.

Sight lines are critical in large rooms like auditoriums. To see over the person in front of you, you must either be seated high enough or be staggered to see between two people. A person typically will be uncomfortable if they have to move their head up more than 30 degrees to see the screen. The maximum viewing angle to the screen, based on seat location in the room, should be 45 degrees. Chalkboards and display panels towards the side of the hall should be angled to improve sight lines. Sloped floors and fixed seating can impede the usage of video cameras for taping lectures and bringing in new demonstration equipment.

If the space has auditorium-style chair seating, this may not include enough space for students and their laptops, etc., but if the space instead has stationary chairs and large tables, there will be a large workspace, but the room will feel isolated and inefficient. One difficulty at the University of Washington Physics and Astronomy Building by Cesar Pelli is that the closer spacing of lecture hall seats has forced changes in educational procedures for examinations.

Hallway entries to lecture facilities (as well as classrooms) should be finished with wood or other touches that echo the interior lecture spaces. It would be helpful to include a transitional “lobby” space to enter a lecture hall for handouts, announcements, and traffic. A good scheme for dealing with high volumes of traffic may include aisles through the seats that start at the floor of the lecture hall, with the addition of secondary aisles along the sides that are partially concealed. For example, at the 10-250 lecture hall at MIT, these aisles are concealed by a pair of diagonal, tall, blank walls that are used as a projection surfaces by lecturers.

A lectern is best located to the left of the audience, since people tend to read from left to right and look back at the presenter after each image. This lectern can be a place to incorporate controls and connections for technology, projection, and lighting, but fixtures at the front of the room should not be too bulky as to make the students and lecturer feel separated. If the presenter has hot lights shining down, there should be the possibility of additional air conditioning. It is good to have a hard surface behind a presenter in a lecture hall if you want to increase the sound directed out to the audience, whereas a soft absorbing surface behind a person will enhance their ability to hear what someone else is saying, such as having a soft surface behind a lobby reception desk.

Especially for smaller facilities, track lighting is good for the front of the room, and recessed lighting is good for "wall wash" light. Overhead lights should be able to be dimmed and return to full brightness quickly for short video clips, etc. during presentations, but exit lights can be a distraction. In lecture facilities, all of the lighting (as well as technology and video inputs) should be controlled at the front by an interface, perhaps integrated into modular presentation tables.

General halls in universities often serve multiple purposes; even in a new facility intended for one department, other campus organizations will want to use the facilities. A facility may need an ability to be functional in settings including humanities discussions and presentations, science lectures, movies, exams, and interactive multimedia presentations. As mentioned above, the teaching styles of professors will likely include several digital and analog technologies within a single lecture, so avoid complex or difficult interfaces for switching media. Within the hall, it may be practical to have larger faculty workstations for colleagues, printer stations for students to produce hard copies of notes, or even coat rooms.

When designing auditorium spaces within the larger context of educational facilities, other adjacent spaces should include considerations for storage, equipment setup, presenter preparation, and catering. Surrounding circulation spaces need to be accessible and efficient to deal with inflow and outflow between classes, but there should be smaller-scaled, more intimate spaces available for informal discussion before and after lectures. One possible way to allow for consolidation of technology spaces while spreading out traffic is to have several lecture halls clustered around centralized AV and storage rooms. Especially with science facilities, the program of lecture and teaching space should be articulated differently from research laboratories, with the interstitial spaces forming a link with the larger community, perhaps as a courtyard or atrium.

Conference room benchmark facilities are often corporate headquarters' meeting rooms. Education institutions often emulate these corporate environments in their meeting and presentation rooms for campus groups and prospective students. Current standards include careful usage of detailed woodwork, wall surfaces, and furnishings, with a wide range of lighting schemes to fit the presentation technologies. "Board-room" configurations of furnishings do not work well for videoconferencing and distance education, so new flexible ways are emerging in which a single wall or truncated corner provides a focal point and location for technology.

Rather than being driven by clunky appliances, new technologies are trying to emulate traditional pen-and-paper or chalkboard/whiteboard usages by providing "smart" surfaces that can read words, drawn images, diagrams, and notes and transmit them to another location for collaboration, client meetings, or a design process. Some of these new technologies are even adopting the name "roomware," alluding to how the entire room is part of the communication and technology apparatus.

As always, though, the delineation between "conference rooms" and other meeting, training, or learning facilities is becoming blurred; the specific use of a conference room is evolving into a general category of smaller presentation spaces that defy classification as merely small auditoriums or technology-rich classrooms. The growing educational trends towards small group project-based learning may cause these small, concentrated spaces to proliferate as a new model for a type of educational and business facility.

Distance learning spaces accommodate education using video technologies that may include 1-way video, 2-way interactive video, satellite-based and/or computer-based teleconferencing, and broadcast and/or cable teleconferencing. Local area networks, fax machines, and other technologies are often needed in these communication-intensive spaces. In distance learning design, parameters are driven by AV requirements, comfort and service to the individual user, and being user-friendly to a technical programmer. Consider the layout of the entire facility in terms of circulation, accessibility, and noise. Keep distance education spaces away from noisy spaces, mechanical rooms, busy streets. Deal with internal room circulation for the instructor to have access into the audience, but minimize disruption of class in session via front and rear doors. Decide how the space will function with respect to local or remote students, and/or whether this facility's characteristics need to match with other existing campus facilities.

Study the customers (faculty and students), and what types of classes, subject matter, and pedagogy are used with existing methods of instruction and/or videoconferencing. Successful students for distance education are often voluntarily seeking further education and career advances, are highly motivated and self-disciplined, and have post-secondary education goals. It is tempting to make technology the key issue, but it is a tool in support of curriculum; research shows that the instructional format itself has little effect on student achievement as long as the delivery technology is appropriate to the content and all participants have access to the same technology. Good videoconferencing professors need new skills and more specialized presentation strategies, and spaces can help to allow for seamless usages of technology and adapt to new learning strategies.

Distance Learning is not a way for schools to save money outright; technology requires more rather than fewer support staff and more professor involvement. Cost factors include technology hardware, transmission expenses, maintenance, telecommunications infrastructure, production, support, and personnel to staff the aforementioned functions.

Include AV with the architecture scheduling process; consider the impact of special technology such as telecommunication, videoconferencing, and other AV and IT systems on other building trades. Installation of AV and telecommunications requires a clean, dust-free environment, so cooperation and proper sequencing is necessary. Delaying AV work allows purchase of more recent equipment because contractors do most work after the bricks and mortar contractors. Delaying AV work has many disadvantages for smaller jobs because occupancy deadlines may be more important than waiting for new equipment. If the AV contractor can work in the schedule with other contractors, the owner can be aware of all costs up front at bid time and conduit or cabling in can be installed easier.

For cameras and displays, decide on placement, size, whether they will be one- or two-way, and if they need capabilities for one or more camera orientations, sending/receiving graphics, or connecting with a document camera. Address possibilities for horizontal and vertical sight lines of the students to displays and cameras, as well as sight lines from the projectors to the screens. Consider possibilities for tiered floors and angled placement of cameras. White boards can be difficult for video transmission depending on lighting schemes, so consider traditional chalkboards as well.

A built-in demonstration bench/table may require an overhead or wall-mounted camera, and the fixed instructors console should be customized with monitor, keyboard, processor, document camera, control panel, cables, plus any other AV equipment. Students' tables should be built-in with modesty panel or full panel front, with wiring for power, voice, data, and shared microphone. For other built-ins, do all custom casework, and have architects, engineers, and AV consultants create designs to show telecommunications wiring.

Distance educational facilities need extensive telecommunications design to develop a passive cabling infrastructure to facilitate changing technology and instruction. This goal is accomplished when cabling environments enable new systems, capacities, and media in a multi-product, multi-vendor environment. Create structured wiring as a flexible, modular system based on standard cable types deployed through the facility in an organized hierarchy of connection, with standardized interfaces for workstations and connections.

Particularly for distance learning spaces, construction documents need to show the enormous amounts of conduits and cables, with section cuts through corridors to coordinate space for cable trays, conduit, ductwork, piping, and equipment from all disciplines. Remodeling projects will require an exhaustive existing field survey. Require the design team to draw an elevation of the teaching/presentation wall with all screens, vertical writing surfaces (dustless marker boards), equipment, device plates, and switches.

For acoustical privacy, identify noise sources and vibrations from mechanical and electrical systems, adjacent rooms, and outdoors. Distance education spaces need a room sound quality NC (noise criterion) 30 rating. As part of this effort, all drain piping should be outside the distance education room envelope, while keeping supply piping and valves away from the ceiling. HVAC (Heating, Ventilation, and Air Conditioning) design should have unobtrusive duct noise, perhaps incorporating duct silencing equipment. The electrical system should ground to one point to avoid noise in electronic signals, and should be connected to emergency backup generators. Lighting systems should use directional, controlled lighting without glare-producing point sources, keeping light on the walls but off the display; if there are any windows, they must have black-out shading to ensure user control. The color temperatures and reflectivity of interior surfaces should work with the needs of the participants and presenter. For example, interior surfaces should be colored in pale pastels, blue, gray, or mauve, but not in skin tones, warm colors, brown or black, or any busy patterns that would interfere with video transmission.

For videoconferencing design, merely "having" video and audio doesn't mean it is good—it must be useable and effective, so verify that audiovisual and telecommunications consultants have experience in distance learning spaces ranging from programming, design, system interfaces, construction administration, and training.

In contrast to programs that enroll large quantities of students, Drake University has chosen to limit enrollment to keep the quality high in distance learning programs. Besides internet and video correspondence, courses are available through the Iowa Communications Network (ICN) Iowa's statewide fiber optic network. This may be the world's first statewide fiber-optic network to connect all public schools, hospitals, libraries, prisons, and the National Guard in a state. This program puts Iowa "in the middle of everywhere" with web-based courses used worldwide. Educators realize that refined teaching methods and electronically delivered interactive courses take time and money to develop properly.

Since 1993, rural aborigine communities in Australia have used videoconferencing as the primary medium for personal and business communications. These systems (using industry-standard PictureTel equipment) can convey hand gestures; most videoconferences are personal or ceremonial in nature. It is important that the subtleties of human communication are not hindered by technology, because learners will reject systems that are not efficient and realistically communicative.

The North Carolina Public Health Training and Information Network (PHTIN) is a government/educational initiative started in 1995 that provides education, training, and information services to the public health work force in North Carolina. Created in response to challenges of future public health practices, PHTIN uses interactive videoconferencing, connecting the UNC School of Public Health in Chapel Hill, the NC department of health and human services, community colleges, hospitals, local health education centers, and the CDC in Atlanta, enabling best practices to be distributed statewide. On a practical level, during one year in 1998-1999, PHTIN's 211 programs had 8783 participants who saved a total of 834,385 travel miles.

The University of California-Davis Health System includes regional and rural telemedicine programs use a videoconferencing system that allows for community service by exporting clinical expertise to rural Northern California clinics and Community Hospital Network affiliates which have a shortage of local physician specialists. Given the interactive nature of videoconferencing, physicians will be able to receive Continuing Medical Education credit for their participation, and administrative videoconferencing allows healthcare professionals to participate in meetings and presentations without traveling to Sacramento.

Science doesn't occur only in the laboratory; there is less clear demarcation between laboratories, classrooms, offices, and public spaces in science teaching facilities. "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 will metamorphose into "learning environments," transitional or contributing spaces," and "utility space."

The location of offices encourages interdisciplinary collaboration and research, and offices need to be in a different space relation to laboratories and classrooms. Especially when the building isn't big enough, avoid a sense of "my office" or "my lab," by bringing together dispersed faculty and/or consolidate disciplines, agencies, etc. Having zones of offices and labs linked by atrium spaces can also bring together people who otherwise wouldn't interact. Site arrangements and using buildings as indoor "streets" faced with visible laboratories and interactive displays can also facilitate interaction between engineering and science students interacting with 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 attached to fixed furniture, so the labs are not forced into a preset modular bay system or pattern, so 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. Often, expensive equipment must 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 makes is good for a learning environment and for some biology experiments, but labs need to be completely darkened for video presentations and experiments that require real control over light.

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