CAMPUS TECHNOLOGY

# Designing the Electronic Classroom

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## The Origin and Development of the Principles of Design

The design principles presented herein have their origin in personal observation of what worked and what did not at literally hundreds of technology-equipped learning spaces at a variety of institutions. I was fortunate to have managed the electronic classroom initiative at the University of Cincinnati from its inception in 1992 through the design of its 165th electronic classroom; my responsibilities included the design and installation oversight of well over 100 completed classrooms, and for a period of time their support. They ranged in size from little 8-seat seminar and conference rooms to our 800-seat flagship auditorium and several distance-learning classrooms as well. My position gave me the opportunity to work closely with faculty, architects, engineers, students, and support staff, all of whom I learned a great deal from in the process of planning and deploying educational technology. The discovery, testing, and rollout of new technologies, such as student response systems and touch screen controls fell happily to me. Half of my job involved the design of the media systems and other learning technologies; the other half was working with architects and engineers to create spaces that promoted interactive learning with those technologies.

A particularly valuable aspect of the job was that it enabled me to see for myself how the learning spaces we built worked out in actual practice. Because I had daily contact with the instructors and students who used them and the staff who supported them I heard first-hand about what worked and what did not. This direct observation and contact were augmented by visits to many other institutions, as well as formal training in facility planning and audiovisual system design. Somewhat fortuitously, my history includes formal education and experience in psychology and various technologies, and many years of teaching at a wide range of levels extending from eighth grade through college and instruction of professionals. Altogether, this background afforded me a unique perspective of how the psychological, pedagogical, and technological factors come together to create highly successful learning spaces.

We built our prototype classroom in 1995, and after a few adjustments, it became our first model and the basis for subsequent improvements. It was received very well and demand quickly fueled an exponential explosion in the number of rooms. It became impossible to observe them all, let alone talk to most users. To garner a deeper and broader understanding of how the rooms were being used, which equipment was important, and what worked and what did not, we developed a rather thorough survey, in which once during each quarter we asked every instructor teaching in every classroom about their usage and experiences. This led to the discovery of previously unknown issues that affected some teachers but not others, often related to their subject matter, teaching style, or other pedagogical considerations. With such a rich source of timely information, we were able to fast-track improvements, trying out new ideas on a small scale, retrofitting existing rooms as needed, and then rolling the improvements into our master design templates which would be used for the next batch of new rooms.

In due time, the things we learned became key elements of the University's new classroom design guidelines, which were eventually codified in a master document that took hundreds of hours over three years to complete.  Its success was due in large part to the depth and breadth of the knowledge and experience of the cross-disciplinary team that created it, which consisted of an academic dean, a campus planner, an architect, the director of renovations, and myself as the educational technology specialist.  When the final document was published and then presented at several conferences, many other institutions across the country and around the world requested copies to use as the basis for their own guidelines.  One indicator of the lasting value of the considerable work invested in creating the new guidelines is that many instructors continue to consider the resultant rooms to be the best they have ever taught in.

## Why Some Classrooms Fail

Most classrooms begin as rectangular subdivisions carved out of a building plan. Audiovisual equipment is added, often much later by an audiovisual contractor who may know the technology but not understand (or have any influence over) many of the elements required to create a good learning space.  The end result is usually a classroom with unnecessary hindrances to learning, which users generally either cannot identify (after all, they are not design experts either); or if they can, tend to believe there is nothing to be done about it.

<u>Major Reasons Classrooms Fail:</u>

- Disregard for the fundamental requirement that everyone can see, hear, and interact with each other and the media), often accompanied by rationalizations, such as “no matter that some seats are outside the viewing zone (where all the information on the screen is legible); the students who care will get there early to get a good seat” -- *even though this guarantees that some students will be shortchanged of the educational opportunity they are paying for and entitled to*.
- Lack of understanding of the synergy of environment, technology, and pedagogy, despite a significant body of research on how people learn and what it takes to support them in that process.
- Inadequate coordination during the remaining design, construction, and commissioning phases.  One example: If an HVAC duct is installed too close to the suspended ceiling in the same spot where a screen housing is to be recessed, the screen will have to either be moved either laterally, which would destroy sightlines,  or downward, which would either in too small an image or the lowering of its bottom edge enough to prevent students in the back rows from seeing the lower portion.  One way or another, visibility is impaired resulting in less learning and more frustration -- almost always needlessly.

**Why Other Classrooms Succeed: the *Student-Centered* Approach to Design**

Since leaving the University of Cincinnati four years ago and founding EduTech Consulting Services, I have attempted to do two things to improve learning space design. The first is to develop a comprehensive set of design guidelines based on observation and experience (from the early days described above to my current consulting practice), which now comprise the *EduTech Guide to Student-Centered Learning Space Design*. The second is to distill a coherent set of simplified interdependent guidelines that, if followed in their entirety, will result in a pretty successful electronic classroom, *most of the time* (there are some caveats). To avoid confusion with other unrelated "rules of thumb," I have dubbed this list *.* It makes certain assumptions that simplify the application of complex issues that are addressed more fully in the *EduTech Guide.* It is essential to understand that while the *Guide* allows much more flexibility without compromising the integrity of the result, it is absolutely necessary to follow all of *Montgomery's 12 Rules of Thumb.* You cannot pick and choose and then expect the outcome to be successful.

What is unique to the guidelines and accounts for their success is the *student-centered* approach on which they are based. Our philosophy at EduTech is that the learning environment design must first and foremost work for the student from the outset, rather than as an afterthought. Our first, fundamental, requirement is that every student must be able to *see, hear, and interact* with the instructor, other students, and the media. As obvious as this may seem, most classrooms fail to deliver on one or more of these essential elements simply because the A/E (architectural and/or engineering) firm does not understand what it takes to create an effective learning space, especially with technology. Sadly, they do not know that they do not know.

In our *student-centered* approach, we begin by imagining what it is like to be a student in an open space with no boundaries, and then apply principles of human perception, behavior, and ergonomics. We use this information to determine what is needed to meet the first, fundamental, requirement (i.e., everyone must be able to see, hear, and interact...).

Let us take an example: it is a psychophysical fact that the healthy human eye's ability to distinguish detail is limited to an arc of 30 seconds (half a degree); legibility thus depends upon the viewing distance and the size of the smallest element of interest, such as a fragment of a letter of text. This ability to resolve detail is also affected by the angle from which the image is viewed, both horizontally and vertically, with the result that one's ability to read text and comprehend imagery accurately, quickly, and without fatigue decreases as the viewer moves off the center axis of the screen. In addition, off-axis viewing beyond certain limits may cause considerable discomfort or even musculoskeletal injury. Taken together, these factors drive the shape and dimensions of the acceptable viewing area and thus the location and number of seats.

There are additional requirements to be able to see clearly. Even assuming there is appropriate coordination of screen and seating area, what our student sees is compromised by ambient light spilling onto the screen and washing out the image. It may come from lights left on for safety or note taking, light leaking from windows and door sidelights, and even light from the projected image reflecting off the screen and bouncing around the walls and ceiling, and finally back onto the screen. It all adds up to fill in the darker parts of the image, hiding shadow detail, and thus denying the student visual information that may be important to understanding the lesson. Poor contrast also causes eyestrain, fatigue, and frustration though its sufferers rarely understand what is causing it

This washout is quantifiable and, fortunately, can be avoided through coordination of lighting, window treatments, and audiovisual system design. In technical terms, washout equates to a low contrast ratio, which for our purposes is the measure of the light falling on the screen taken where the projector is brightest (projector+ambient) compared to the measure taken where it is darkest (ambient alone). These values can be predicted during the design process and measured in the field with an inexpensive light meter. For most educational purposes, the contrast ratio needs to be at least 10:1, meaning that the projector must produce an image at least ten times brighter than the ambient light falling on the screen. Typical acceptable values for, say a 4000-lumen (lm) classroom projector costing around $1500, might be 55 foot-candles (fc) projected+ambient and 5 fc ambient alone (about 55:5 = 11:1). But if the lighting, window treatment, screen surface, and room finishes have not been designed with this goal in mind, the ambient light may easily reach 25 fc or more. There is an undying myth that you do not need to turn the room lights off with today's brighter projectors. Though not may suffice for some material (say, PowerPoint with large high-contrast text and graphics with little detail), the fact is that it is nearly impossible to bring the contrast ratio up to the needed 10:1. In our example, the problem is that although the increase in ambient light from the room lights (rising from 5 to 25 fc) is a "mere" 20 fc, adding 20 fc to the projector's 55 fc output (by switching to a marginally brighter 5500 lm projector) is hardly sufficient. To bring the contrast ratio up even to 10:1 will take 10x25, or 250 fc. This will require a projector five times brighter than the original 4000 lm unit, or 20,000 lm! Such a device may easily cost $20,000, not to mention the cost of constructing a custom soundproof enclosure with an auxiliary ventilation system. Lighting control and projector brightness make a good example of interdependent elements of design and illustrates what can happen when rules are applied in isolation.

## Conclusion

The creation of a successful learning space depends upon coordinated implementation of a coherent set of design guidelines that are *student-centered* and function together to meet fundamental requirements (e.g., that every student must be able to see, hear, and interact with each other, the instructor, and the media/technology). As much as teaching techniques and learning styles may change and cause the guidelines to evolve to accommodate them, the fundamental principles themselves remain unchanged. *Montgomery's 12 Rules of Thumb* are derived from and follow the same principles as the comprehensive *EduTech Guide to Student-Centered Learning Space Design,* and

provide
a simplified set of instructions that, if followed in their entirety, will produce a successful learning space (in most cases; caveats will be explained in the presentation).

Next Steps

EduTech is continuing the development of the *Guide,* with particular attention to the impact of new technologies, new teaching techniques, and alternative learning styles. To encompass these interrelationships, we are developing a new model that views the *teaching-learning-technology complex* as a single system*.*