

The knowledge economy is ushering in new attitudes about teaching and learning. As a result, different kinds of furniture are being specified for the classroom. These are more flexible and comfortable and do more to accommodate technology and information. Furniture also now plays a role in making learning environments more fun and dynamic, even more inspirational.

The Impact of Changes in Teaching and Learning on Furniture and the Learning Environment

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Context for Design

Furniture is both tool and environment. As with every artifact, it is designed and built with a purpose in mind. It is no different for learning environments. Until recently these were built to enable a teacher to deliver a message to a large group, which sat in silence, dutifully listening and taking notes. Rooms were rectangular or wedge-shaped, and the focus—and attention—was directed to the front where the instructor exercised complete control of the pace, content and sequence of activities. Teaching varied little, so the furniture was optimized and bolted in place.

This educational system suited the industrial economy. It matched the economic, social, technological and demographic needs of the times. A literate and competent workforce was provided for hierarchical and centrally controlled organizations. This workforce contributed to an unprecedented period of growth and prosperity in the industrialized countries. Despite the research of Maria Montessori and John Dewey about better ways to teach, "stand and deliver" remained the dominant design for all educational environments—from young child to seasoned executive.

Today, the industrial economy is history. In his groundbreaking books *Future Shock* (1970) and *The Third Wave* (1980), Alvin Toffler was one of the first to popularize the notion that our economy—and hence our lives, work and behavior—was undergoing tremendous change. The industrial economy has given way to the knowledge economy. Economic power no longer resides in land, natural resources or capital, but in knowledge, networks and relationships. Over 59% of the workforce is knowledge workers, that is, knowledge and information are the raw material *and* product of our efforts (Stewart, 1997). But *all* work has a strong knowledge component. Witness autonomous teams of factory workers deciding about product improvements.

Successful leaders realize they need learning organizations. Successful educators realize they need to prepare a different breed of citizen. In a sense, work needs to become more like school, where learning is an expected part of the job. And conversely, school needs to become more like work anticipating the kinds of skills and knowledge students will require for a happy and successful life. Work activity, or pedagogy in the case of education, has changed drastically. New methods require new tools and environments. Since furniture is a tool with a specific function, it too must change.

Pedagogical Shift

Much has been written about how teaching methods are changing. The change is driven in large part by economic need. However, other contributing factors include improved understanding of cognition (Gardner, 1983; Reber, 1993), attitudes regarding the nature of knowledge (Davenport & Prusak, 1998; Gardner, 1999), the role of context in learning and behavior (Brown & Duguid, 1997; Suchman, 1987), and the importance of social learning (Ormrod, 1998; Wenger, 1999)—just to name a few. This research and its impact is too vast to review in depth here, but has been summarized in Table 1. This table addresses the shift taking place in education today.

Table 1. Emerging Paradigm of Teaching and Learning

<u>From an Industrial Economy</u>	<u>To a Knowledge Economy</u>
passive learners	active learners
directed learning.....	facilitated learning
knowledge revealed	knowledge discovered
explicit knowledge	explicit and tacit
knowledge is discrete.....	knowledge is embedded
single assessments.....	multiple assessments
single intelligence	multiple intelligences
instructor technology	ubiquitous technology
alone.....	alone and together
just in case.....	just in time
content.....	content and process
linear and planned.....	planned and chaotic

The tenets of the emerging model are not new, but our circumstances have changed. The industrial era begot an educational environment that has been in place since the late 1800's. That era passed years ago, but we struggle to shake free of its legacy. It is time to move on.

User-Centered Design

Any designer worth her salt takes into account the needs and wishes of her intended audience. The human factors profession made a science of this in the 1940's, and in Europe the ergonomics community goes back even further in history. More recently, "user-centered" design has gained popularity. The essence of the idea is that the needs of the end user should constantly drive design. When it comes to furniture, we need be concerned with two kinds of users—instructors and learners. Instructors include teachers, professors and trainers, and learners include children, teens, adults or employees.

Most furniture design focuses on *functional* need, such as flexibility, mobility and wire management. It focuses on helping the user achieve a goal, be it relaxation, entertainment, educational or work related. In a user-centered approach, functionality is just one of at least four dimensions to consider. Another design objective is

comfort, safety and health. The design should maintain if not promote well-being and quality of life. No design should be harmful. A third dimension is *usability*. The intended purpose and operation should be obvious to all users, hopefully with little or no training. The intention is to prevent accidents and optimize use. And fourth, the design should have *psychological appeal*. The user should feel motivated to use the design over and over again.

Unlike Maslow, this is not a hierarchy of needs. They are not additive but multiplicative—poor performance on one undermines the performance of the overall system. Furniture must address all four simultaneously or the efficacy of the design is in question. As described by Duke (1998), researchers tend to focus on one or two areas. In practice, all must be present.

Implications of User-Centered Design on Furniture

All four dimensions are important to furniture design, but that is not the total story. The best solution is one in which furniture, architecture and technology are designed to work seamlessly and harmoniously. McVey (1996) provides an excellent overview of how these three come together. In the following, however, the focus will be on furniture.

Comfort, safety and health: The intent of addressing comfort, safety and health needs is to promote well-being and minimize distractions. The new pedagogy listed in Table 1 has actually improved classroom ergonomics. The “stand and deliver” method required uninterrupted sitting for long periods. This can result in drowsiness and muscle fatigue, especially in un-upholstered, non-articulating chairs. No *static* posture is good. The more engaging process on the right of Table 1 typically requires students to be more active physically and mentally, eliminating static postures.

Even when we sit, we should still be able to move. Chairs that have a flexible back are preferred because they allow greater occupant movement and positioning. The tension in the back should be adjustable to accommodate the large and small user. Upholstery with adequate foam—usually in excess of one-inch thickness—will reduce pressure points on the back, buttocks and legs. A waterfall front seat edge is better for circulation and comfort. A seat height adjustment range of 16 to 21 inches is available on many chairs. Other recommendations on chair dimensions can be found in the 1988 American National Standards Institute guideline, which is still the best available on the subject.

Regarding tables, a fixed height of 28.5 inches provides the best universal surface. It can be used for writing, drawing, computer use or collaboration. Fixed height tables are simpler, less expensive and align when nested side-by-side.

For dedicated computer tables, an adjustable height table should be considered. Three factors contribute to the need for adjustability: task duration, posture static-“ness”, and availability of an adjustable height chair. The longer the task and the more static the posture, the greater the need is for adjustability. An adjustable height chair often will obviate the need. Adjustable keyboard shelves may also be considered.

Tables and chairs get most of the attention because people sit and lean on them. But cupboards, carts, shelves, audiovisual units and display screens also have to be carefully designed. All mobile elements should be on casters and lockable casters may be appropriate for tables and carts. Flooring is a consideration because casters for

carpet are different than those for hard surfaces. Even with casters, some units may be too heavy to move around. AV cabinets may have a high center of gravity and may be prone to tipping over if care is not taken.

Usability. Clarity, ease of use, access and control are all part of usability. A product may be tremendously functional and wonderfully ergonomic, but if it is not usable, if users do not understand how it works, then it is a failure. They need to understand its operation and feel empowered to use it.

Usability can be achieved in several ways. The best is to follow industry standards or common practice. (For example, “rightie-tightie, leftie-loosie”, the [P R N D L] on an automatic transmission) If none exists, the design should be intuitively obvious. This is problematic due to the diversity of cultures and experience in our society. Few things are “obvious” to everyone. A third course is to provide labels or instructions with the product. Fourth is training. Especially with furniture, a quick demonstration is often all that is needed.

Unfortunately, there is little standardization in furniture controls. The operation/location of levers, buttons and knobs vary within as well as between manufacturers. Labels and trial and error often overcome this provided users are encouraged to try things out. Experience shows that instructors and students take the room “as is”, rarely moving tables or even adjusting seat height. Making the functions easier, providing training/orientation and posting suggested room layouts all help people make better use of the environment.

Psychological appeal. Learning is a social process and is often informal. It is no longer about showing up at a specified time and place, but about being at the right place at the right time. Networking and relationships are key to learning. Thus, more than ever, the environment must serve as a magnet, drawing in people. When people feel comfortable and valued they will come, stay, and return. Learning communities will result.

The space predisposes people to certain kinds of behavior. A fixed, “eyes forward” arrangement says the environment is one for listening, not interaction. Furniture on casters indicates that the room is reconfigurable. Chairs that are adjustable convey a concern for the user and his comfort. Tables arranged in clusters, facing one another suggest collaboration. Table size and shape also have an impact. People can sit on all sides and collaborate at a table that is 30 or more inches deep. Not so at an 18 inch table. Round and curvilinear tables also promote collaboration.

The fit and finish of furnishings also convey a message. Boardrooms, with their leather chairs and polished mahogany tables, certainly say something about the users. Dull, institutional and otherwise ugly furnishings do not motivate people to stay. Nicely appointed furnishings convey a message of trust and respect that is reciprocal between owner and visitor.

Functionality. The user-centered design criterion that gets the most attention is functionality. Furniture should help the instructor and student achieve their goals using the methods and tools of their choice. Furniture should facilitate learning, not just be a place to sit. To support the emerging paradigm listed in Table 1, the architecture, furniture and technology must be integrated to provide the capabilities shown in Table 2.

Table 2. New Learning Environment Capabilities

Fold-n-go. Users—instructors and students—need to be able to quickly and easily reconfigure rooms from lecture to small group and back again. The unused equipment needs to be easily put away.

Plug-n-play. Access to technology needs to be provided for students as well as instructors. Power and data connections should be ubiquitous, no hugging the walls for connectivity. “Plugging in” may be physical or wireless.

Say-n-see. Instructors and students need to be able to present, modify, record and retrieve information within the classroom. Electronic and non-electronic presentation needs to be massively supported.

Relate-n-reflect. Student collaboration—from dyads up to groups of 15 or more—needs to be supported. But so does solitary concentration. Somewhere within the environment, both must be available.

Inspire the intellect. Motivation plays a major part in learning. Environments that are fun, energetic and enjoyable will yield better learning opportunities.

Fold-n-go. Simply pushing unused furniture to the side does not work, it is messy and it wastes space. It is better if the furniture folds, compresses or is designed to store. Casters generally work better, but lightweight construction may allow stacking. Square footage per student needs to increase from the 12 to 15 common in dense-pack classrooms, to 22 to 25 square feet or higher. The floor needs to be flat, no terraces or platforms.

Plug-n-play. Instructors typically get all the technology, but now students need it too. Until wireless connectivity becomes ubiquitous, table height access is best for laptops. Ports/duplexes can be mounted in the table or provided in freestanding posts. Floor boxes are less convenient but workable. Laptops are small, but still require more worksurface per student—30 inches wide by 24 deep minimum. Most tablet arm chairs and student desks are too small for laptops, but can be made to work if books and notes are not required.

Pending advancements in battery and wireless technology, designers will be hard pressed to simultaneously provide both fold-n-go and plug-n-play. In the meantime, table-based modular data and power are available. With the proper building infrastructure, this allows facility managers to reconfigure and power-up tables in 30 minutes or less.

Say-n-see. Instructors are always provided with the tools to present information. Increasingly, students need this ability too, especially for small group sessions. During lectures, students take notes, writing on pads on a horizontal surface. With teams, the notes are large and vertical, so everyone can see. Teams share knowledge, create ideas and solve problems. Their activities need to be recorded, displayed and retrieved. Mobile display boards and computer projectors allow groups to take notes in the middle of the room rather than along a wall. They also serve as a visual barrier between groups. Students may wish to remove tables and simply gather their chairs around the board.

Relate-n-reflect. Collaboration is the biggest pedagogical factor driving change in classroom design. It is why rooms are becoming larger and more flexible. It is the chief reason for the shift from desks to tables. With tables, students can face one another and documents and materials can be shared. Trapezoidal and other non-

rectangular shapes enable different kinds of spatial arrangements for collaboration. Chairs without tablets are more flexible and generally more comfortable.

But some of our best learning, achieving those “a ha” experiences, occurs during periods of solitude and quiet. Privacy is usually provided by the architecture, being remote or by background noise. Mobile easels, lightweight screens or cabinetry can also provide privacy, at least visually.

Inspire the intellect. In user-centered design, psychological appeal addresses the user’s emotional reaction to a product. In learning environments, this not only makes users feel good, it has the functional benefit of improving learning. Environments can create a more relaxed, sociable setting by including lounge seating, sofas, standing height tables and coffee tables. A Starbucks-like atmosphere is more conducive to networking and informal learning than a typical classroom.

The user-centered approach suggests that design is multidimensional. While functional requirements are usually the most pressing and challenging, all issues must be incorporated into the design.

An Experimental Case

User-centered design principles were put to use in a study of college accounting classes (Cornell and Martin, 1999). The experiment was driven by the faculty’s desire for more in-class collaboration and visual display. Student desks were replaced with 20 x 60 inch tables and lightweight chairs. Mobile easels provided additional markerboard surface. A cart housed a computer and document camera while another held an overhead projector. Information could be displayed in three ways simultaneously—projector, overhead and markerboard. Twelve professors taught fourteen different classes. Video ethnography recorded behavior and surveys and focus groups provided student and faculty feedback. Time-lapse video recorded a full semester, and four surveys were administered.

Students found the furniture to be more comfortable than the desks and were observed to assume a variety of postures. Student and faculty made use of the flexibility, but the frequency varied considerably between faculty members. Two preferred lecture format and had students arrange it for them in advance. Others created large aisles, U-shaped layouts and small group clusters. They would then “work the room”, getting out among the students rather than remaining on stage. This improved student interaction and engagement. Instructors were often observed using two or three of the displays, but for different purposes. The computer projector displayed the prepared lecture notes, the overhead often showed the schedule and the markerboard was used in answering questions. The layout of the space when students arrived had a bearing on their participation. In lecture format, students appeared to get set for listening. In cluster layout, students arrived and started conversations.

This study is significant in several ways. First, all four aspects of user-centered design were assessed. Second, professors varied significantly in how they want to teach, supporting the need for flexibility. Third, what was taught had a strong bearing on how it was taught. For example, the class on accounting standards is mostly memorization so student collaboration is not helpful. Fourth, different display mediums lend themselves to different uses. All serve a purpose. And finally, the environment had an unpredictable impact on behavior. Professors had not anticipated the “working the room” and multi-display behavior. As a result of this experience, several said they were going to experiment even further in the following semester.

Breaking Patterns

In addition to field research, insight can also be gleaned from the actions of leading institutions and organizations that are creating knowledge age learning environments.

Take, for example, the Massachusetts Institute of Technology's Department of Aeronautics and Astronautics. They discovered their graduates took a long time to "come up to speed" once hired. After considerable study, MIT determined it needed to change the curriculum to be more like work and less like college. With a new emphasis on corporate-sponsored project-based learning, they realized the classroom building was inadequate. They remodeled, creating more project rooms and informal meeting areas, a large project studio and new lab space. They also made the space more open, replacing solid walls with glass. This enabled students to participate vicariously in other projects. It also aided in informal communication.

The inspiring story of Bill Strickland and the Manchester Craftsmen's Guild provides an excellent example of how the environment sets the tone for the entire learning experience. Located in Pittsburgh, Manchester's target audience is high school students who have been unsuccessful in school. Despite their often troubled past, they are treated with respect and dignity, and much is expected in return. Most not only graduate but go on to very successful careers. There is much to be said about the program and its philosophy, but of interest here is the use of the environment. Office furniture is used in place of standard high school desks. This provides a comfort advantage, but more importantly to Strickland, conveys a professional look that students respond to. Their demeanor and performance is more professional as a result.

Aquinas College's Masters of Management program is directed at professionals seeking an advanced degree. One of the benefits is it enables employees from different companies to collaborate and work together on neutral ground. The classroom building that housed the program did not support this behavior, and most students remained on-site only during class. A renovation was an opportunity to create team and communal spaces, including a "piazza" in the center with social and eating areas. In the classrooms, stacking chairs were replaced with more comfortable office chairs. Student tables were replaced with occasional tables, many of which had power and data ports.

Corporate learning centers also leverage space. At Arthur Andersen's Center for Professional Development, all new employees attend a three-week training regimen. The corporate processes, procedures and tools are acquired, but just as important, so is the corporate culture. Most spaces are reconfigurable to support lectures, small group, individual study, simulation and computer labs. Much of the furniture can fold, nest or stack for quick reconfiguration and compact storage. To facilitate knowledge transfer, the areas are made to look like workspaces and customer offices. What is the outcome of this attention to detail? When the newly trained employee finally reports to the office, she already has a worldwide network of Andersen colleagues—her fellow "boot camp" attendees. And this occurs after just three weeks.

Boeing faced a challenge when it merged with McDonnell-Douglas—there were two cultures and two management teams spread throughout North America. They established the Boeing Leadership Center to develop a new class of leaders. A mix of spaces provides a variety of settings conducive to teaching, talking and socializing.

Some areas are formal while others are almost residential. But none look like a typical office. The intent is to provide a setting for the leadership of the company to learn and network, and to create a new culture.

The Steelcase University Learning Center is a resource for the company and its dealers. A variety of spaces support formal and informal learning, lecture and collaboration, teamwork and solitary study, quiet and noisy areas, and high and low-tech. These are provided in sufficient number to allow visitors to select what is best for them. With the exception of technology hubs, users can move all elements. Technology access is within the length of a patch cord everywhere in the building except the cafeteria. The result is a highly dynamic, energized space that serves as a hub for the organization.

The Role of Furniture in Knowledge Age Learning Environments

While the purpose of a learning environment is unchanged, nothing else remains the same. Society needs citizens who are not just literate, but have the ability to continuously learn and grow. Companies need workers who are skilled at research, interpersonal skills, technology and adaptation. Teaching methods now emphasize more collaboration, computer use and social learning. Learners need to be treated as individuals, with their needs, strengths and weaknesses accounted for within the curriculum. At the root of all these is our economic march towards the knowledge age.

To accommodate these changes the physical environment needs to be bigger, more flexible, provide ubiquitous access to technology, promote interaction and a sense of community, enable formal and informal learning, and convey a sense of energy. The environment should be a place people want to be, not a place they have to be. They should be motivated by fun and enjoyment as much as by a desire to learn.

For its part, furniture needs to be more: comfortable, adjustable, intuitive, reconfigurable, technology-capable, compressible, and attractive. When its design incorporates ergonomics, usability and functionality, furniture will help teachers and students achieve their learning objectives. Being user-centered will enhance the overall experience. In the knowledge economy, where learning is not only continuous but also more informal and serendipitous, anything that makes the experience more positive will also increase learning. If properly leveraged, furniture is more than a place to sit; it can be a strategic asset.

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