MODULAR AND MOBILE, SUSTAINABLE AND AFFORDABLE

The Challenge of Implementing Universal Design

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Abstract
Universal design has been called the new design paradigm for the 21st Century. On a global basis, from universal design guidelines and standards to case study examples and information technology, there is growing evidence of the acceptance of and activity in universal design. Universal design and technology are closely interconnected through the actual performance of building parts, systems and entire assemblies of spaces, as well as facilities. This paper discusses two major, emerging questions: First, can the concept of universal design be applied to different cultures without losing its validity in attempting to accommodate most people (for example, space standards for the same functions in housing vary significantly across cultures). Second, while universal design criteria have been well developed at the level of product and home design, this cannot be said for a range of common building types. In other words, implementing the lofty ideals implied in the Principles of Universal Design remains a daunting task and research agenda for years to come. A Universal Design Evaluation (UDE) process model is proposed, which permits testing of design concepts and solutions from a technological and building occupant perspective.

Introduction

Various definitions for universal design have been offered, including that by the Center for Universal Design (Story, 2001). The meaning of "universal" in this context is to make products and environments usable by a majority of people, regardless of gender, disability and health, ethnicity and race, size, or other characteristics (Mace, Hardie and Place, 1991).

Could it be that "universal design" is an oxymoron? Stephen Kurtz (1976) observed in "Nothing Works Best:" " . . . the designer is faced with a multitude of groups, often conflicting, who do not share common educational or class values, and who have little experience in major decision making."

Previous attempts at designing environments for all to use did not necessarily meet with success: the Usonian house, designed by Frank Lloyd Wright in the 1950s was to make affordable housing accessible to everybody. As it turned out, it was not very affordable and barely habitable, with the kitchen and bedrooms the size of closets.

What features should universally designed houses or public transportation systems have in an age when mass-produced products can be individualized by seemingly endless choices? On one hand, current car production techniques demonstrate that the consumer is king and the same production line can assemble cars with seemingly limitless variations. Feedback, feedforward and control are the watch words (Preiser, 2001) in a world of changing paradigms (Petzinger, 1999) in which information and knowledge is the new currency.

On the other hand, in the U.S. housing market banks dictate the features and sizes a house must have in order to be resalable, individual choices and variations are minimized, and the "cookie cutter" approach to housing design is pervasive. The result is that only a tiny minority of houses are designed by architects, and almost none are accessible from a universal design perspective.

Implementing Universal Design in the Cross-Cultural Context

How universal is universal? In a homogenistic community and culture it may be possible to define and describe cultural norms and expectations, as far as products, spaces and buildings are concerned. However, in a world that is getting ever more diverse and globalized, the question has to be asked whether any one standard or set of criteria can universally meet everybody's expectations and needs.

Serious issues of relativity and establishing priorities in universal design arise when dealing with different cultural contexts. Not only do space, lighting and other standards vary considerably across cultures in identical types of environments, such as housing, but economic conditions, technological developments, and culture-specific customs and patterns of space utilization add to the complexity of this question.

The seven Principles of Universal Design, as developed by the Center for Universal Design (1997), constitute ideals that need to be operationalized for use in the real world and in everyday design situations. Some products, such as "Mr. Good Grips" kitchen utensils by Oxo and scissors by Fiskars, have been developed to meet universal design needs. Much less has been done to accomplish this goal in everyday environments, such as homes, offices, schools, public transportation facilities, and so on. Despite the fact that universally designed homes are available (Young and Pace, 2001), there is continuing resistance in the design professions and the building industry to adopt the new paradigm, and to incorporate universal design criteria into home design. The fact that even in the

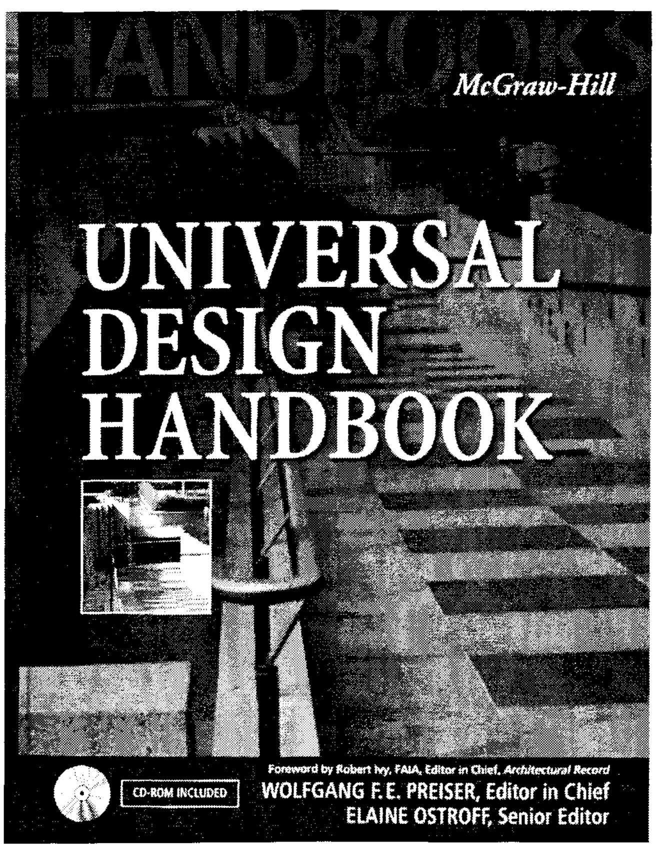

Fig. 1. Universal Design Handbook.

21st Century, virtually no universally accessible homes are being built is very discouraging, indeed.

While there are a number of building types and case studies in the Universal Design Handbook (Preiser and Ostroff, 2001;see Figure 1), which can serve as examples to be emulated, the only realistic hope to see Universal design operationalized and implemented is through three strategies:

1. Short-term: carry out evaluations of existing facilities, using the Universal Design Evaluation (UDE) process model outlined below;
2. Medium-term: carry out programming projects for future facilities by incorporating universal design criteria from the start, and by integrating them with existing standard building performance criteria;
3. Long-term: universal design education – infuse universal design into design curricula as a required subject matter, in hopes that ultimately, professionals will practice what they have been taught. This is where the ACSA and architecture schools can play an invaluable role in the years to come.

Universal Design Performance

The goal of universal design is to achieve universal design performance of designs. A philosophical base and a set of objectives are the seven Principles of Universal Design referred to above, with these characteristics in mind:

- They define the degree of fit between individuals or groups and their environments, both natural and built.
- They refer to the attributes of products or environments that are perceived to support or impede human activity.
- They imply the objective of minimizing adverse effects of environments, on their users, such as discomfort, stress, distraction, inefficiency, and sickness, as well as injury and death through accidents, radiation, toxic substances, and so forth.
- They constitute not absolute, but relative concepts, subject to different interpretations in different cultures and economies, as well as temporal and social contexts. Thus, they may be perceived differently over time by those who interact with the same facility

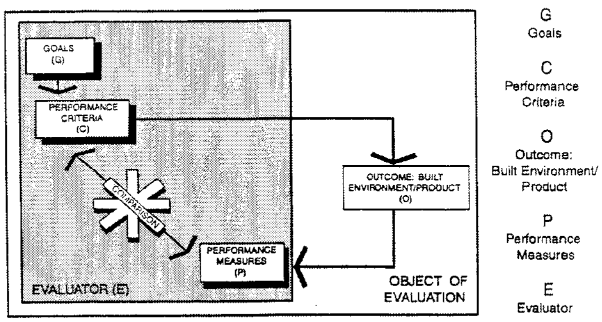

Fig. 2. Performance Evaluation Framework

or building, such as occupants, management, maintenance personnel, and visitors.

The conceptual framework of universal design evaluation (UDE) is based on consumer feedback-driven, evolutionary evaluation process models developed by the author; i.e., Post-Occupancy Evaluation, or POE (Preiser, Rabinowitz and White, 1988), and Building Performance Evaluation, or BPE (Preiser and Schramm, 1997). The nature of basic feedback systems was discussed by von Foerster (1985): the evaluator makes comparisons between the outcomes (O), which are actually sensed or experienced, the expressed goals (G), and expected performance criteria (C), which are usually documented in the functional program and made explicit through performance specifications. Von Foerster observed that " ... cybernetic systems require a motor interpretation of a sensory signal" and, further, "the intellectual revolution brought about by cybernetics was simply to add to a 'machine,' which was essentially a motoric power system or a sensor that can 'see' what the machine or organism is doing, and, if necessary, initiate corrections of its actions when going astray." The evolutionary feedback process in building delivery is shown in Figure 2. The motor driving such a system is the programmer, designer, or evaluator who is charged with the responsibility of ensuring that buildings meet state-of-the-art performance criteria (Preiser, 1991).

The environmental design and building delivery process is goal oriented. It can be represented by a basic system model with the ultimate goal of achieving universal design performance criteria. It has the following characteristics and elements:

- The universal design performance framework conceptually links the overall client goals (G), namely those of achieving environmental quality, with the elements in the system that are described in the following items.
- Performance evaluation criteria (C) are derived from the client's goals (G), standards, and state-of-the-art criteria for a building type. Universal design performance is tested or evaluated against these criteria by comparing them with the actual performance (P).
- The evaluator (E) moves the system and refers to such activities as planning, programming, designing, constructing, activating, occupying, and evaluating an environment or building.
- The outcome (O) represents the objective, physically measurable characteristics of the environment or building under evaluation; e.g., its physical dimensions, lighting levels, and thermal performance. By definition, all elements inside the box or shaded area (G, C, E, and P) are relativistic and subject to change over time.
- The actual performance (P) refers to the performance as observed, measured and perceived by those occupying or assessing an environment, including the subjective responses of occupants, and objective measures of the environment.

Performance Levels

Building performance can be structured into three performance levels pertaining to user needs, as outlined below. With reference to these levels, goals might include safety; adequate space and spatial relationships of functionally related areas; privacy; sensory stimulation; or, aesthetic appeal. For a number of subgoals, performance levels may interact and also conflict with each other, requiring resolution.

Framework elements include products-buildings-settings, building occupants, and their needs. The physical environment is dealt with on a setting-by-setting basis. Framework elements are considered in groupings from smaller to larger scales or numbers, or from lower to higher levels of abstraction, respectively.

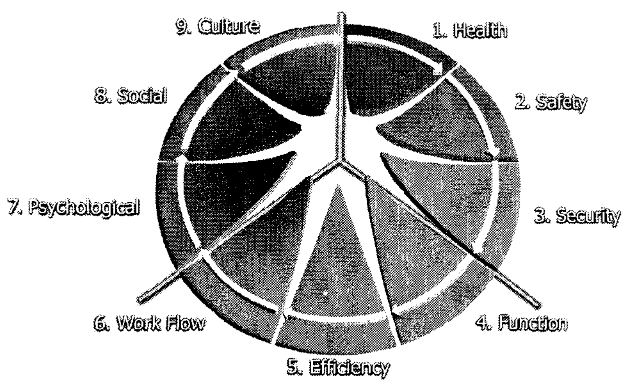

Fig. 3. Evolving Performance Criteria.

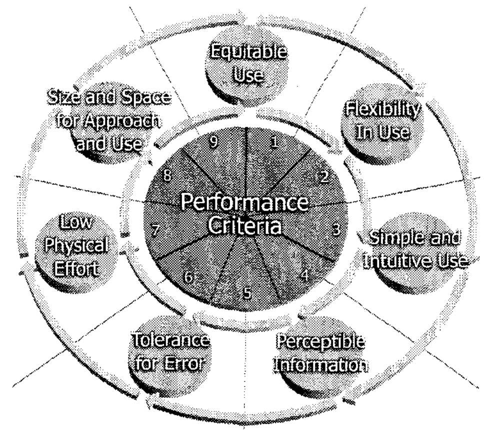

Fig. 4. Universal Design versus Performance Criteria.

For each setting and occupant group, respective performance levels of pertinent sensory environments and quality performance criteria are required; e.g., for the acoustic, luminous, gustatory, olfactory, visual, tactile, thermal, and gravitational environments. Also relevant is the effect of radiation on the health and well-being of people, from both short- and long-term perspectives.

As indicated above, occupant needs versus the built environment are construed as performance levels. Grossly analogous to the human needs hierarchy (Maslow, 1948) of self-actualization, love, esteem, safety, and physiological needs, a three-level breakdown of performance levels reflects occupant needs in the physical environment. This breakdown also parallels three basic levels of performance requirements for buildings (i.e., firmness, commodity, delight), which the Roman architect Vitruvius (1960) had pronounced over 2,000 years ago.

The above historic constructs, which order occupant needs into hierarchies of priorities, were transformed and synthesized into the Habitability Framework (Preiser, 1983) by devising these three levels of priority with nine performance elements:

Level 1 Health, safety, and, security performance;

Level 2 Functional, efficiency, and, work flow performance; and,

Level 3 Psychological/social, cultural, and aesthetic performance.

The three performance levels correlate with codes, standards and guidelines designers can use. Level 1 pertains to building codes, and life safety standards projects must comply with. Level 2 refers to the state-of-the-art knowledge about products, building types, and so forth, exemplified by agency-specific design guides or reference works, such as Time-Saver Standards: Architectural Design Data (Watson, et al., 1997). Level 3 pertains to research-based design guidelines, which are less codified but nevertheless of importance for building designers and occupants alike.

The relationships and correspondence between the Habitability Framework and the Principles of Universal Design devised by the Center for Universal Design (1997) are shown in Figures 3 and 4.

In summary, the framework presented here systematically relates buildings and settings to building occupants and their respective needs vis a vis the product or the environment. It represents a

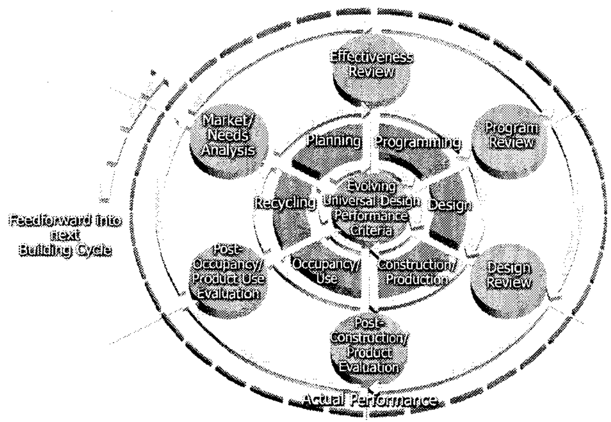

Fig. 5. Universal Design Evaluation Process Model.

conceptual, process-oriented approach that accommodates relational concepts to applications in any type of building or environment. This framework can be used to permit stepwise handling of information concerning person-environment relationships.

Universal Design Evaluation: A Process Model

The book Building Evaluation Techniques (Baird, et al., 1996) showcased a variety of building evaluation techniques, many of which would lend themselves to adaptation for purposes of UDE. In that same volume, this author (Preiser, 1996) presented a chapter on a three-day POE training workshop and prototype testing after one year of occupancy, which involved both the facility planners/ designers and the building occupants. A proposed UDE process model is shown in Figure 5.

Major benefits and uses are well known and include, when applied to UDE, the following:

- Identify problems and develop universal design solutions.
- Learn about the impact of practice on universal design and on building occupants in general.
- Develop guidelines for enhanced universal design concepts and features in products, buildings, urban infrastructure, and information technology.
- Create greater awareness in the public of successes and failures in universal design.

It is critical to formalize and document the expected performance of facilities in terms of universal design in the form of qualitative criteria and quantitative guidelines and standards.

Strategies for Universal Design Evaluation

It is customary to include Americans with Disabilities Act (ADA) standards for accessible design as part of a routine evaluation of

Fig. 6. Entrance Without Step or Threshold.

facilities. The ADA standards provide information on compliance with prescriptive technical standards, but say nothing about performance – how the building or setting actually works for a range of users. According to Story (2001), the Principles of Universal Design constitute an occupant need-oriented set of performance criteria and guidelines. Data gathering methods typically include interviews, surveys, direct observation, photography, and the in-depth case study approach, among others.

It is suggested that in order to advance the state-of-the-art case study examples of different building types should be carried out, with a focus on universal design. These case studies will be structured in a standardized way, including videotaped walk-throughs of different facility types, and with various user types. The universal design critiques would focus on the three levels of performance referred to above.

An example of a UDE on a residential design prior to construction is shown in Figures 6 and 7. While the resulting universal design performance was particularly helpful to the home owners, both of whom had severe disabilities, both assistive technology and/or modified standard details played an important part in the design solutions, for instance:

- Zero threshold entrance with seals in entrance door preventing water seepage.
- Slide-out drawers and adjustable heights in kitchen cabinetry.
- Sunken floor drain for roll-in shower.
- Overall, open floorplan with wider hallways, a minimum of doors, and low pile, commercial grade carpeting or hardwood flooring.

Other UDE examples are currently under development through the Rehabilitation Engineering and Research Center at the State University of New York at Buffalo. One study focuses on wheelchair users; another, on existing buildings throughout the United States. Its Web site explains that research in more detail (*www.ap.buffalo.edu*).

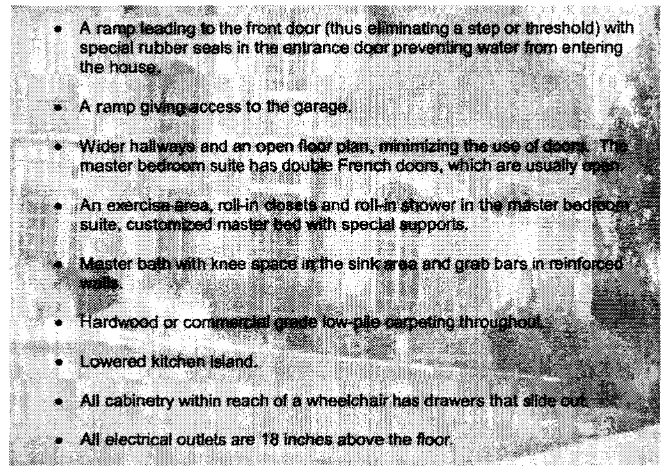

Fig. 7. Summary of Residential Universal Design Features.

Furthermore, methodologically appropriate ways of gathering data from populations with different levels of literacy and education (Preiser and Schramm, 2002) are expected to be devised. It is hypothesized that through these methodologies, culturally and contextually relevant universal design criteria will be developed over time. This argument is eloquently presented by Balaram (2001) when discussing universal design in the context of an industrializing nation, such as India.

The role of the user as "user/expert" (Ostroff, 2001) should also be analyzed carefully. The process of user involvement is often cited as central to successful universal design, but has not been systematically evaluated.

Conclusions

For universal design to become viable and truly integrated into the building delivery cycle of mainstream architecture and the construction industry, it will be critical to have all future students in these fields familiarized with universal design, on one hand, and to demonstrate to practicing professionals the viability of the concept through a range of UDEs, including exemplary case study examples, on the other.

Now, since the "performance concept" and universal design criteria are made explicit and scrutinized through UDEs, they have become an accepted part of a good design by moving from primarily subjective, experience-based evaluations to more objective evaluations based on explicitly stated universal design performance requirements in buildings. This includes assistive technology and materials which meet the Principles of Universal Design.

Critical in the notion of universal design criteria is the focus on the quality of the built environment as perceived by its occupants. In other words, building performance is seen to be critical beyond aspects of energy conservation, life-cycle costing, and the functionality of buildings: it focuses on users' perceptions of buildings.

Evaluations have become more cost-effective due to the fact that shortcut methods have been devised that allow the researcher or evaluator to obtain valid and useful information in a much shorter time frame than was previously possible. Thus, the cost of staffing evaluation efforts, plus other expenses have been considerably reduced, making UDEs affordable.

Acknowledgments

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