Aging Research, Design Education, and the Perceptual Limits in Seniors Housing Design: Development of a Research-Based Design Model for Better Aging Environments

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Abstract

A growing body of research suggests that aging and decline are two separate processes. A reframing also has been moving through the medical, psychological, and specialized sensory research communities in studies of the relationship between sensory and cognitive activity and decline. We now know the extent of sensory decline in aging, yet companies are building and renovating facilities that don't employ either the research on perceptual decline or formal standards for improving the perceptual aspects of facility design. Over the past four years, Orfield Laboratories and the Architectural Research Consortium have instituted a research program in aging perception and performance that has developed building performance standards for seniors housing architecture and design. Intuitive attempts by the design community to understand the knowledge base and experience of aging perception have been unsuccessful. By adding a research-based design program to the design process, these definitional problems can be overcome. The result is generally a far better performing building constructed for the same total cost, with design focused more on the user than on the façade.

Introduction

For many years, there has been a growing body of research that suggests that aging and decline are two separate processes (Sale, Berardi, & Maffei, 2012).

While some decline is thought to be normal in aging, the variability associated with decline has resulted in many investigations of the influence of certain aspects of aging life on decline. The results of these investigations are beginning to bring together the findings of many fields in support of a newer view of aging. This has been clear in the seniors housing field with the emergence of the household model of familial nursing homes, which has now been in practice for more than 20 years in a small segment of the nursing home industry. Retraining of nursing home staffs to move from an institutional model to a familial model is beginning to be more broadly considered as well.

The changes have prompted a movement in architecture to downsize the scale of the aging resident's experience to approximate prior experiences in non-institutional living. This reframing also has been moving through the medical and psychological research communities and the specialized sensory research communities in studies of the relationship between sensory and cognitive activity and sensory and cognitive decline. Recent findings in the neuropsychology field suggest that when visual, aural, and cognitive connections to the environment decline due to disability or other causes, parallel declines occur in the brain (visual, auditory, cognitive declines). Even more recent studies suggest that due to brain plasticity, reversals of some of these losses are possible via specific therapeutic training that can be employed with aging populations, as well as surgical interventions such as lens implants for visual diseases with attendant increases in physical, adaptation, and neurological improvement (Fine, Smallman, Doyle, & MacLeod, 2002).

We are entering a more hopeful age in terms of understanding how lifestyle can mediate, reduce, and reverse some aging-related decline. Typical declines in aging become severe to many in their 80s and 90s, and while those of us in the aging research and seniors housing field have a significant part to play, we are building and renovating facilities right now that don't employ either the research on perceptual decline or formal standards for improving the perceptual aspects of facility design. Our recent work in creating perceptual standards for aging design is suggesting a radically new view of design for aging that has the potential for reducing perceptual declines and supporting the stabilization and reversal of some of these declines.

Design

Orfield Laboratories (OL) is a 42-year-old architectural and product design, research, and testing lab in Minneapolis. In architecture, the lab has been developing design standards for more than 35 years for building performance in architecture (daylighting, lighting, acoustics, thermal comfort, and indoor air quality). OL also has been developing and administering occupancy studies for much of this time. These standards as well as occupancy quality consulting have been used to design commercial environments in many building types in commercial architecture. In each building type, the standards relate to two user experience issues. First, the building needs to be perceptually comfortable for its users (building performance). Second, the building needs to have "design resonance" for its users. This means that the user needs to have a positive user experience that is reinforced by the aesthetic and user experience design of the spaces. Thus, we must apply building performance science to provide comfortable environments, and we must use quantitative subjective measurement science, not opinion-based methods, to define user feelings, associations, and preferences.

In the product development field, "user experience" is a well-known concept among major firms, but in architecture, user experience consulting is not formally used in the design of buildings, as architectural education seldom teaches user measurement

and benchmarking. (While the user is often lightly involved with the design process, there is the practice of programming and design charettes, the latter being a method of gathering user opinions in a focus group context.) Architects aren't trained to understand that opinions are not user measurements and have little predictive validity.

In the pursuit of what is known as research-based design (often referred to in the medical field as evidence-based design), we have employed two well-established tools: instrumentation measurement of building performance and quantitative subjective measurement of the user's response to perceptual models of the proposed environment.

Research

In 2009 OL founded the Architectural Research Consortium (ARC), the nation's first research-based design architectural collaboration (currently, 21 architectural firms collaborate across the U.S.). Over the past four years, OL and ARC have instituted a research program in aging perception and performance, based on a 90-year-old cohort, in a four-part program to develop building performance standards for seniors housing architecture and design:

- in-depth discussions with major national nonprofits and their associated experts
- review of medical and psychological research on perception and aging, as well as personal discussions reviewing research with many top aging researchers
- review of the field in collaboration with academic programs associated with aging, on referral from the aging nonprofits and researchers
- conversion of research into architectural engineering metrics that can be directly applied to the normal design process in renovations or new buildings

Perceptual Research and Knowledge Transfer

As we entered into detailed discussions with many of the top researchers in perception, we found a great deal of useful information to better understand aging perception. These researchers were collaborative in explaining their research and discussing its implications, but the research was specialized and was, like most research, not in a language and form that the public or the design field could easily find useful. So as we told the researchers about our efforts, we invited them to get involved in our process of defining standards and working with aging residents and facilities. Most declined and told us that their interest was research, not application. This response, which we have experienced in many areas of research, is one of the reasons why research often does not find its way into design education or practice, and this is one of the reasons for the development of "technology transfer" departments at many major universities; unless the architect or designer has been educated in specific research areas, there is no common ground for translation, assimilation, and use of research-based knowledge in design.

Aging Perception and Architectural Education

It has long been known that older populations have perceptual deficits that come with aging, and there is much research in the medical and psychological fields that attempts to define typical age-related ranges of performance in each of the areas of perception. Yet, there are some overwhelming structural reasons why the design of aging facilities, as with most facilities, has not taken science into account:

- Architects and designers, for the most part, do not have a professional background in scientific research related to buildings. As we have founded and administered national design research collaborations for 16 years, it is clear that this is true even with the largest of design firms that talk openly about research.
- Architects are educated in the use of intuition in design. Expert Intuition, a concept supported by the American Institute of Architects, suggests that design training teaches the architect a sufficient level of intuitive problem solving, and

that this is the method of design engagement. There is little scientific support for the use of intuitive expertise by creative professions as a method of defining needs accurately. Yet, architectural education supports this as a definitional method without regard to the architect's research knowledge of the specialized field of a particular building type (medical, aging, etc.).

- Those who are interested in science in design often have little training in reviewing research or in converting this research into quantitative design definitions or metrics.
- The evidence-based design movement in architecture has had the intent of bringing science into architecture, but it has had little success, due in part to the fact the architecture does not often employ or use a range of research experts. Some of the best-known evidence-based design organizations in the U.S. often release publications written by academics with no specific topic expertise in the areas in which they are writing. And many firms who claim that they do research admit privately that this is usually nothing more than reading design articles to get new ideas that can be employed.
- Most architects and designers leave building performance design to mechanical and electrical engineering consultants. Yet, most architectural engineers, who actually design the building systems, have not been trained in building performance science or engineering, and they often know little more about measurement and research in perception than the architects and designers they serve. Their engineering is often more focused on energy use and technology cost.
- Over the past few decades, architectural engineering has moved from a profession that models and calculates design solutions to a profession that often looks to the vending community for their engineering process and design, but the vending community is unlikely to provide performance metrics that can be used to benchmark the performance of their free design and advice. (And, of course, many aging projects do not employ an engineering team for building system design, only mechanical and electrical contractors. Surprisingly, this also is often true in hospital design, another area where older populations are a primary market.)

The Consequences of Design Based on Expert Intuition

While research in aging is a very rich field, the intuitive attempt by the design community to understand the knowledge base and experience of aging perception is often a failure, as intuition is not a substitute for knowledge. Intuition is usefully practiced in thinking about relationships within a base of knowledge with which one is highly familiar. Aging perception is not such a field. Thus, attempting to understand the experience of aging perception via discussions with providers and older residents is a task that is destined for failure—it is like attempting surgery after interviewing a series of surgeons. The problems in aging facilities' design that arise from this practice are broad and deep, some of which include:

- In lighting design, while the architect may well be aware of the concept of visual deficits and the need for more lighting, there is little knowledge of the fact that lighting level (illuminance) is far less important than lighting glare (luminance). As a result, when lighting is increased in seniors housing in hopes of making the environment clearer for the elders, often the result is lower visual performance (less visibility). At age 90, visual acuity is often in the range of 20:100 to 20:150. A reading of 20:200 is the normal benchmark for legal blindness. Thus, aging vision is often very low in resolution. There is little understanding that the color and gloss of finishes can dramatically reduce the problems of visual clarity for older residents. This same elder population is often hundreds of times more visually disabled by glare, has poor color vision, has poor stereopsis (3-D vision), has narrowing

peripheral vision, and often may have specific visual diseases that add to this burden, including macular degeneration, glaucoma, diabetic retinopathy, etc.

- In acoustic design, an intuitive awareness of hearing difficulties is often dealt with by specifying the use of carpet. What's needed is acoustically modeling the space for reverberation, background noise, and other aural interference. The result of intuitive design is usually not beneficial. At age 90, reverberant spaces and background noise have a large impact, and the majority of this population does not have correct hearing instruments, as most medical plans do not pay for them. A large portion of understanding of speech is accomplished by lip reading, which is reduced by the environmental glare and darkness so often found in aging residences.
- In thermal comfort design, it is assumed that older residents need warmer environments, but thermal comfort theory and calculations are essentially unknown. If they were, designers would understand that thermal comfort differences in aging are partially accounted for by the thermal insulation value of clothing (the CLO) and the metabolic rate of the resident (the MET). They do not understand that the conflict between the thermal comfort of residents and staff can be at least partially compensated for by using those variables to bring the two populations' thermal comfort into equilibrium.
- In daylighting design, most facilities have small amounts of daylight, often for the stated reason that daylight can cause glare. But there is little understanding that glare is partially a function of luminance ratios in the field of view that are too extreme (a bright window in a dark room), and that visual adaptation is far more difficult unless the design systematically deals with balanced interior brightness and glare shielding, both of which can be computer modeled. Designers often don't know that the failure to get sufficient daylighting reduces production of vitamin D and melatonin, thereby reducing the ability to sleep and causing significant restlessness in dementia and Alzheimer's residents. Daylighting also can have other health benefits, such as blood pressure reduction (Weller, 2013).
- In heating and cooling (HVAC) design, there often are clear goals for temperature control, but indoor air quality is seldom adequately dealt with. It is not well known that the percentage of fresh air in a facility is not a function of fresh air intake but is rather a function of how much of what is taken into the lungs is fresh air. Often, the HVAC system takes in sufficient levels of fresh air, but the air supply and air return diffusers (vents) do not sufficiently include the resident in their path. And although there are requirements in most building codes for fresh air for residents, there are no site measurements normally required. In situ measurements often have confirmed limited fresh air, finding that when the fans cycle on, the CO_2 values don't change as they would with fresh air infusions.

In all these areas, there is much research available from professional societies about the consequences of not designing to specific performance standards.[1]

Communication Between Designers and Clients

In order for a designer and a client to work together, there needs to be a common language shared by both, and this common language must include language that is useful in solving the major problems that are the focus of their collaboration. Architecture depends heavily on a visual and metaphorical language that most clients do not understand. It is often a poetic and reassuring language, and it often carries meaningful emotional and intentional messages.

[1] Professional societies with relevant background performance research include the American Society for Heating, Refrigerating and Air Conditioning Engineering - ASHRAE (HVAC), Acoustical Society of America - ASA (Acoustics and Hearing), Illuminating Engineering Society of North America - IESNA (Lighting, Daylighting, and Vision).

It is not a language shared between the client and designer. Architecture is not alone in this problem; most specialties have this same problem of communicating in different languages, with neither side letting on that they don't understand the other.

There is a further problem in aging design; neither the client nor the architect has personal experience in what the older resident perceives. Thus, the client and designer are not only talking in a different conceptual framework, but the assumption of shared understanding breaks down under the weight of lack of expert knowledge on either side. It is similar to what takes place in office workplace design discussions: The architect and the client share a motivation to talk about the relationship between design and productivity, but neither side realizes that most office work tasks are far too undefined for measurement of productivity to be possible, as one cannot measure what one cannot define with reasonable precision.

The Bridge Between Design and Perception—Experiential Immersion

This problem of common language has always been a core issue in our practice, and when we designed a new headquarters for architectural and product consulting in 1991, we were determined to bridge it. Our set of conclusions was so simple as to be obvious from the moment that we focused on them. Our experience in writing technical and research reports and making design recommendations inherently had the classic design problem: no common language with the client. So, as we planned to move to our new building, we decided that we would move toward an experiential practice. And a practice mantra followed this move toward experiential education and the decision to leave the formality of science in the background when dealing with clients and their design teams.

First, we had to speak in the common language of the client and avoid specialized language (our fields contain many specialized languages). Anything less was a failure to communicate. It also may be an indication of too little knowledge and the use of language to obfuscate rather than to clarify. Second, we had to be able to construct real or simulated experiences that would allow the client to move through education, not didactically but experientially. We did not want clients to have to believe explanations; we wanted them to experience the concepts and self-educate. The result of this was the design of our Acoustic Simulation Lab, Visual Performance Lab, Open Office Lab, and other experiential simulations labs and computer simulations of many of these phenomena. This was followed later by incorporating the perceptual simulation software that came on the market over the following decade.

As we faced the problems of understanding design for aging, we found ourselves in the most difficult range of design communication in architecture, and we began to develop an experiential basis for this communication. Our educational process in this set of communications became the ARC Immersion Session, a four- to five-hour process of bringing clients through the understanding of design research via the perceptual experiences of older residents. This process of immersion has been the basis of our ARC members and their clients' ability to decide that they want to engage in research. With little knowledge of research upon arrival at our labs, the majority of design-client teams who visit make the decision to use research-based design by the end of the first visit.

During the Immersion Session, we use examples to demonstrate that research-based design, with its overlay of additional practices added to the standard design process, can be done in ways that add nothing to the total cost (fees and construction) of a building. While a building with set performance targets and definitions is always more successful for the user, it is also often less costly than a building designed based on "going shopping" for technology (rather than performance) solutions with vendors. Thus, we change the priority of projects toward a focus on the user and the interior and reduce the cost of overly expensive façades and non-user areas. We do spend more

money on our areas of user focus, but we save that by reducing the costs of non-user areas and façades. As I've shared in many seminars, in 40 years of consulting, I've never seen a dissatisfied client walk outside their building, look up at the façade and say, "Now I understand." Façade design is often important for marketing and branding purposes, but the solution to user experience problems is usually on the inside. Good architects can design successful façades less expensively in order to more strongly support better user experiences for these aging populations.

Process And Results

With an awareness of the failure of many aging facilities to solve the perceptual problems of the older population, we must begin to reexamine the whole context of elder living. In this process, we must become aware that one of the main reasons for elder deterioration is the deterioration in the structure of the life of elders. Their perceptual clarity is often dramatically reduced, and their cognitive function slows. Their social life is reduced, their physical activity is lowered, and their perception of self-worth is in decline for good reasons. In the field of elder housing, there is often a failure to look at the matrix of quality of life issues and to understand that decline in elders is a logical consequence of many declines and withdrawals from full participation in life. This includes decline in their quality of experience, perception, activity, and social life.

Those of us in the seniors housing field can deal directly with perceptual clarity and therefore increase the ability to deal with these other deficits with a research-based design program. Research-based design normally functions on the basis of a design structure for a new or renovated facility that includes:

- market research and measurement of elder facilities perceived to be high in quality
- preoccupancy studies of a baseline client facility via building performance measures as well as subjective measures of the user population
- building performance standards development so that the environment will be perceptually clear and comfortable for the elders
- perceptual visual juries to measure evoked feelings and associations related to the proposed design options
- building performance consulting to ensure that quantitative standards are modeled and met before construction (most architects and engineers need consulting help to engineer or measure at this complex level)
- performance commissioning to confirm that building performance standards are met
- post-occupancy studies to confirm perceptual comfort and user satisfaction, to be benchmarked against the preoccupancy studies that were completed earlier

Case Studies

Two ongoing projects have accepted this process with the commitment of their management and design teams that their budgets (design and construction) will not increase due to research-based design. (For our last ARC project, the client saved many times the research costs, so the budget was significantly reduced.)

Western Home Communities, Iowa. We are working with Western Home Communities (WHC), a 100-year-old nonprofit nursing care organization in Iowa, in the design of four household-style nursing care facilities for 15 residents each, two for memory care and two for non-memory care. WHC's design firm, AHTS Architects (an ARC member), decided to suggest research-based design to their client after an immersion visit to our laboratory. The CEO of WHC, Kris Hanson, went through this immersion with his design firm and supported his design firm's recommendations to take on a research-based design process.

WHC's nursing home project is intended to include the design of a research-based aging lab setting in public areas for observation of the benefits of environmental change (via controls on many perceptual variables) and therapeutic change. This facility also is planning a multisensory environment

to be used for experiential immersion and therapy for residents, as well as reminiscence immersion, remote training, and teleconferencing. This project has gone through preoccupancy studies as well as building performance measures on the existing building. Currently, it is near the end of schematic design, with design development and construction documents following. WHC will break ground on this project in fall 2013.

In addition, we are consulting with WHC and AHTS on an eight-story high-rise seniors housing project targeted for 55+ seniors but designed for the perceptual performance of 90 year olds. This is designed so that as the residents start to age into their late 70s and beyond, the housing unit that they occupied when they had fewer perceptual problems will suit many of them into their 90s, as perceptual performance reduces significantly. This is essentially the opposite of many seniors housing projects, which emulate condominium design, with its darker colors, high-glare lighting, and high levels of noise and reverberation.

Fair Haven—Methodist Homes, Alabama. We are also working with Methodist Homes of Alabama and Northwest Florida, one of the largest nonprofit nursing care organizations in the Southeast, and their designer/developer, Action Pact. This project includes the redesign of an existing campus and the addition of a 10-story high-rise central complex to tie the campus together, and to add a series of community amenities such as theaters, restaurants, and doctors and dental clinics. This project is an effort to renovate eight existing freestanding buildings, based on household design concepts, and to overlay the ARC building performance standards on all these facilities to adapt to elder standards for acoustics, lighting, daylighting, thermal comfort, and indoor air quality. The new 10-story tower will contain additional elder care facilities and will tie the existing campus together with a concourse that runs through the main and second floors of the new building, offering private and employee dining, conference rooms, clinics, a business center, coffee bistro, post office, restaurant, theater, salon and barber shop, learning center, and billiards lounge. Each of these ancillary facilities will be designed with the same perceptual standards as the residence spaces, providing a cohesive community where social involvement will adapt to the population rather than create perceptual stress and difficult visual and aural communication in the public areas.

Methodist Homes and Action Pact have the intention of integrating the physical, financial, cultural, and operational elements of this project in the form of futuristic models that are designed and operated so that elders and the people who serve them will flourish.

Conclusion

Both of the aforementioned facilities will have a radically different level of perceptual clarity as well as user preference, and they will be validated by pre- and post-occupancy studies and measures of buildings and residents. These concepts and practices, comprised in a presentation titled "Universal Design: Research from Senior Design and Related Fields" were presented in an ARC conference at Orfield Labs in fall 2012. The concepts were again presented at a conference in Orlando on May 2, 2013, in a presentation titled "Innovations in Aging Environments," organized by the Florida Council on Aging. Sponsors included Florida Blue, in partnership with the Florida Association of Aging Services Providers; Florida Health Care Association; AARP Florida; Walgreens; Chapters Health System; Leading Age Florida; Florida Department of Elder Affairs; Gresham Smith Architects; and the Architectural Research Consortium. (Margaret Lynn Duggar of Margaret Lynn Duggar and Associates, and Sue Maxwell, system director of gerontology at Lee Memorial Health System, the largest medical system in Florida, were the local organizers of this conference.)

Orfield Labs is in the process of developing standards for buildings for the autism spectrum disorder community as well as for other communities living

with perceptual disabilities.

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