Teaching Today's Students to Build Tomorrow's Universally Designed Society

Carolyn Ahmer

Department of Civil Engineering, Bergen University College, Bergen NO-5020, Norway

Abstract: The Convention on the Rights of Persons with Disabilities defines the term universal design as the design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. This paper attempts to highlight the importance of universal design as a core element in the training of architects and engineers. It emphasizes the need for students to take an interdisciplinary, comprehensive, and analytic approach to universal design through degree courses in these fields. An interdisciplinary teaching program for universal design as part of an introductory course for first-year students at Bergen University College in Norway, illustrates one possible strategy for raising awareness of universal design and for improving interaction across disciplines. In this context, the paper discusses the relevance of the seven principles of universal design as guidelines for the built environment. It also emphasizes why universal design should be an integral part of established subjects rather than be classified as a separate subject in a bachelor's or master's degree program.

Key words: Universal design, built environment, policy, interdisciplinary, education.

1. Introduction

“About 80 million people living in the European Union have a mild to severe disability and the obstacles they often face as they participate in urban life can reduce their access to parks, town halls, libraries, online services, buses, trams and other civic amenities. These barriers mean disabled people find it harder to be fully part of society” [1].

A range of international documents have highlighted that disability is a human rights issue. The Convention on the Rights of Persons with Disabilities outlines the civil, cultural, political, social and economic rights of persons with functional impairment. The convention defines universal design as the design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design [2].

The terms “Design for All” and “Inclusive Design”

are also used to describe this concept, which incorporates a stronger focus on equality than is implied in the concept of accessibility for people with reduced functionality. By addressing the needs of people with reduced functionality in terms of movement, vision, hearing, comprehension, and environmental conditions (asthma/allergies), products and physical environments became more widely usable by everyone. In this context, universal design is understood as a common term for all work processes involved in shaping the physical environment. This encompasses community planning, land use, architecture, construction activity and product development.

Universal design has become widely recognized and applied in political documents, statutory frameworks and technical guidelines. However, The World Health Organization's first world report on disability ascribes the gap between creating an institutional and policy framework and enforcing it to various factors, including limited research and the lack of a disability awareness component in the training curricula for planners, architects and

Corresponding author: Carolyn Ahmer, associate professor, research fields: architecture, spatial planning and cultural heritage. E-mail: cah@hib.no.

construction engineers [3].

This paper attempts to highlight the importance of universal design as a core element in the training of architects and engineers. It emphasizes the need for students to take an interdisciplinary, comprehensive, and analytic approach to universal design through degree courses in these fields. In this context, the paper discusses the relevance of the seven principles of universal design as guidelines for the built environment. It emphasizes why universal design should be an integral part of established subjects, rather than be classified as a separate subject in a bachelor's or master's degree. An interdisciplinary teaching program for universal design as part of an introductory course for first-year students at Bergen University College in Norway illustrates one possible strategy for raising awareness of universal design and for improving interaction across disciplines. It is the understanding of universal design as a fundamental human right that will make future generations of planners, architects and engineers lead the way towards a universally designed society.

2. Equality in Different Settings

Historically, the lack of knowledge about human needs has resulted in exclusionary or discriminatory environments. In the age of humanism, architectural principles were influenced by Vitruvius' proportional system, which revolved around the notion of a perfectly built man (Fig. 1).

The need to develop appropriate design tools was something that concerned many leading representatives of the modernist movement in architecture. The most notable attempt to resolve this issue was devised by Le Corbusier. The Modulor, which patented in 1947, comprises two numbered series in a geometric progression based on the golden ratio and a figure of a male body measuring 183 cm in height. The Modulor was intended as a universal system of standardized dimensioning of all types of mass-produced objects. The modernist city would be

open and green, and buildings would rise up as independent yet uniform structures from a kind of park environment in between the concrete and tarmac surfaces of the streets. However, the planning ideals of the modernist movement have since proven to be unsustainable and an obstacle to basic psychological functions such as orientation and identification.

Densification has been a planning goal in Norway since the 1990s. The focus has shifted away from the car as the primary design consideration in favor of vulnerable road users; from open and spread-out urban areas in favor of to densely built and more intimate cities; and from cities based on zoning and segregation in favor of mixed-use neighborhoods.

Streets and squares should once again serve as natural meeting places. Universal design plays a supplementary part in this attempt to create an inclusive society in which everyone can participate on broadly the same terms. The ideas behind universal design are based on the empirical fact that solutions intended for the normative body represent unsuitable or useless solutions for many people. Norms often lead to pigeonholing and ranking and, as a consequence, to stigmatization.

The study of universal design derives much of its inspiration from research conducted on relationships

Fig. 1 The Vitruvian man by Leonardo da Vinci.

between man and the environment, including ergonomics (human factors). The theory behind this research is in turn based on disciplines such as physiology, psychology, and anthropometry (the study of human measurements) as well as on concepts relating to technology and sociology [4].

The work carried out in the field of universal design normally coincides with other objectives in society. More people are able to participate in working life. This is of value both to those directly affected and to society as a whole. A universally designed society will also be better prepared to tackle the much discussed ageing society. More people will be able to look after themselves in many respects.

The challenge is to design buildings and outdoor spaces that do more than just comply with regulations; they must stand out as being universal in terms of concept, function, space and material. Reflective thinking should therefore be the norm in implementing universal design in education. Greater emphasis on universal design as a multidimensional strategy that focuses on aesthetics and health could be one approach. How do engineers make cycle paths accessible to everyone? How do architects make buildings visible for people with impaired vision? How do they prevent standards for inclines in public spaces from making outdoor spaces seem monotonous and boring? New practical knowledge can be acquired through work processes that require new problems to be formulated, defined and solved.

3. Interdisciplinary Approach

Technology, knowledge, and attitudes are changing quickly, and educational institutions must place more emphasis on universal design as an innovative strategy. Only by acknowledging that the human population comprises people with different physical abilities can planners, architects, and engineers address the issue in discussions, analyses, planning proposals, and impact assessments. In this context, a user-centered approach is crucial, as it will highlight

the need to continuously assess new ways of reducing physical barriers in our surroundings.

An interdisciplinary teaching program for universal design as part of an introductory course for first-year students could be one strategy for raising awareness and for improving interaction across disciplines. This was the idea behind a study program on universal design in the public sphere, that was attended by 300 students from two faculties at Bergen University College (the Faculty of Health and Social Sciences and the Faculty of Engineering) in fall 2012. The students were enrolled in courses in occupational therapy, data and information technology, surveying or construction engineering. They were divided into 50 interdisciplinary groups. Some of the students were then equipped with wheelchairs, Zimmer frames, and special glasses and earplugs while the others acted as guides and observers.

An interdisciplinary seminar was held ahead of the exercise. Some lecturers focused on the Gap Model (Fig. 2). In this model, “disability” is interpreted as the difference between an individual’s ability to function and the demands of his/her physical environment. The aim was that the students should experience first-hand that “disability” arises when there is a discrepancy between the ability of the individual and the design of the physical environment.

The program was concluded with a half a day secession to sum up and reflect on the exercise. Some of the groups presented websites on how to reduce

Fig. 2 The gap model [5].

disabling barriers in the physical environment. An evaluation panel included a representative from the council for people with reduced functionality. For example, the students learned that wheel-chair users (who may be unable to cross high door thresholds) could be accommodated by installing a ramp or by removing the threshold: people with visual impairments that prevented them for reading signs could be given tactile or verbal information and people with hearing impairments could read information. A subsequent survey of 123 students found that 32% of the students were previously unfamiliar with the term universal design, and that 2% of the students were previously very familiar with the term. When asked how useful they found the experience of simulating having reduced functionality 12% answered not useful, 31% slightly useful, 34% quite useful, and 23% very useful (Fig. 3). The students of data and information technology found the exercise least relevant to their education.

User orientation is central to the teaching of universal design. Simulation exercises are therefore a commonly used method, but not everybody is convinced of the benefits: “The argument against simulation exercises is chiefly that the awareness which is created is unreal; handicapped people have learnt to live and cope with their handicaps in ways which the simulation exercise cannot hope to illustrate, and, for a handicapped person, technical aids are necessities without which certain functions cannot be performed, while a non-handicapped person may experience technical aids as an impediment” [6].

Academic staff at Bergen University College who took part in the simulation exercise found that the exercise could overshadow the complexity and concept behind universal design. The argument was that people with reduced functionality do not represent a homogenous group with identical traits and needs, but are in fact an extremely diverse population with differing and sometimes contradictory requirements.

However, when students enter the labor market many of them will be charged with devising solutions that must be universally designed, while others will have to cater to people with special needs.

Universal design can reduce the level of functionality in relation to the demands of the physical environment, while technical aids can increase the level of functionality in relation to a person's capabilities (Fig. 4.) The Convention on the Rights of Persons with Disabilities also emphasizes that universal design shall not exclude assistive devices for particular groups of people with disabilities where this is needed [2]. In this context, it must be mentioned that the benefits of simulations exercises in connection with technical aids have not been evaluated.

A number of students in the survey mentioned the experiences of a visually impaired engineer at the

Fig. 3 Simulation exercise, evaluation of results.

Fig. 4 The gap model: disability, universal design and technical aids.

Norwegian Public Roads Administration as being a very informative contribution. Lecturers with reduced functionality can convey evidence-based knowledge about accessibility, participation and barriers. They can also advise on good solutions and help establish what universal design actually is, thus providing a supplement or better alternative to simulation exercises.

The most important goal of an interdisciplinary teaching program, however, must be that first-year students develop a shared understanding of the concept, that they understand the importance of interdisciplinary cooperation, and that they see how universal design serves a purpose and solves social challenges which in turn can serve as an inspiration later in their studies and careers. Further specialization in the subject should be incorporated into technical subjects and in projects at bachelor's and master's degree levels.

4. The Seven Principles

The term universal design became formalized in the Seven Principles of Universal Design. The principles were developed in 1997 by a working group of architects, product designers, engineers and environmental design researchers at the Centre for Universal Design at North Carolina State University. The principles are applied to evaluate existing designs, guide the design process and educate both designers and consumers about the characteristics of more usable products and environments. The principles are as follows: (1) equitable use; (2) flexibility in use; (3) simple and intuitive use; (4) perceptible information; (5) tolerance for error; (6) low physical effort; (7) size and space for approach and use.

The principles are important for understanding the origin and development of the term universal design as well as the application of the concept as an innovative strategy. For example, dual-lever mixer taps were gradually replaced by single-lever models which had originally been designed to simplify

operation by people with reduced mobility. The change turned out to be practical for everyone. Remote controls, plastic lids for coffee cups and bent straws are other examples of how knowledge relating to certain user groups has helped develop products that benefit most people and therefore constitute an improvement in quality.

The relationship between people and space is fundamental to the practice of architecture, and the principles cannot automatically be transferred to buildings and outdoor areas. Principle 2 (flexibility in use) states that "the design accommodates a wide range of individual preferences and abilities." The ability to adapt in function and shape was the basis of a debate on structural architecture in 1960s and 1970s, where the concepts of flexibility and extensibility were key. Housing should adapt to its residents, rather than residents having to adapt to their homes. Flexible housing needed reconstructing. However, this places demand on the user, both from a resource and an intellectual perspective. Thus, one could say that this principle contradicts the simple and intuitive use of Principle 3. Moreover, one could question whether the need to have a fixed limited space to occupy and feel secure in could be reconciled with the principle of flexibility in the sense of modifiable buildings and space.

This problem is evident in the discussion on schools, where open-plan solutions and large common areas dominate over traditional classrooms. Switching between large and small groups, and between different group situations requires joint use and multiple use which in turn requires flexible building systems. Mobile furniture and units that "suddenly" appear do not give the visually impaired enough time to avoid a collision. Standard lighting can also cause problems because it provides no orientation points. Way-finding elements as an integrated part of architectural design can also hamper a wide range of individual preferences and capabilities. In this context, Principle 2 (flexibility in use) may be applied at the expense of

acoustics, orientation, concentration, and affinity.

The innovation of industrial products takes place through various phases such as the concept development, the testing of prototypes, further development and implementation. This allows us to develop new and ever better solutions. When it comes to the construction sector, new concepts are built but not subjected to sufficient systematic testing in terms of their quality in use. Thus, the experiences that have been garnered only partially benefit future clients/development teams. This means that major experiments are conducted when building new schools, kindergartens and care homes, without any significant knowledge or expertise being transferred to future building projects [7].

SINTEF Building and Infrastructure concludes that the seven principles are less suitable in architecture and inadequate in a planning and building context [8]. Sanford puts it like this: "Personally, my problem with the assessment based on the UD (Universal Design) Principles is that they are not validated in the first place. I always argued that instead of using the Principles to determine if a design is universal, we should use the design to determine if the Principles are valid" [9]. In this context, participation by user organizations and various types of user groups become significant.

5. A Holistic Perspective

In Norway, the drive towards universal design has primarily involved work on legislation, standards and detail design. These have been and remain important factors, but detailed requirements have occasionally meant that the planning and development process has become detached from the holistic approach. Solutions may be satisfactory in their own right, but often appear removed from the rest of the structure or from their surroundings.

Universal design is about people, senses and movement and about how multiple properties and forms of movement must be applied to get from one

place to another. The various elements mutually affect each other, and the sum of their individual contributions determines the usability of a space.

Leon Battista Alberti (1404-72), the Renaissance architectural theorist, saw houses as small towns and towns as large houses in which people move from room to room. Public spaces are where different user groups and their respective priorities always converge.

Two factors are especially important in assessing universal design in our environment, factors that are not brought to the fore when considering individual elements of our surroundings in isolation: (1) The individual links form part of a chain; the weakest link is what determines usability; (2) The location of the individual functions may determine their usability. The first factor suggests a need for an overall assessment when considering shortcomings in accessibility and the consequences of possible remedies. The second factor addresses the issue of location, and stresses that universal design needs to be a criterion in overall planning decisions. Universal design can be considered as a design and planning process based on the interaction between the individual parts and their interrelationships.

Planners, architects and engineers are facing major challenges with respect to land use development and to converting and upgrading existing buildings, outdoor spaces, and infrastructure. Increased access to transport is considered one key factor for improving equality for people with functional impairment. It is no good if buildings and outdoor areas are universally designed if the transport system, with its bus stops, stations and terminals, remains inaccessible. Step-free access, way-finding systems, clear information systems, and unobstructed footpaths are central elements in making the transport system accessible by everyone.

Through various externally commissioned projects students at the Department of Civil Engineering at Bergen University College co-operate with professionals in both the public and private sectors.

While some of the bachelor's degree projects concern upgrades of existing outdoor spaces and infrastructure, while others focus on universal design as an element in site analyses and the preparation of development plans. The project assignments are divided into two parts: a theoretical part and a practical part. During the theoretical part the students familiarize themselves with legislation, regulations, standards and guidelines. The practical element involves looking at the current status of and needs for universal design and conducting interviews and analyses in order to design appropriate measures and prepare planning proposals.

Discussions and reflections upon possible solutions seem to play a particularly constructive role in developing an understanding of universal design as an innovative strategy for finding even better solutions. They help raise awareness of universal design amongst professionals, while the requirements of the Norwegian Planning and Building Act are addressed in a realistic manner [10].

A group of former students charged with upgrading existing ferry slips to incorporate universal design in partnership with the Norwegian Public Roads Administration shared their experiences during the interdisciplinary seminar [10]. The experience and enthusiasm of former students could help highlight the importance of taking a comprehensive approach to universal design. They conveyed that inclusive design is a complex process that requires creative solutions based on knowledge about—and participation by—various user groups.

6. Political Intentions and Reality

The Norwegian government has placed universal design high on the agenda with its vision that the country should be universally designed by 2025. Universal design is already an integral element in a number of laws and regulations, including the Anti-Discrimination and Accessibility Act and the Planning and Building Act. An important driving force in this respect is the government's action plan

for universal design and increased accessibility. The action plan covers four main areas: planning and outdoor spaces, building and construction, transport, and ICT (information and communication technology). The phasing-out of disabling barriers will be implemented by ordinary, general measures integrated into planning and development processes.

Despite its ambitious targets, the plan does not address research and education to any significant extent. Academic staff at Bergen University College who took part in the interdisciplinary teaching program on universal design in public spaces concluded that one challenge in the project was that universal design would not be followed up on and integrated into other subjects, thus detaching it from its context. This could be because universal design has not been incorporated into the regulations for a new framework plan for engineering courses, nor in the descriptions of learning outcomes for the respective courses.

Perhaps the construction and housing sector, which for financial reasons is seeking to relax the requirements for universal design, has exercised some influence? Or has there been too much focus on design disciplines such as product design and architecture and too little focus on engineering? I shall let these questions remain unanswered. It should be added, however, that a survey of living conditions in Norway [11] shows that 66% of wheelchair users aged 20-66 live in homes where there are stairs, steps, slopes, or other obstacles that make it difficult for them and for other people with mobility issues to move around freely outdoors. The survey also found that people with reduced functionality are more likely than the population in general to live in places where they suffer from noise, dust and other pollution problems.

In order to achieve the goal of an inclusive society, the various parties involved in planning, development, and building control must know how to convert the needs of the various users groups into practical

solutions. They must be familiar with the specific requirements for universal design laid down in regulations and standards, and they must know how to execute the planning and building process in a way that meets these requirements. With regard to public procurement, both buyers and suppliers must familiarize themselves with how to specify requirements for universal design.

Once again this requires a certain level of expertise on the part of the academic staff who will be training the architects and engineers of tomorrow.

“Unless the inclusive approach is accepted as a guiding philosophy, it is likely that new generations of built environment professionals will continue to be educated in a way that fails to consider inclusive design. This clearly requires a paradigm shift in current pedagogical approaches. A major challenge that needs to be addressed is educating the educators” [12].

Universities and colleges have a responsibility for contributing research and professional development which in turn can be applied in teaching and practice. As regards the built environment, universal design covers a range of specialisms: fire safety, installations/elevators, indoor climate, acoustics, use of materials, lighting and layouts. For example, decisions on acoustics conditions, floor markings, way-finding systems, and materials must all be made at an early stage when planning foundations and floor structures.

A recurring theme that applies to universal design is whether training in this field should be given in a separate course or integrated into existing courses. Making universal design a speciality subject or speciality skill in education, runs the risk of wrapping the “subject” in theoretical jargon and making it a peripheral part of the design process. This could make universal design less binding and less accessible for both students and practising engineers and architects, and would contradict the concept of universal design as an integrated and inclusive approach.

Awareness-raising and skills development are crucial in order to develop and work towards a common understanding of what universal design actually is. Good solutions are often identified through dialog between different disciplines, and knowledge of universal design should therefore be implemented in existing courses, not least in order to encourage a better relationship between theory and practice.

7. Conclusions

This paper emphasizes the importance of incorporating universal design as a core skill into the training of architects and engineers, both in the form of interdisciplinary courses and as an integral part of established subjects. Acquiring basic knowledge about the various user groups, and learning how to apply it to planning and development represent the key to allowing students to evaluate specific situations and to developing a normative standpoint as to what they believe represents good design.

User orientation is central to the teaching of universal design. An introductory course could be an ideal setting for making architects and engineers aware of the general value of universal design and its role as a strategy for equality through planning and physical design. However, the academic staff at Bergen University College who took part in the interdisciplinary teaching program on universal design concluded that inviting different user groups with reduced functionality to give talks about their problems and how to overcome them seemed to be a better approach than simulations exercises.

This paper also highlights how raising the skills levels of the academic staff members who train the architects and engineers of tomorrow is essential in order to achieve the goal of an inclusive society.

Universal design is an innovative strategy and a field that offers great potential for research and development, requiring academic staff to keep up to date with new knowledge and to possess

research-based knowledge and a sense of interdisciplinary understanding. Cooperation across disciplines is a prerequisite for designing innovative solutions to building and planning challenges. For example, a holistic approach to the sustainable upgrading of buildings and urban areas implies seeing management processes, environmental issues, climate, and universal design as being interlinked. Universal design should therefore not be classified as a separate subject within a wider program of study.

Students possess significant potential that should be exploited far better in terms of data collection, analysis and development work. Project-based collaborations between students and various professional groups in the public and private sectors could help raise awareness and create an understanding of the importance of universal design in planning, design, and construction. Teaching should therefore aim to make the issues of accessibility and universal design something more than just questions of practicality and priorities and instead link them to a fundamental understanding of human rights such as equality and equal opportunities. As well as studying legislation, regulations and standards, students must know more about the consequences of a lack of appropriate adaptation. Students must see how knowledge and skills in the area of universal design add substance and a new dimension to their future careers as architects or engineers.

Architects and engineers serve an important function both as developers and as consultants for clients in planning and building applications and will figure among the key players in the quest for a more

inclusive society.

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