A THEORETICAL FRAMEWORK FOR THE IMPLEMENTATION OF BUILDING USER'S LIFESTYLE IN nD CAD SYSTEM

BHZAD SIDAWI
College of Architecture and Planning, King Faisal University, KSA
Bsidawi@kfu.edu.sa

Abstract. People's lifestyle, traditions and culture affect the way they live, interact with the built environment and erect buildings. Lifestyle influences the physical characteristics of the space such as: organization of spaces, distances between spaces and location of spaces. Taking lifestyle aspects into account by architects would provide comfortable environment that is tailored to people needs and aspirations. On the other hand, rapid developments in computer modeling of buildings since 1960, led to the invention of 3D CAD systems that are capable of modeling the physical volume, shape and form of buildings and helping project team members to virtually visualize buildings. 4D CAD systems went beyond the mere 3D modeling of the physical building as they link the 3D virtual building model with other building's information such as construction process, cost estimation etc. The nD CAD research that emerged in the late 1990s proposed endless dimensions of CAD modeling that would include the building regulations' requirements, basic user needs and client requirements. This paper argues that it would not be enough to model the client requirements and some of user/ occupant's physical and environmental aspects as it does not reflect the real utilization of the building by building's user and the way that he/ she likes to live. This research aims to define the lifestyle characteristics of the architectural space and its boundaries. It suggests that various aspects of the user's lifestyle such as degree of privacy, flexibility and adaptability required for each space, organization of internal spaces and style of spaces should be implemented in the future nD CAD models. Such implementation would enable designers to consider real life scenarios, model the real needs of people and provide the adequate end product for them.

1. Introduction

The mission of architecture is to address the human needs and to respond to how people like to live. The architect should not make a building and enforce people into it. Instead, he/ she should consider a number of design parameters in his/ her design that would address people lifestyle and common conventions. A lifestyle typically reflects an individual's attitudes, values or worldview and would include patterns of social relations and entertainment. The incorporation of knowledge about people lifestyle and preferences in the design process is vital as it would increase user satisfaction about the end product and may create a human, sustainable, flexible and quality product that would address people real needs and hopes.

The extended use of 3D CAD models has been under interest by researchers in the building industry from around couple decades ago. Various parameters can be assigned to CAD models so these models would be used for visualization and walkthrough, simulation of the progress of the construction process (or 4D); people accessibility; energy acoustic; and people safety. The examination of these concepts during the early stages of design stage would help the designer tailor the design and to produce a sustainable and safe product.

The current theme of nD CAD research aim is to respond effectively to client needs (e.g. a housing developer or a residential building's owner) in regards to the building regulations and guidelines requirements. This paper however, suggests that it is not sufficient to model the client needs and some of occupant's/ user's physical and environmental comfort and the focus should be on modeling the end user's or occupant lifestyle in the future nD CAD system. This would guarantee that the real utilization by users of the building is fully considered and modeled.

The lifestyle aspects can be categorized into: physiological, spiritual, social aspects and they are suggested to be an integral part of the future nD CAD system and these can be embedded as properties in spaces and building elements. These properties can be defined as the visual comfort of spaces, level of privacy of each space, the flexibility of internal and external spaces and intelligence of spaces and so on.

In the following sections, this paper will discuss the importance of various aspects of the user's lifestyle such as: visual and sound privacy, the need for flexible and adaptable use of spaces, arrangement and configuration of internal spaces in regards to local traditions and beliefs. It demonstrates how these aspects should be implemented in the future nD CAD system. Such implementation would facilitate not only multi criteria assessment and decision making but also participation of the end user in the design process which would be an added value to the design product and process. The proposed nD CAD system adopts IFC (Industry Foundation Classes) concept that represents not only the elements of 3D architectural models but also

abstract concepts such as schedules, activities, spaces, organization etc in the form of entities. The IFC hierarchy would allow the user preferences to be translated into parameters that can be attached to each element of the building.

2. nD CAD model concept and architecture

In the second half of the 20th century, the design of buildings has become more sophisticated, and increasingly high level of detailed information is required to be incorporated in the building design. This has influenced the way of how the building's design information is modeled, coordinated, exchanged and communicated.

The use of CAD systems to model buildings starts as early as 1960 to help architects and other project team members to improve management of the architectural product. 3D CAD models created are capable to model the physical features of buildings and can be used for visualization purposes but are not capable to provide further and detailed information that is required by various members of the project team. The 4D CAD concept that raised in the mid 1990's can simulate the progress of the project construction process in real time which would help project team members to foresee any construction complication or problem that would occur during the construction of a building (Broekmaat, M., de Vries B. 2007).

The design of modern buildings required an input of multiple, and often conflicting, design perspectives such as acoustics, accessibility, maintainability, sustainability, energy, crime etc. Thus, the research emerged at Salford University in late 1990's has aimed to integrate a number of design dimensions or information into a holistic model, thus enabling designers to portray and visually project the building design over its complete lifecycle (Lee *et al*, 2003). Researchers at University of Salford suggested nD CAD system and they defined it as an extension of the building information model, which incorporates multi aspects of design information required at each stage of the lifecycle of a building facility (Lee *et al*, 2003). nD CAD modeling is based upon the building information model (BIM), a concept first introduced in the 1970s and the basis of considerable research in construction IT ever since. A BIM[1] is a computer model database of building design information, which may also contain

[1] This database is constructed with intelligent 'objects' which represent building elements like walls, doors and windows. From this central database, different views of the information can be generated automatically; views that correspond to traditional design documents such as plans, sections, elevations, schedules etc. As the documents are derived from the same central database, they are all coordinated and accurate – any design changes made in the central model will be automatically reflected in the resultant drawings, ensuring a complete and consistent set of documentation (Graphisoft, 2003).

information about the building's construction, management, operations and maintenance (Graphisoft, 2003).

The holistic nD CAD modeling tool uses IFCs that enables good interoperability of CAD models between CAD tools. It helps to improve decision-making process and construction performance by enabling true 'what-if' analysis to be performed to demonstrate the real cost in terms of the variables of the design issues.

The key feature of nD CAD is its ability to incorporate various design perspectives in one system, and to systematically assess and compare the strengths and weaknesses of different design scenarios presented by the nD knowledge base. Aouad & Lee (2007) suggested that nD CAD prototype could be built on the concept of BIM, and is IFC-based that would include the following:

• nD knowledge base: a platform that provides information analysis services for the design knowledge related to the various design perspective constraints of the nD modeling (i.e. accessibility requirements, crime deterrent measures, sustainability requirements etc). To undertake an analysis of the building performance, information from various design handbooks and guidelines on the legislative specifications of building component can be used with physical building data from building information model thus analyzed.

• Decision support: multi-criteria decision analysis (MCDA) techniques have been adopted for the combined assessment of qualitative criteria (i.e. criteria from the Building Regulations and British Standard documents that cannot be directly measured against in their present form) and quantitative criteria (e.g. expressed in geometric dimensions, monetary units etc). Analytic Hierarchy Process (AHP) is used to assess both qualitative criteria (i.e. criteria that cannot be directly measured) and quantitative criteria.

The present nD CAD research as demonstrated above, concentrates on addressing client needs and building user's needs in regards to the building regulations. This would leave a gap for this research to discuss the concept of user's lifestyle and its impact on design of buildings and why it is vital to be considered in future nD CAD system.

3. User's lifestyle

The importance of incorporating knowledge about the user lifestyle in the housing design has been highlighted by a number of researchers. Such incorporation would provide a tailored design solution to people needs. Researchers such as Bourdieu (1984) stated the significance of getting information about the social status, Douglas (1996) highlighted the significance of the research about attitude and Hojrup (2003) pointed out that information is required about professional status in order to define user

requirements. These views do not however; take into account neither the cultural and tradition aspects, nor the differences in people culture as well.

Habraken (2003) highlighted that a designer should not design buildings and enforce people into it. Instead, he/ she should consider a number of parameters in his design that would reflect people lifestyle and common conventions. Salama (2006) highlighted the importance of not only getting information about the user but also to integrate information about the user, family, future housing preferences and current houses characteristics together in order to build a complete picture of the user's lifestyle. This information should be implemented in e design of buildings to guarantee that real needs and activities of users are considered.

Al Kurdi (2002) and Darweesh (2003) investigated the private housing in Saudi Arabia. They pointed out a number of aspects of lifestyle related to the life in Saudi Arabia and are absent in the house design and are needed. These are: the visual and sound privacy, outdoor space for children activities or entertainment activities, the flexibility in the design of internal and external spaces in order to accommodate the increase of family members, change of use or multiple use, and separate spaces and services for male and female guests.

This causes a number of harmful consequences that makes the living inadequate and not comfortable to the users and has enforced them to carry out a number of costive alterations. Some of the consequences are changing the configuration of internal spaces to accommodate multiple use or change in use, upgrading partitions to provide the required visual and sound privacy between spaces, dividing or adding up spaces, modification of front and rear garden to accommodate family and guest's entertainment activities and changing the arrangement of spaces. These changes aim to adapt properties to suite the user's local lifestyle.

Similarly, Ahmed and Parry (2002) did a study on Mubarak city that is built according to western built laws and compared it with existing low income housing in Cairo. They found that Mubarak city constitutes of blocks of flats that do not reflect people lifestyle and Islamic beliefs and traditions. Despite some disadvantages that exit in the low-income housing in Cairo, the researchers pointed out that residents were be able to reach to best solution that would satisfy everyone. This is done through the corporation of residents with their neighbours upon making decisions regarding alterations or building new blocks. Such decisions would respect and consider the local traditions, beliefs and lifestyle of the resident as well as his neighbours.

Hillier (1984, 1996) pointed out that spaces have qualities and characteristics that would affect people interaction and use of these spaces. For instance, he suggested two social dimensions of buildings and mentioned that buildings operate socially in two ways: they constitute the social organisation of everyday life as the spatial configurations of space in which we live and move, and represent social organisation as physical

configurations of forms and elements that we see. Space creates and controls the interfaces between different categories of people and their interaction with objects. Therefore, if spaces are designed wrongly, then natural patterns of social co-presence in space are not achieved.

As a conclusion, the lifestyle can be defined as a number of physical, psychological, social, spiritual (e.g. traditions and beliefs) needs of the building user. The above studies suggested that when lifestyle, traditions aspects, and other needs of the user were respected and taken into account by designers, the user was more satisfied about the architectural product. The abandon of the lifestyle aspects by the architect/ designer would produce poor, unpleasant, inflexible and uncomfortable architectural product i.e. spaces and boundaries of space. Such disregard would have a number of harmful consequences on building owner and users as explained above.

4. The proposed framework of nD CAD system

It was concluded in section two that present nD CAD system aims to model the client requirements and some of user/ occupant's physical and environmental comfort aspects. Section three has highlighted the significance of incorporation of user's lifestyle in housing design. Thus, this paper argues that lifestyle features - which are absent from nD CAD system- at present should be considered in future nD CAD system. Such implementation would enable designers to model the genuine requirements of building users and provide the adequate architectural product for them.

This section will discuss how to incorporate user's lifestyle into nD CAD system. It is suggested that initial nD CAD system should take into consideration the following aspects (see figure 1): user's lifestyle requirements, client's needs and building regulation's requirements.

The above mentioned aspects are likely to change during the lifecycle of the building. The lifestyle of the building or home user – for instance- would change or the pattern of the user or occupant would change. The owner requirements would change over time and possible renovation or alterations would occur.

Furthermore, the building regulations [2] are under continuous modifications in regards to a number of social, environmental and economic factors, and such updating of building regulations would enforce possible changes in buildings. Thus, nD CAD system should be flexible and dynamic enough to incorporate such future changes to the building that would take place (see the figure 1, the reverse arrow).

[2] For instance building regulations are frequently updated in the UK. In Europe, there is an intention to replace building regulations of each European country with a uniform building regulations what so called *Eurocode* for all European building industries.

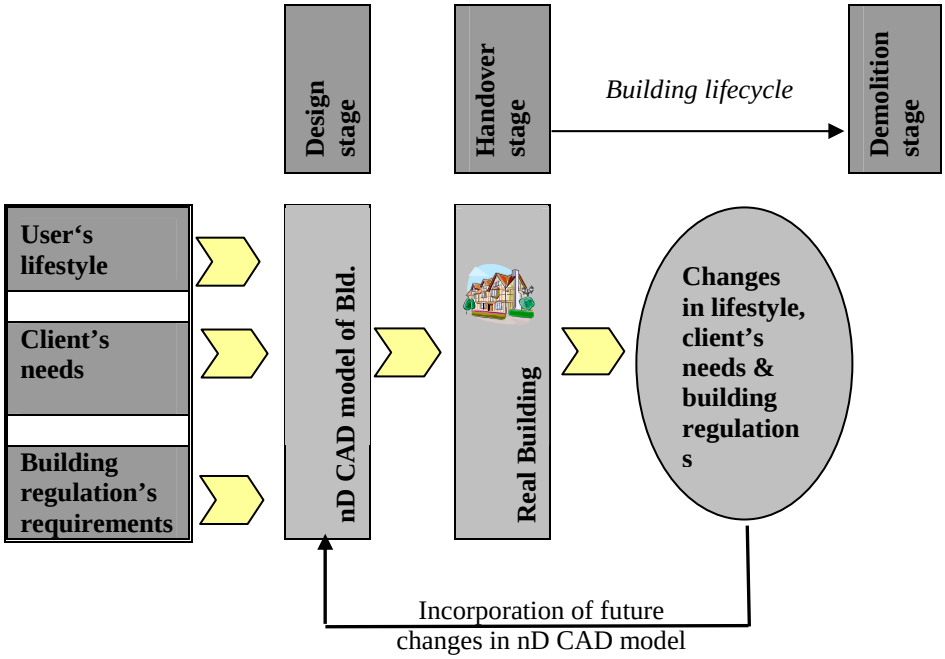

Figure 1: The proposed nD CAD framework incorporating user’s lifestyle

To model the user lifestyle as an integral part of nD CAD system, it is suggested to use IFC classes’[3] standard, in which the building can be defined as spaces that have boundaries and within the boundaries, opening’s elements would exist. Each of the building elements has its own characteristics. Characteristics of each space can be defined by two aspects: the characteristics of it’s’ boundaries and the space’s own characteristics. Each of them should address the physical, psychological, social and spiritual needs of the user as mentioned in section 3.

The characteristics of each element of the building in regards to the lifestyle are illustrated in figure (2). A space would comprise a number of physical features such as i.e. shape, dimension and style. It would be opened partially or fully into another space.

[3] See for instance IFC expressed in Express diagram in: *http://www.iai-international.org/Model/IFC(ifcXML)Specs.html*

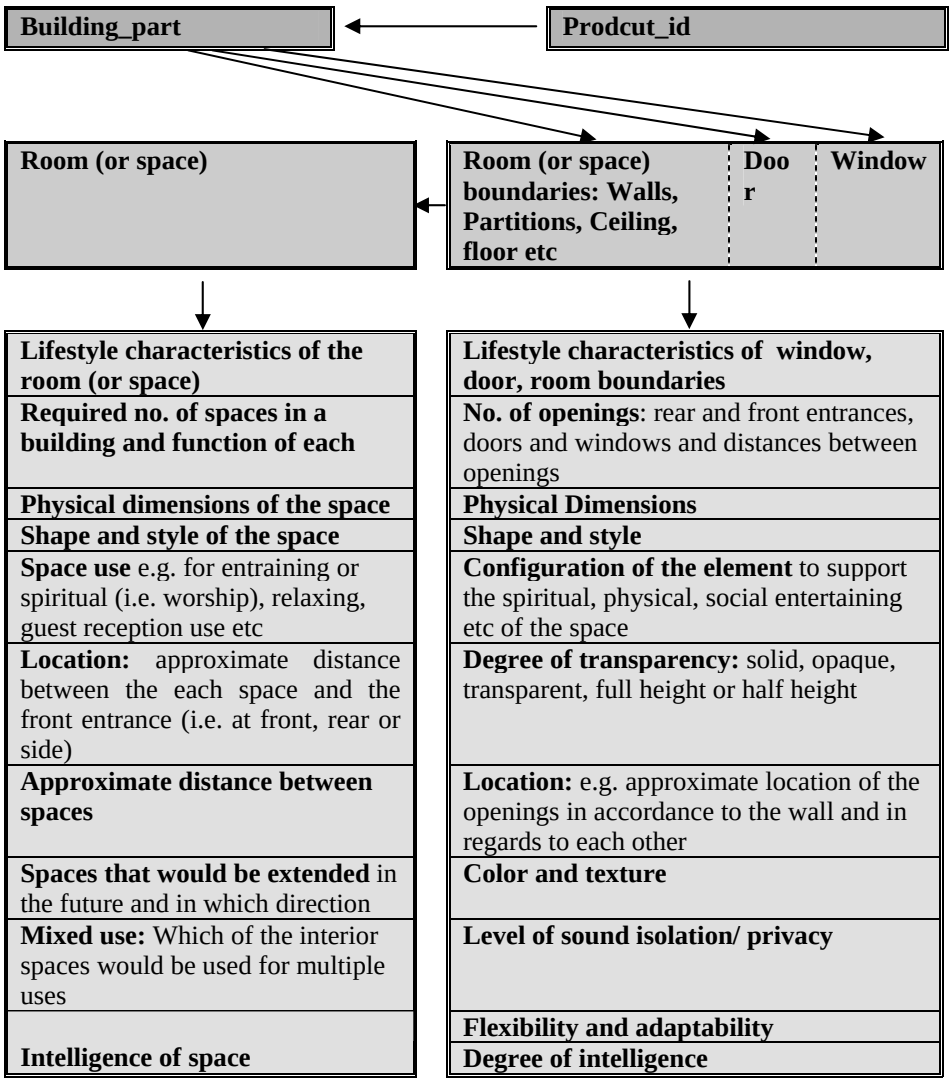

Figure 2: Lifestyle characteristics for building elements that are structured according to IFC classes *(inspired and simplified from EXPRESS diagram)*

The distance of a space from another space can be categorized as internal and external. An internal distance is the distance between internal spaces such as distance between dinning room and men guest room and distance between girls, boys and parents bedrooms. An external distance would be the distance between the outside (i.e. rear of front) gate and the servant/ driver room – if exist-, the distance between the family entertainment space

in the garden and the outdoor men space. The distance would be defined as near or far away and a scale from 1 to 10 can be used to define the distance.

The distance of an internal space from the front entrance can be defined in the same manner. The privacy of a space would be defined according to the type of its boundaries. For instance, a space with large, transparent openings and transparent boundaries, which has low sound isolation value, can be defined as a space with little privacy and vice versa.

Working patterns have become much more flexible over the last two decades. Many people now work from home on a laptop computer, connected to their colleagues via e-mail, video conferencing, web site and fax. There is a need to build flexibility into the structure of buildings so that they can continue to be useful as circumstances alter. Therefore, building elements should also be flexible and easily to be adapted according to the change in the user lifestyle or change in occupancy pattern. Such features could be defined at a scale that would range from very rigid to very adaptable and flexible.

The ability of the user to control the space and boundaries is vital in the future homes and can be considered as one of the lifestyle features. The user should be able to interact with the building fabric and systems, and create a connection with the external climate (e.g. view, shutters, air through a window opening to a quiet courtyard). This would not be possible without embedding intelligence in space and boundaries and model the intelligence in future nD CAD system.

The embedding the lifestyle specifications into the building elements would help an architect or a designer to define the present needs of the building user and to predict future needs as well. It would also help the client to get knowledge about the total cost of the building that is designed in regards to the present user needs and compare between various design scenarios.

5. Conclusion and future research

An important feature, which is the user / occupant lifestyle, is suggested to be implemented in the future nD CAD system. This would help the architect to address genuine needs of the building user's in the early stage of design and to discuss different design scenarios with other project member team including the owner/ client. The implementation of lifestyle in nD CAD system would prevent some of the harmful consequences to take place during the building lifecycle and some of these would include possible waste of time and effort of the owner/ user who would like to adapt the building in regards to his/ her lifestyle. It also would make the building's user/ owner more satisfied about the end product. However, this would be a subject of future research that would investigate the user/ owner satisfaction in regards to the implementation of their lifestyle in nD CAD system. The satisfaction

of the user would be best achieved through the participation of building's user and owner in the design process and discussion of nD CAD model with the architect. Therefore, future nD CAD system should not only support the decision-making by the client or the architect but also facilitate building's user participation in the design decision making.

Such system should be also capable to predict and model new lifestyles that could be used in the design of virtual buildings (i.e. virtual homes& campuses). In addition, these new lifestyles could be suggested to real building's users/ owner who may like to adopt it. The invention of virtual lifestyles may have an influence on real lifestyle and this needs to be investigated by researchers.

References

AHMED KG and PARRY CM**.,** 2002. Design for the poor in Egypt: Satisfying User Needs or Achieving the Aspirations of Professionals? the case of Mubarak National Housing Project for Youth, *the Design Research Society International Conference, Brunel University, London* .2002. ISBN 1-904133-11-8.

AHMED K and PARRY CM**.,** 2001. Towards a relevant framework for participatory decision making processes in low-income neighbourhoods in Cairo, Egypt: As an approach for socio-culturally responsive public housing product. *1st International Postgraduate Research Conference on the Built and Human Environment University of Salford*. ISBN 1-90049-184-2

AHMED K and PARRY C M., 2001. Traditional Settlements, User Participation and the 'No-Harm' Principle Towards a contemporary participatory process in low-income public housing in Islamic cities. *IAPS Second International Symposium Traditional Environments in a New Millennium: Defining Principles and Professional Practice Amasya, Turkey*.

Al-KURDI, FERYAL., 2002. *The labor city in Dammam: an analysis of its house forms*. Advanced workshop ARAR 602. King Faisal University.

Al-KURDI, FERYAL., 2002. *Lifestyle and house form: the case of Aramco houses under home ownership in Dhahran*. Unpublished graduate dissertation, King Faisal University.

ANUMBA C. & J. AMOR, R. CEC'99. A survey and analysis of integrated project databases.

BOURDIEU, P. 1984. *A Social Critique of the Judgment of Good Taste*. Reprint. International Sociological Association, Boston: MA, USA.

DARWEESH, LENA., 2003. *Dweller-initiated changes and transformations in Built environment: the impact of building regulations*. Unpublished MSC thesis. King Faisal University.

DOUGLAS, M., 1996. *Thought Styles: Critical Essays in Good Taste*. London, UK: Sage Publications.

GHASSAN AOUAD, ANGELA LEE. *nD Modeling Road map: A Vision for nD-Enabled Construction. Salford centre for research & innovation in the built & human environment*. Available also on line on: [WWW http://ndmodelling.scpm.salford.ac.uk/Doc/ndReport2.pdf. (July 2007).

GRAPHISOFT, 2003. *The Graphisoft Virtual Building: Bridging the Building Information Model from Concept into Reality*. Graphisoft Whitepaper.

HABRAKEN, J., 2003. Questions that will not Go Away: Some Remarks on Long Term Trends in Architecture and their Impact on Architectural Education. Keynote Speech: *Proceedings of the Annual Conference of the European Association of Architectural Education-EAAE*. Hania, Crete, Greece. pp. 32-42.

HILLIER, B., HANSON, J., 1984. *The Social logic of Space*. UK: Cambridge University Press.

HILLIER, B., 1996, *Space is the Machine*. UK: Cambridge University Press

HOJRUP, T. 2003. S*tate, Culture, and Life Modes: The Foundations of Life Mode Analysis*. London, UK: Ashgate.

LEE, A., MARSHALL-PONTING, A.J., AOUAD, G., WU, S., KOH, I., FU, C., COOPER, R., BETTS, M., KAGIOGLOU, M. and FISCHER, M., 2003. *Developing a vision of nD-enabled construction*, *Construct IT Report*, ISBN: 1- 900491-92-3.

LEE, A., MARSHALL-PONTING, A.J., AOUAD, G., WU, S., KOH, I., FU, C., COOPER, R., BETTS, M., KAGIOGLOU, M. and FISCHER, M., 2003. Developing a vision of nD-enabled construction, Construct IT Report, ISBN: 1-900491-92-3

MARCEL BROEKMAAT, BAUKE DE VRIES. *Implementation Scenarios for 4D CAD in Practice*. Available also on line on: [WWW] http://www.ddss.nl/downloadPublication.php?ID=215&view (July 2007)

SALAMA. A.M., 2006. A life style theories approach for affordable housing research in Saudi Arabia. *College of Environmental Design. Emirates Journal for Engineering Research*, 11 (1), 67-76.

INTERNATIONAL ALLIANCE FOR INTEROPERABILITY (IAI). *Industry Foundation Classes*. Available on line on: [WWW] http://cig.bre.co.uk/iai_uk/iai/ (July 2007).