An Interface Proposal for Collaborative Architectural Design Process

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Abstract. *The aim of this paper is to explore how new technological opportunities affect approaches of designers during collaborative architectural design process. Which factors affect the communication and the quality of interaction? The study is based on two phases: the data input by the designer via devices to the computer environment and the transformation of data into design product in the software by scripting addition. Input devices that are used are 3D mouse, graphic tablet as a tangible interface and implementation of second mouse besides a standard mouse and keyboard. The potential usage of these interfaces in collaborative architectural design process is discussed and proposals are developed in 3ds max scripting environment.*
Keywords: *Collaborative design; human-computer interaction; user participation in design.*

Introduction

The concept of 'design' is rapidly changing depending on new opportunities of the technologic improvements. 'Collaborative design in virtual environment' is emerged as a new phenomenon, although collaboration is not a new concept. To decode collaborative design process, it is important to overview designer behaviors and how they communicate and interact. In this case the communication media becomes an important issue to analyze the design environment. Which factors affect the quality of interaction? What is the impact of novel representation and communication tools on architectural design process? What are limitations and potentials of already existing interfaces? The goal of this paper is to evaluate effect of new interfaces on attitude of designers during collaborative design, from the view of interaction and creativity and develop an integrated interface proposal.

Collaborative design process

Collaborative design term has become prevalent in parallel with the usage of virtual environments (Achten, 2002). Virtual Design Studio term has been

used at the first time by Mitchell in 1990 during conference in MIT (Çağdaş, 2007). Since that time different classifications and requirements has been defined for virtual and collaborative design studios. In this paper basically collaboration term is used for architectural design process by multiple participants.
For an effective collaborative design, designers should share:

- design tasks,
- communication,
- presentation,
- design documentation (Çağdaş, 2007).

Achten (2002) indicates importance of communication language, communication media, communication behaviors of the designers and pedagogical framework for collaborative design process to be discussed.

Condon (1993) suggests three type of classification according to how designers control during design process:

- fascist,
- communist,
- anarchist,

There is one dominant designer in fascist design that controls the input and output devices such as keyboard and mouse during design process. In fascist design one person has authorization of data sharing, while in communist approach the system itself becomes a controller. Communist approach is rule based and usually preferred when the designers does not know each other enough. How long and with which periods the designers will participate to the design is planned in the beginning of the session. In anarchist approach designers are totally free to control the design model or session or changing the system (Condon, 1993; Cicognani and Maher, 1997; Çağdaş, 2007).

If we take Condon's assumptions as a base, it is possible to add another definition: 'democratic' control model. In this approach the important point is 'how much' and 'how directly' designers participate to the design process. The design process control models can be expressed as:

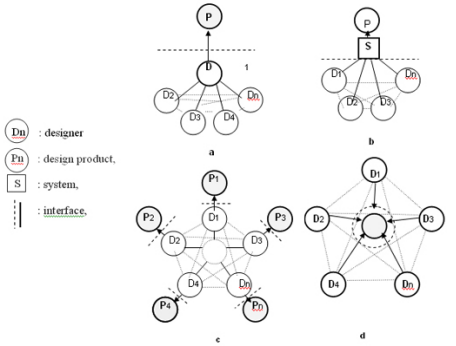


Figure 1
Control models during collaborative design process. Fig.1a: fascist control model; Fig.1b: communist control model; Fig.1ca: anarchist control model; Fig.1d: democratic control model.

Condon (1993) asserts anarchist model is the most proper approach for Computer Supported Collaborative Work. However, these concepts which are taken from economy has not examined comprehensively in the field of architecture yet. For instance if each designer works separately can the process still called as collaborative? What are the difference between individual design and anarchist design model? According to which criteria design product and the design process could be evaluated? For example, could fascist model be preferable in some conditions such as there is a knowledge level difference among designers. Or oppositely, does anarchist design model supports creativity? These questions can be increased.

According to different conditions, the priority of these design control method can vary. The critical point is that design environment should have a flexibility of permeability between different control models in case the priority and conditions change.

Communication during Collaboration

Communication can be simply defined as exchanging ideas and messages between sender and receiver of the message. This exchange can be done with 'language', signs and signals. Communication involves encoding, transmitting and decoding processes. According to these definitions, it is obvious

that communication requires 'at least two interacting agents' and 'a symbolic way' to exchange the set of sign. In collaborative design there are already more than one participant. Therefore the possible question is that in which ways designers communicate through the collaborative design process?

People communicate through sensory ways. The five basic sensory perception ways are visual, auditory, gustatorial, olfactory and tactile perception. Today besides five sensory, kinesthetic perception is also accepted (Mitchell, 1990). The common denominator of comprehension process with different sensory can be defined as ability to distinguish the relative differences such as cold- warm, static-dynamic. In the perceptional sensory context. Mitchell (1990) also mentions qualitative (color, smell) and quantitative (scale, duration) modalities.

Kim and Maher (2005) specifies communication ways for collaborative design as verbal such as talking, writing messages, etc and non-verbal such as gestures, sketching, any 2D and 3D environment. In other words graphical representation in the visualization process is an example for non-verbal communication. Besides these, any kind of body movement can be added. In verbal communication, language is the tool to communicate. Chomsky (2002) classifies semantic, syntactic and verbal values for messages. The same sentences carry different meanings when it is said in different intonation and emphasis. All these modalities and communication ways listed below can be sometimes intersect (Fig 2).

Figure 3
Models of Communication

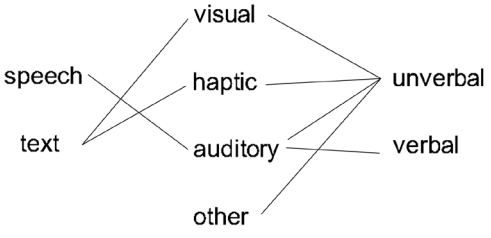
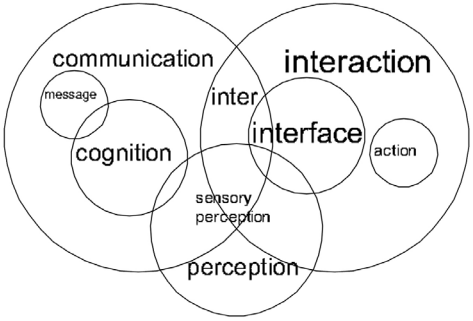


Figure 2
Models of Communication

Interaction in Collaborative Design

Interaction basicly requires at least two entities and communication among them. However this is not enough to define it. Bonger (2004) clarifies: When two entities interact, both will change state during or after the process taking place at both sides. In order for two entities (people, systems, computers) to interact, they must both have the ability to act, and have internal processes of some degree of complexity that can change.

On the other hand interaction itself holds a set of concepts: human-human interaction, human-computer interaction, etc. In this paper both human-human interaction and human-computer interaction will be taken into consideration. Human- human interaction is mostly based on communication and cognition; human-computer interaction is related to interfaces and opportunities they provide.



Basically computation improves both kinds of interaction while providing alternative communication ways in the course of designing process. Mitchell (2003), remarks that the most interesting kinds of learning communities are communities where there are multi-way interactions. He also underlines that the more multi-way, peer-to-peer kinds of communities allow unpredictable things to happen, that allow exploration of ideas during problem solving processes (Mitchell, 2003).

Besides human-human interaction, for the human-computers interaction programming or a level of programming (for the non programmers) increases the bandwidth of the communication while facing the computers individually or collaboratively. In other words, ability of taking inputs in different ways supports the human-computer interaction.

Related Work/ Samples of Interfaces for Representation: TUIs and GUIs

Fundamental of communication with computer is input - output process. The interfaces can be roughly examined in two titles:

- data input devices: e.g. tracking device, pointers, 3D command devices, keyboard, light pens, different sensors,
- display devices : e.g. head mounted display, single or multiple screens, desktop screen.

In terms of architectural design another type of classification can be used: Graphical User Interface (GUI) and Tangible User Interfaces (TUI) (Kim and Maher, 2005). Graphical User Interfaces include icons, menus, windows, a display in desktop screen. The current 2D and 3D architectural design programs can be considered in this GUI. Those architectural design programs can be classified as:

- drawing programs,
- modeling programs,
- programs supporting creative design process.

On the other hand tangible user interface (TUI) applications can include any haptic devices or tactile interaction surface or multi touch input systems. ARToolkit, Illuminating Clay, Metadesk, Skecthand+, isphere can be listed as current samplers od TUI in architectural design field. ARToolkit, Metadesk, Sketchand+ are also augmented reality implementations.

Proposed Interface and Its Implementation

Basicly interface model includes two phases. First part is taking data into computer, second part is processing the data in one of the graphical user interfaces and converting it into modification commands for surface control. To set up an experiment, besides mouse and keyboard, a series of combinations of input devices are the options:

- graphic tablet,
- 3D mouse,
- second mouse.

3Ds Max is selected as a graphical user interface. A graphic tablet is used as a tangible user interface. In addition to these, 3Dconnexion SpaceExplorer mouse is used in 3D graphical software. The operating system is Windows XP and to implement second (ordinary) mouse environment CPN mouse driver has been installed.

For the second part, a simple geometric form, plane surface is selected in GUI. The interventions will be applied on plane form. User will define the number of segments and dimensions of the plane surface, in the beginning as usual. The designer will control the 3D model with using both 3D mouse and a tactile device (graphic tablet).

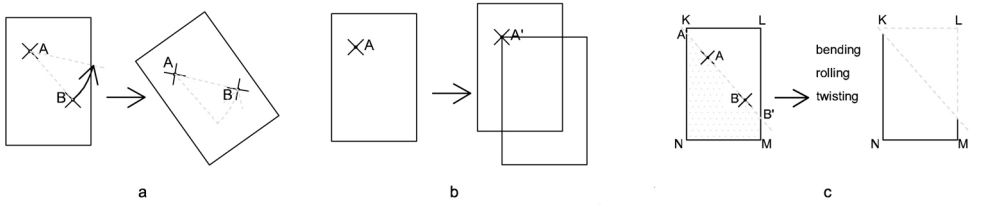
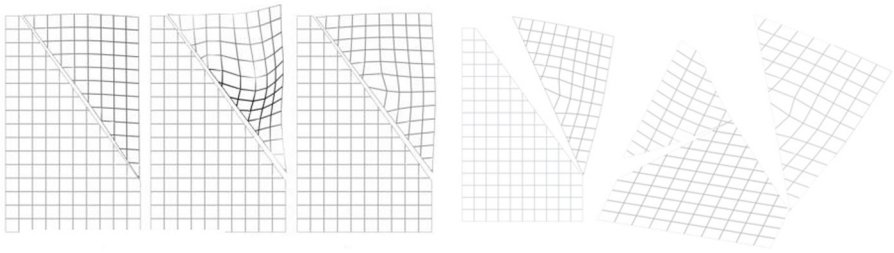


Figure 4
Sample of operations. Fig 4a: rotation; Fig 4b: moving; Fig 4c: partial intervention

Figure 5
Sample of manipulation



The data is translated into such standard commands: selection of meshes, bending, rolling, rotating, twisting and moving with two methods:

- one fixed point- one movable point method (Fig 4a, Fig 4b),
- partial intervention: two fixed point method (Fig 4c).

In Fig 4a and 4b A and B refers to:
A = Origin, static point (X, Y),
B = Variable (Mouse X, Mouse Y),
On the other hand in Fig 4c, A and B are both fixed points defining a separator line.

During the process, it is recognized that with using two mice simultaneously or graphic tablet and mouse, there occurs a potential of manipulating the model with using 'paper rolling metaphor'. Therefore in designers manipulate physical models via two hands. However, by the usage of computers, the spontaneity of manipulation action turns into more controlled process. For example in order to do the modifications which are shown in Fig4 and Fig 5, designers it takes a series of commands and it can be done by keyboard and only one mouse:

- Selection of the object,
- Defining origin point (or pivot point in 3ds max),
- Typing rotation angle from keyboard or rotating manually,
- Ending the operation.

If two mice or graphical tablet used, there will be shortcut in this process and by using two hands designers will control the model in a rapid way which allows them to behave spontaneously.

Technically, while usage of two mice simultaneously, one mouse works ordinarily (clicking, rolling) but the other mouse provides only changing two parameter (X an Y) In this situation ordinary mouse can be used for defining fixed A point, the other can

Figure 7
Proposing operations that can be applied to the partial selection of model.

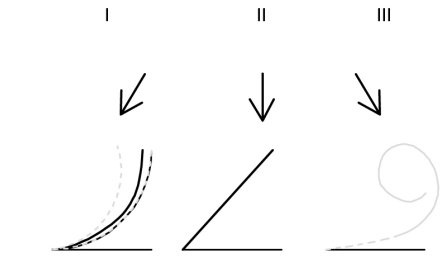
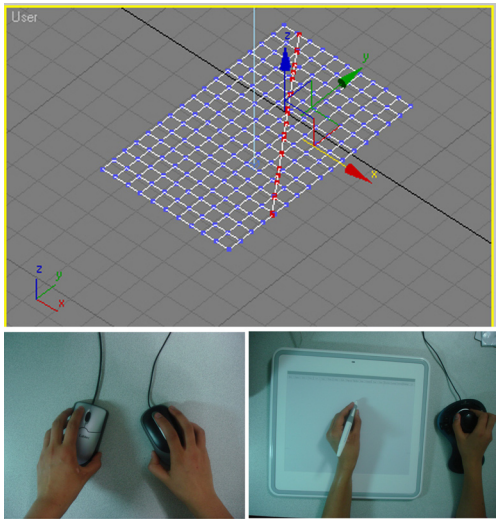


Figure 6
Sample Illustration of Integration of GUI and TUI environments



be used for controlling the operation with changing X and Y variables.

Conclusions

It is important for an environment to be flexible in terms of transitions among different control models such as fascist, communist, anarchist and democratic controls. This is because any of them may be needed during collaborative design process supporting creativity.

Tangible interventions may provide visibility and awareness to the designers while designing process and have a potential to enrich the level of interaction.

While the operation of rotation which is shown in Fig 4a applied consecutively, it is seen that using two hands can contribute to speed up the rotation action.

Moreover with paper metaphor, potential of adding new functions such as folding, bending partially, creasing, sketching partially are recognized (Fig5, Fig 7).

Physical materials have some limits. People are used to manipulate them for hundreds of years with hands. Therefore with the integration of physical and virtual environments, the number of new intervention techniques may increase. For instance, it is possible to crease a paper physically but stretching a surface is only possible in virtual environment unless the physical material is not flexible.

3D mouse is used for view control. Therefore, it is not tested enough with the other input devices yet. It is one of the topics of following future studies. Besides this multi touch surfaces and sensors are also should be examined on.

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