Fuzzy Layout Planner

A simple layout planning tool for early stages of design

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Abstract. This study presents a digital architectural design tool named “Fuzzy Layout Planner” that helps architects create two dimensional sketchy footprints for their design. The purpose of the tool is to extend limits of early design thinking. It uses fuzzy modeling techniques to adapt the ambiguous design phase. There are several commands in this digital tool to generate and modify layouts. Users can create, move, combine sketchy bubbles to form bigger footprints and see them in action dynamically. The tool offers a manual creation process.

Keywords. Architectural representation; digital design tools, early design, fuzzy modelling.

INTRODUCTION
Architects use various representation types such as sketches, technical drawings, physical and virtual models. These types of representations have the role of communicating with design. From early design stage to the last, this “translation of thought” method has an important role. With these kept in mind, in this study, early design phase supporting tool; Fuzzy Layout Planner is developed.

In early design phase, the tools we use affect our design thinking because external representations have direct impact on our thoughts. In addition to this, representations that architects produce are not only output of thoughts. They also serve to justify their thinking method. Goldschmidt (2003) says that “one reads off the sketch more information than was invested in making.” This applies to sketch like interfaces and most of the quick design tools also. External representations in architecture are aids for thinking. They help designers to try possibilities outside of “mind” and pull in new information from the previous output. While combined with computer environment, digital space can give us live feedback such as seeing things dynamically in a special designing environment. A digital sketch-like interface can be useful for reading more information from the outputs of mind.

Diagrams, infographics and technical drawings transform information; their purpose is to describe their content. Whatever the content be, the way of showing things on selected medium is important. There are many types of representations in design. The medium changes the way designers’ thinking method. Representation differences may be useful for different thinking. In summary; extending capabilities of digital design, developing a design environment for architects and architecture students are
the purposes of this research.

Fuzzy Layout Planner is a simple digital design tool to create plan layouts with a sketch like interface. It aims to create digital bubble diagrams that mimic the real world physics.

**Layout Planning**

Layout planning is an architectural design problem. Various research has been done in this field. Especially in automated layout creation systems, there are significant studies including some methods such as evolutionary/genetic algorithms and constraint based selection systems (Jo and Gero, 1998; Elezkurtaj and Franck, 2002; Baykan and Fox, 1991) (Figure 1). The traditional ill-defined layout creation problem should be formulated to make it more well-defined in these processes. There are different types of approaches in early design phase in the context of layout plan creation.

Based on the same philosophy of layout generation via digital tools, there are some examples including bubble-diagrams, agent based systems and less optimization more selection adapting studies exist (Hua and Jia, 2010; Schneider et al., 2011) (Figure 2).

**Fuzzy Modeling**

Fuzzy modeling is an example of an alternative representation method. It brings the importance of relations between spaces. It is used for defining uncertain information. There are various representation types in fuzzy modeling context. Boundaries and fuzzy information can be modified (Figure 3). In this representation method there is abstraction and continuity (Koutamanis, 2001). It can be used in early design phase of design effectively. In Fuzzy Layout Planner software, there are different representation methods and they can be modified.

**FUZZY LAYOUT PLANNER**

Fuzzy Layout Planner is a computational tool that allows creating sketch-like footprints. On a blank digital environment, user creates layouts made of bubbles for the spaces needed. The bubbles can
be named and they automatically show total area. When fixed to that number, total area stays the same and space dimensions can be adjusted as height and width (Figure 4). This helps user to maintain the total sum of spaces.

Commands
Fuzzy Layout Planner has some basic sets of commands for the creation phase. These commands are accessible with keyboard buttons and can be shown on the commands info page. They are described as separate tools like:

- Bubble tool for creating bubbles as zones.
- Select tool.
- Move and Copy tool.
- Cut and Join tool.
- Group/Ungroup tool.
- Name tool for naming bubbles.
- Rotate tool.
- Resize tool.
- Paint tool to assign different colors for bubbles.
- Layer tool for placing bubbles into different layers. This helps user to define different floors.
- Import tool for background images such as site plans.
- Export tool for saving layout images.
- Pan and zoom tool for viewing environment.
- View options tool for changing the representation types such as point sets, moving/static bubbles, intersecting boundaries, general colors etc.
- Rules tool for adjusting the overlapping spaces, repulsion forces between bubbles etc.
**Layout Creation**

In this digital design environment, the bubbles are moving dynamic parts as default. They have fuzzy boundaries which can be adjusted. This helps designer to see zoning of the spaces better. They can overlap and make intersections of zones if overlapping property has been set.

The bubbles can be split into smaller parts via cut tool. By default, every bubble created is non-overlapping (Figure 5). The separate bubbles can be joined together also with the join tool.

When moved, the bubbles push each other with a pre-adjusted and modifiable force. When working with large scale projects, multiple bubbles can be grouped and moved together (Figures 6 and 7).

Designers decide the level of detail. In one sce-
nario, the bubbles can define the smallest unit of a building or in another scenario, the zoning is a part of an urban space and smallest element can be a whole building block. In Figure 8, a single storey building is zoned as inner spaces. Specific areas can be fixed into area size and could be modified as shapes.

Fuzzy Layout Planner is a highly customizable information carrying design environment. It is a tool that you can interact and play with footprints of the space you are going to build later on. The benefits of trial and error in early design phase are indisputable. This tool is an experiment on the intersection between bubble diagram and layout planning methods.

**Scenario Example 1**

A dwelling layout is studied in this first example. In this scenario, there is no strict list of spaces before. Designer creates the spaces on the go. First, there are three zones; an entrance, rooms and a hall connecting them together. So user imports a site plan into the environment as a background image. The image can be scaled to match real world units.

At first, the total space is defined. The area of the bubble is not accurate at this point. Then it is divided into smaller parts (Figure 9). The parts are resized and copied to arrange some rooms and a hall between them (Figure 10).

**Scenario Example 2**

An early design of a museum building is explained in this example. In this scenario, there is a list of spaces that needs to function in the project. So the user creates the spaces roughly. According to their priorities in terms of adjacency, some bubbles are grouped. When pushed towards each other, the group has more repulsion force because it has more volume in
it. The user is expected to make inferences from the process of moving and resizing bubble zones. At the very end an arrangement is selected and saved to support later stages of design (Figure 11).

**CONCLUSION**

This study will make a contribution to early design stage works. As Goldschmidt (2003) says; “Designers make sketches because the sketch is an extension of mental imagery, and therefore has the freedom of imagery to retrieve previously stored images and to manipulate them rapidly.” This research is based on sketch-like thinking. With this computer supported tool, bubbles can be quickly generated and moved around, split, joined together. There is size information on top of them and they can be modified like a physical model. The way you represent the problem affects how you solve the problem. Fuzzy Layout Planner is made flexible as possible to adapt itself for the architect.

**Benefits and Drawbacks**

Fuzzy Layout Planner tool intends to make things quicker and efficient in early design phase. Its purpose is not to replace sketch but it is to help architects in some ways like rapidly creating and organizing layouts. Evolutionary systems, genetic algorithms and other automated processes are not included in the software. It is a fully manual process. They can be supporting tools in the system in the future versions while keeping the approach the same.

There are some limitations in this tool. For example, for projects containing a few spaces, the design tool is not very effective to use except for seeing the spaces in dynamic fuzzy contours. On the other hand, if a detailed long list of spaces is the starting point, fuzzy layout planner becomes handy. Controlling entire layout and many sub-spaces in an efficient way, it makes more sense to use this software. It improves the communication between the designer and the drawing as it can change representation styles and it provides the possibility to...
be in a dynamic layout environment. One can use it along with sketching. Sketchy interface stands for the vague definitions of the placement of spaces. It helps to read more information from the environment and get more opportunities to see while designing. Also right now the system works only in plan view mode as it refers to traditional layout problem solving approaches, but it would be helpful if it was optional to change view for three dimensional, orthographic or perspective views. Of course this implementation will come with different arguments and this feature will be one of the future additions.

REFERENCES
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