Digital Design Methods 1

Introduction

Digitally supported space-planning methods have been researched for past thirty years. In those researches, several different aspects were raised and developed for reaching the optimization of space layout, which include issues of travel distance and frequency of people in different level of importance, travel distance and frequency of objects, and the cost of the travel distance (Hsu, 2003). The computer-aided space-planning programs that were created by these methods produce two-dimensional space diagrams to present the relationship of spaces, which satisfied the designer in certain level at that time.

As we notice during this decade, however, two-dimensional space layout is no longer enough for a designer to study or develop the required architecture in their minds. Instead of creating „ideal“ architectural form, they compromise and create the „substitute“ form for their project. (Serriano, 2003)

In this research, the authors propose a new method to study architectural form generation, which includes an improved space-planning concept and transform the result from a two-dimensional space layout to three-dimensional space massing. With this method, designers can explore the architectural form by observing the development of three-dimensional space diagram that is arranged according to space adjacency requirements.

Development of Three-Dimensional Space Diagram

Before the improved space-planning method is discussed, a new representation of space diagram should be addressed. By pushing two-dimensional space diagrams to three-dimensions, designers are impedied by some modeling methods of the software. Instead of

Form Development with Spatial Character

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In space planning programs, two-dimensional space diagrams have been developed as the result for showing space relationships. With these results, a designer can only see two-dimensional possibility of the building development, or combining space stacking plan for the concept of three-dimensional space relationship and imagine the further development. In addition, a designer may spend times on the form development from two-dimensional space diagrams. To breakthrough this limitation, several methods have been studied for transform two-dimensional space diagram to three-dimensions for a designer’s further use.

Keywords: Space planning; form generation; spatial character.
able to experience and understand the feeling of the space arrangement. As we discuss the three-dimensional architectural form, two kinds of forms are commonly use for current architecture: a solid form and a fragmented form (Figure 1). During the design process, some designers picture a beautiful solid form before or after they see the site for the project, and start to arrange spaces into the form; some designers create a fragmented architectural form to fit the environmental conditions functionally or conceptually after they study the site. With a solid form, it may or may not satisfy the space arrangement for the project; a fragmented form, however, has more possibility to fit the functional or spatial requirement by organizing spaces to certain places with the fragmental character.

In this study, the authors propose a form generation method that creating fragmental forms compositing by the spaces. Two directions are approached in this research for developing a three-dimensional space diagram that can be an improvement over the result of the past space-planning methods.

1. Multi-story space diagram: The original space-planning programs only produce two-dimensional space diagram for single story. For a multiple stories project, a designer repeat the process for each story, and then combines the results into a space section plan to understand the space relationship. By improving space allocation technol-
explored after combining the new space-planning technique: Spatial character.

**Concept of Spatial Character**

In order to satisfy the flexibility of generating each designer's personal preference and design style, as well as for the benefit during further status of form generation, this research gives the space-planning program the additional ability of adding personal preference by creating unique space organization module. Spatial character is proposed for this method. Designer can use this method to grant personal space organization aspect during the architectural programming process. In this method, designer can visualize the space as a person and apply personal experiences of space organization to different category of gathering behavior to arrange spaces. Every human being has a different personality that consists of one or more characteristics. Their personality reacts differently in different environments or with different people. Consider a space as a person. Every space has its own personality with several spatial characters that differ by project. These characters cause the space interact with other spaces in certain manner. These characteristics can be categorized as seven expressions of human behaviors:

1. Leading / Following: A person with leader quality attracts people to follow. As the term, the space with a „Leading“ character gathers spaces that relate to it (following) and forms a group. The „Following“ space only follows the space with „Leading“ character; there is no relationship between following spaces (Figure 4a). As in an architectural firm, for example, the relationship between principle's office and design studio could be leading-following relationship (Table 1). Design studios are responsible for different projects follow their own principle or manager. However, the principle's office or manager's office does not always play the leading role, this depends on different projects or different designer's concept. As in a bank, a waiting area could play a leading character that is followed by ATM area, tellers, and a personal banking area.

2. Grouping: People gather for a certain purpose, same objective, interest or goal. By imitating this characteristic, the spaces that carry the same „Grouping“ character gather as a group (Figure 4b). These spaces are related to each other. Using the previous example, the architectural firm, design studios prefer to be together for project discussion, as well as, with the staff conference room. (Table 1)

3. Loner: This character affects the space distance from groups for a person who prefers more privacy and avoids social conversations and stays away from a crowd (Figure 5a). In a residential project, some clients may prefer more privacy for their master bedroom. In this case, the Loner can be a proper character to keep a distance away from certain spaces; the living room, dining room, or even other bedrooms (Table 1).
4. Servant: A space that serves other spaces in some way that needs to be adjacent to them but prefers not to appeal visually, which as in reality, servant needs to be near to the master while stay out of the sight (Figure 5b). In most of the case, the restroom plays a servant character in many projects. People need restrooms but prefer them out of the sight (Table 1). By adding these additional parameters to the spaces, a designer is able to witness the changes of the space relationship. Furthermore, more design possibility can be produced during this observing process.

5. Watcher: This character causes a space to locate beside the boundary of the project for attractions in the environments. It is based on the human nature that people like to watch or close to certain incidents. The attractions can be different type of environmental conditions, like views, parks, lakes, or parking (Figure 6a). This character is useful for many different spaces in design projects, for example, the principle’s office, a waiting space, a dining space or a café (Table 1).

6. Outreaching: The space with this character locates near the entrance or corridor for meeting or activities that relate to outreaching. This type of space represents an outgoing or sociable behavior like human that can represent a welcome space or a gathering space for a building (Fig. 6b). For example, a living room for residential unit, a lobby for office building, or a waiting area for a bank (Table 1).

7. Worker: A space that offers supplies to other spaces. It is not necessary for the space with this character to be adjacent to other spaces, but it needs to be near to a second entrance or service entrance. This concept represents the rule of separate entrance and activity area for workers and customers (Figure 7). The difference between Servant and Worker is that the Servant dose not need to adjacent to any entrance. A service area usually has a Worker character in several building type, as a loading dock area, a mechanical room, or a janitor room (Table 1).

Generally, every designer has a different set of ideas for each project, or the same project but different goals. To address this variety, spatial characters can be very different even for the same space type. The following concerns can be a reference that how to address the spatial character to spaces. (White 1975)

- Similarity of general role: Leading / Following, Grouping
- Relatedness to department, goal and system: Leading / Following
- Environment related: Outreaching, Watcher, Worker
- Effect produced: Servant, Worker
• Frequency of activity occurrence: Grouping
• Duration of activities: Grouping
• Privacy: Loner

These attributes can help architects understand more about the behavior of each space character; Table 1 shows the possible space selection according to behaviors of each spatial character. Based on different design issues, functional considerations and a designer’s style, different characters could be applied to every space. The suggestion list in Table 1 tends to give a designer better understanding of how spatial character works.

Figure 8 displays a complete space diagram that includes the selections of spatial characters in an architectural firm. In the diagram, the two principles’ offices are followed by different design studios and a secretary office. Also, spaces with different Grouping character clustered into different groups, which shows Group 1 (Gr1) as design studio, staff conference room, and computer room; Group 2 (Gr2) as material and sample room, storage room, and service area. The diagram demonstrates that each character can carry different symbol (or number) to separate from the space with same character but gather spaces with same symbol (or number).

### Merging Form Generation with Spatial Character

After generating three-dimensional space diagram by applying spatial character to the space-planning program, a designer can start using different form elements for each kind of spatial character. Conceptually, different types of spaces or space groups contain different context, needs, or style.

<table>
<thead>
<tr>
<th>Character</th>
<th>Residential</th>
<th>Architectural Firm</th>
<th>Bank</th>
<th>Theater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading</td>
<td>living room</td>
<td>principle’s office</td>
<td>waiting space</td>
<td>lobby, theater space</td>
</tr>
<tr>
<td>Following</td>
<td>dining room</td>
<td>design studio, secretary office</td>
<td>tellers, ATM, personal banking</td>
<td>vestibule, coat closet, café, restroom</td>
</tr>
<tr>
<td>Grouping</td>
<td>bedroom</td>
<td>design studio, computer room, staff conference room</td>
<td>teller’s office, personal banking</td>
<td>galleries</td>
</tr>
<tr>
<td>Loner</td>
<td>master bedroom</td>
<td>storage room, files room</td>
<td>manager’s office, vault</td>
<td></td>
</tr>
<tr>
<td>Watcher</td>
<td>living room, bedroom, master bedroom</td>
<td>principle’s office</td>
<td>waiting space, managers office, lunch room</td>
<td>café</td>
</tr>
<tr>
<td>Outreaching</td>
<td>living room</td>
<td>lobby, client conference room</td>
<td>waiting space, ATM, community room</td>
<td>ticket vestibule, lobby</td>
</tr>
<tr>
<td>Servant</td>
<td>bathroom</td>
<td>restroom, lounge, material/sample room, print/work room, library</td>
<td>restroom, training room, conference room, lunch room</td>
<td>restroom, coat closet, backstage, dressing room</td>
</tr>
<tr>
<td>Worker</td>
<td>Kitchen</td>
<td>mechanical room, garage, service area</td>
<td>storage, janitorial, data/telecom room</td>
<td>supply storage, mechanical room, loading</td>
</tr>
</tbody>
</table>

Table 1 Possible spatial character suggestions for different building type.
With this concept, designers can apply form elements to each space group that has its own spatial character and explore great amount of possibility of form generation that related to spaces relationships and function. According to the method of architectural form development in schematic design, two methods are proposed in this study:

1. Spaces as simple geometries: With this method, each single space or group of spaces is given a geometry that represents its character. The combination of geometries forms a unique shape that can be studied for potential architectural form. Combined with the spatial character, the designer can assign geometries based on different character and observe the form generation. The form that produced by this procedure suggest a possible architecture form which follows space interrelationship, functions, characters, and designers style.

Before architectural form generation is involved, different colors of rectangular-shape boxes represent variety of space and the quantity of the spaces to serve the space arrangement purpose for designers. The experimental result from the space-planning program shows a three-dimensional space diagram with rectangular shape in the same height (Figure 9a). As taking the advantage of three-dimensional model of the space diagram, different geometries and heights can be applied to spaces for architectural form study based on spatial character, such as cylinder, extrusion of polygon, different aspect-ratio rectangular or even a sphere (Figure 9b).

2. Spaces as free form: Free forms are popularly used now in architecture design because of the help of easy-operating CAD system and design fashion in this period of time. This method is fairly personal and objective, which can create wide range different forms. With combining

![Spatial Character diagram (architecture firm).](image)
mathematical equations and drawing techniques in CAD system, this research is able to propose a way for designer to explore free form with spatial character. A three-dimensional free form can be assign to certain spaces according to designer's design style, conceptual idea or project theme. The free form can also be related to the environment. According to the purpose or the concept of the design, certain spatial characters can be assigned as particular free forms in some projects. The following figures show the possible forms with this concept (Figure 10).

**Conclusion**

Instead of creating another space-planning optimization technique, the authors propose a new method of customizing space layout and producing a three-dimensional space diagram for the purpose of architectural form studies. Different from using current CAD system to create forms, this method offers designers to „discover“ the possible architectural forms from the composition of spaces based on space adjacency consideration, meanwhile, designers can also add in their idea of form during the process. With further research and case studies, more potential of form development can be expected in the near future.

**References**