Multi-Functional Furniture Design in Small Living Space

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Abstract: This study intended to present a new direction of differentiated and innovative furniture design for small living space overcoming the uniformity of conventional small living. In order to achieve these goals, a new piece of furniture with multi functions useful for such small space has been designed and explained in this study. This new type multi-functional furniture can be utilized as kitchen, dining table, home bar or office stand depending on the user's necessity. In particular, it provides more adaptability to changing life and spatial availabilities for small living space in terms of space division, separation and fusion features. Based on the needs of small living space brought by social changes, the conventional concept of small living space, which divides space by partitions or walls, should be changed into flexible perception of space. Also, this research proposed the features of furniture design for functional shifts in terms of its functional, structural, and systematical aspects. In this respect, space can be regarded as a variable place and the image of space can be differently appreciated by means of shift, functional transition and mobility. That is, small living space can be perceived as kitchen, living space or working space at the same time. In conclusion, the versatile use of limited space can be a solution to the issues related to small living space; the convertible and movable furniture called F4 Island presented in this study can transform such spatially limited space into a space with multiple functions to meet the requirements of its residents.

Keywords: functional shift, space saving kitchen, small living space

1. Introduction

1.1. Background and Objectives
Changes in life patterns and more diversified values of the people in modern society have greatly contributed to the expansion of one- or two-person households, facilitating a rapid growth of studio type houses. The changes in the roles and uses of living area have been accelerating as the level of demand for such spaces rapidly grows and varies. In addition, the structure and function of studio type living area are transforming in response to the consumer trends and lifestyles. This study is aimed at providing the design suggestion for previous studio type house and furniture in order to present ideas to effectively utilize the space of living area and practical solution for daily living based on the common life patterns.

1.2. Scope and Method
This study intends to propose furniture design, which meets user's various life patterns and is open to functional changes, for small living area.

In order to achieve such goals, we have analyzed the characteristics of such styles on the ba-
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Fig. 1. Changes of family structure and diversification of household types (Lee, 2010).

Fig. 2. Relationships between spatial transformation and products (Choi, 2009).

Table 1. Relationship between products for a functional shift

<table>
<thead>
<tr>
<th>User</th>
<th>Functional features</th>
<th>Spatial features</th>
<th>Object</th>
<th>Fusion-convergence functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shape to ensure convenient transport and rotation</td>
<td>Movement to open to change and transform</td>
<td>Incorporation of different elements</td>
<td>Versatility</td>
</tr>
</tbody>
</table>

sis of the concept and types of small living area while reviewing the general features of the changing types and family members. Furthermore, we have examined the functional, spatial and fusion-convergence functional aspects of various integrated furniture based on inter-relationship between the necessary functional transformations of small living area.

Specifically, the functionally shifting Island kitchen that is being developed is the key element of this study. This is an example that meets the current requirements of residents of one person household and small living area in terms of the quality and satisfaction of life, and such requirements will be soon increased.

2. Overview of Design of Small Living Area

2.1. Understanding living area in the context of social environmental changes

Industrialization and urbanization in modern society have led to the advancement of people’s educational level, contributing to a number of changes in overall society including the increase of women’s participation in economic activities and ages for the first marriage, extended average life span and shifts in their values. The transformation of family structure and the types of households affected by such change can be illustrated as follows (Fig. 1):

Two of the most prominent social and demographic shifts in Korea are that households are becoming smaller and that single households are getting increased due to the decrease of the average number of household members.

2.2. Meaning of small living area

A small living area indicates a studio type house where there is no separation between the spaces for sleeping, living and cooking except bathroom; in other words, almost all the functions required for daily life are not separated by fixed walls but are took place in one small open place where is just enough for living of one or two people.

A small living area refers to a small scale house that is built for one or two people’s living. That is to say, the space is characterized as an open flowing space that allows freely transforming one function to another one rather than separating the space with fixed walls. A small living area tends to occupy a small space in general; however, it may be possible to implement unique,
Table 2-1. Characteristics of relationship for functional shifts

<table>
<thead>
<tr>
<th>Features</th>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
</table>
| Functional Features | ![Fig. 2.1. Ron Arad. 2003. BOUTIQUE Y'S. Tokyo.](image1) | - Four pillars: Rotation table made of aluminum  
- 34 rotation ring pillars: stacked up from the floor to the roof  
- It slowly moves due to the turn-table on the floor  
- Adjusted to turn very slowly so that it would not be noticed Yohji Yamamoto’s Flagship Store |
| Spatial Features | ![Fig. 2.2. Turn on project. Visionary housing. 2000 experiment prototype.](image2) | - A unit used for setting the position of furniture by turning the wheel  
- Programs such as shelves, chairs, beds, etc  
- One third of the wheel can be opened to the outside direction  
- A living area can be formed by connecting multiple wheels  
- The bed turns into the roof and the dining table appears from the wall - while cooling in the module. |

Table 2-2. Characteristics of relationship for functional shifts

<table>
<thead>
<tr>
<th>Features</th>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
</table>
| Spatial Features | ![Fig. 2.3. In association with Prof. Luigi Colani & HANSE HAUS Germany.](image3) | - Arranged in circular type, which integrates the functional and structural areas of the spaces for sleeping, cooking and bathing  
- Rotation rotor depending on the necessity of functional space  
- Same dimensions of necessary space, each space rotates separately.  
- The smallest dimensions so far. |
| ![Fig. 2.4. Q4 Plugged. Philips Design. 2001.](image4) | - Future oriented integrated furniture system  
- Present new future life image by integrating modern technologies and furniture  
- Incorporated the interactions among man’s behavior, appliances and furniture  
- Design conversion to more versatile functions to cover rest, work and even play. |
| ![Fig. 2.5. Joe Colombo. 1970. Cabriolet-Bed. Milano.](image5) | - Designed to allow doing various activities a person wants to do on the bed at the same time.  
- open and closed a tent-like roof of the bed  
- Perfect privacy within the bed.  
- A radio and ventilation system for listening to music and smoking |

versatile and changeable designs depending on how to utilize the space, for example an effective arrangement of furniture.

2.3. Characteristics of interrelationship for functional shifts

We have intended to propose building an unique and versatile small living area by achiev-
Table 2-3. Characteristics of relationship for functional shifts

<table>
<thead>
<tr>
<th>Features</th>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
</table>
| Fusion conversion functions       | Fig. 2.6. Stand by Office. Koenig & Neurath. Germany.                 | - More aggressively reduced the space occupied by furniture  
- Used as a partition to separate spaces in normal times  
- More space can be secured by opening the door which is set beside the wall  
- To form a desk, screen and book shelves in a work area |
|                                   | Fig. 2.7. Choi. K. R. 2005. DOBO11 Furniture for children’s room. Hansssem | - Considered the physical and intelligent growth of children  
- Unit system furniture that constitutes the entire set by itself  
- Effective in a small space, in particular, in a studio house because multiple functions are embedded into a piece of furniture |
|                                   | Fig. 2.8. Clever Kitchen .Exhibition hall in Kölle. 2007.              | - Clever rotation kitchen where the entire set of kitchen furniture can be installed in a minimum space  
- Possible to install a freezer, dishwasher, ceramic hop, hood, micro- wave and oven.  
- The cooking table can be rotated by 180 degree reducing the movement of user as much as possible.  
- The kitchen disappears when the rotation door is closed. The circular kitchen is an element of interior design |
|                                   | Fig. 2.9. MITON. Exhibition hall in Milano. 2006.                     | - Tools for cooking and storing  
- Lift up and down system.  
- Maximize the spatial use both it is in use and not in use |
|                                   | Fig. 2.10. POGGENPOHL. Exhibition hall in Milano. 2007.               | - The function extends when bring the food cooked in the kitchen to the dining table  
- Movable cabinet thanks to the wheels underneath. |

2.4. Characteristics of relationship for functional shifts

Thus, the functional shifts of furniture and behaviors of the user in a studio house will play a crucial role and affect the human relationship and spatial structure inside the house. It could be one of the reasons why it is necessary to perform the researches on the furniture with functional shift features to adopt various experiences occurring inside the living area and its spatial concept.

Three types of relationship pattern have been analyzed as an integrated system after being classified into User, Space and Object. And the interactions of furniture that has adopted functional shifts and spatial concept along with its respective
key word have been summarized as in the chart below (Table 2-1, 2-2, 2-3).

3. Development and Features of Design

3.1. Design Direction (Table 4)

It is possible to properly separate the spaces or sometimes to adopt fusion elements in order to maximize the utilization of small space. The space must be separated functionally according to respectively designated purposes to maintain its original characteristics while exhibiting changeable functions in detail depending on the user’s desire at the same time (Kim 2004).

3.1.1. User

The rotational top board rotates allowing the use of the stove and cooking area. When completely opened or closed, the space can be fully utilized.

When the rotational top board is completely closed, the area can be utilized for other purposes.

3.1.2. Space

A unique living area is formed by integrating different elements and divided into four space types; x_space when it is opened by 360 degree, Y2_space sink area, Y1_space stove area and C_space when the top board is fully closed.

3.1.3. Object

It consists of the bearings and wheels underneath for rotation, which allow easy and convenient control and multi functional use of the space depending on the user’s desire. It can be opened from the side allowing more effective use along with other space.

3.2. Design Development

3.2.1. Sketches and Description of Ideas (Zoning, User Postures, Movement Path) (Fig. 3,4,1)
3.2.2. 3D Simulation

The rotational top board is made larger than the body of the lower board to ensure nothing exists inside the rotation radius according to the first 3D simulation. As a result of that, issues related to the type of hardware of the rotation bearings and dull external circular lines were identified (Fig. 3.5.1).

The Island table has been designed too big due to the second simulation, resulting in no compact and ideal space for small living area. We have set the ratio of the rotating board to the fixed upper board one to one by amending the legs to be exposed and used as the handle and dishcloth hanger (Fig. 3.5.2).

3.2.3. Production Drawings and Prototype (Figs. 3.6.1, 3.6.2, 3.6.3)

3.2.4. Mockups and assembly process

Produced the real size sample for checking the ratios, adjusting dimensions and rotation radius in detail. Came up with the variables of dimensions to minimize scratches on the lower board when the upper board is rotating.

Fig. 3.7.2 contains the pictures of lower body made of artificial marble, LED embedded 8T glass shelf, the position of circuit breaker, etc. Fig. 3.7.3 shows pictures of the doors of lower cabinet as it is completely assembled. They are made of P.P. and roller shutter style, often called sliding doors. Installation of LED shelves illuminate softly through opaque glass.
Table 5. Pictures from product

<table>
<thead>
<tr>
<th>Fig. 4.1. C_space.</th>
<th>Fig. 4.2. Y1_space.</th>
<th>Fig. 4.3. Y2_space.</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the rotating top board is completely closed.</td>
<td>Rotating top board – space for the sink</td>
<td>Rotating top board – space for the stove</td>
</tr>
<tr>
<td>Fig. 4.4. X_space.</td>
<td>Fig. 4.5. C_space.</td>
<td>Fig. 4.6. X_space.</td>
</tr>
<tr>
<td>Rotating top board - fully rotated</td>
<td>Lateral view of the roller shutter door</td>
<td>Front view of the roller shutter door</td>
</tr>
</tbody>
</table>

3.2.5. Pictures from product (Table 5)

3.3. Change Elements at Each Space of the Prototype

Y1 and Y2_Space are mainly designed for dining, in which the cooking table and the stove space are conveniently arranged. It is a place for a rest drinking a cup of tea. C_Space has been focused on the uses of bedroom and living room, reducing the kitchen functions. X_space is the table space intended to facilitate changeable spatial elements, in particular, to have both work and living spaces where the user can work as well as meet friends (Table 6.1).

3.4. Design Suggestion for Utilizing the Space

The suggested design focuses on the spatial uses of X-Space. The table space which has been expanded from the dining area allows both work
Table 6-1. Space utilization and spatial element type

<table>
<thead>
<tr>
<th>Design direction</th>
<th>Design Concept</th>
<th>spatial element type</th>
<th>Icon</th>
<th>Space utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional features</td>
<td>Rotation</td>
<td>Y1_space Y2_space</td>
<td><img src="image" alt="Icon" /></td>
<td>For drinking tea during rest</td>
</tr>
<tr>
<td>Spatial features</td>
<td>Convertibility</td>
<td>C_space</td>
<td><img src="image" alt="Icon" /></td>
<td>For drinking a glass of wine in home-bar</td>
</tr>
<tr>
<td>Fusion-conversion features</td>
<td>Versatility</td>
<td>X_space</td>
<td><img src="image" alt="Icon" /></td>
<td>① For enjoying cooking time ② Party, social gathering ③ Expanded dining area</td>
</tr>
</tbody>
</table>

5. Conclusion

The basic premise of this study is that “functional shift” is one of the crucial elements that can provide a solution for recent issues with respect to present living space and meet the requirements of users.

In this study, we have intended to propose criteria for the shifting elements and practical ideas for planning the functional shifts and transforming the spatial structure inside a small living space. In addition, we have produced prototypes based on the ideas to provide methods to effectively improve the utilization of spaces for living and cooking, promoting more active response to the changes in users’ living patterns.

Firstly, it has been revealed that more aggressive approaches to the furniture design for such small living area is required based on our review of the changing trend of small living space in our society. The previous concept of separating spaces of studio house with fixed walls can be considered as a rather passive approach. More variable methods using transforming and moving elements have to be applied for the spatial separation, division, fusion, increase and reduction.

Secondly, we have reached conclusion that the image of space can be shifted to a variable ele-
Table 6.2. Focused on the spatial use for activities

<table>
<thead>
<tr>
<th>Spatial Element Type</th>
<th>Icon</th>
<th>Activities</th>
<th>Spatial Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y1_space Y2_space</td>
<td></td>
<td>Listening to music and drinking tea for a rest</td>
<td>Focused on the effective use of cooking table and stove area to provide convenient place for cooking.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cooking</td>
<td>Flexible Life</td>
</tr>
<tr>
<td>C_space</td>
<td></td>
<td>For drinking a glass of wine in home-bar</td>
<td>The work top has rotated fully 360 degrees, reducing the kitchen space and providing more space for sleeping and living area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To take a rest</td>
<td>Time for a rest</td>
</tr>
<tr>
<td>X_space</td>
<td></td>
<td>To enjoy cooking with companions</td>
<td>Transformed to have a space to allow working at home or having social meetings with friends.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Party and invitation of friends</td>
<td>Place for social life</td>
</tr>
</tbody>
</table>

ment applying changes to the structure and functions of furniture based on the variability analysis of small living space in terms of function, space and fusion-conversion multi function aspects. We have identified three facts by applying such idea to the living space and kitchen. Spatial element type - X space: it can be utilized as a space for works or meetings with friends and spaces for working and living can be separated while variable spatial elements can be applied to kitchen area.

In the future, this kind of living environment, more specifically, designing furniture whose functions can be shifted to meet the contemporary users’ values and consumption trends has to be encouraged more.

Acknowledgement

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