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Information Tree - Establishment of Lifestyle-Based IT Visual Model

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***Abstract*—**Traditional service channel is losing its edge due to emerging service technology. To establish interaction with the clients, the service industry is using effective mechanism to give clients direct access to services with emerging technologies. Thus, as service science receives attention, special and unique consumption pattern evolves; henceforth, leading to new market mechanism and influencing attitudes toward life and consumption patterns. The market demand for customized services is thus valued due to the emphasis of personal value, and is gradually changing the demand and supply relationship in the traditional industry. In respect of interior design service, in the process of traditional interior design, a designer converts to a concrete form the concept generated from the ideas and needs dictated by a user (client), by using his/her professional knowledge and drawing tool. The final product is generated through iterations of communication and modification, which is a very time-consuming process. Although this process has been accelerated with the help of computer graphics software today, repeated discussions and confirmations with users are still required to complete the task. In consideration of what is addressed above a space user's life model is analyzed with visualization technique to create an interaction system modeled after interior design knowledge. The space user document intuitively personal life experience in a model requirement chart, allowing a researcher to analyze interrelation between analysis documents, identify the logic and the substance of data conversion. The repeated data which is documented are then transformed into design information for reuse and sharing. A professional interior designer may sort out the correlation among user's preference, life pattern and design specification, thus deciding the critical design elements in the process of service design.

***Keywords*—**Information Design, Life Model-Based, Aesthetic Computing, Communication.

I. Research Objectives and Background

ARCHITECTURE Design refers to a design activity that is specific to the purposes of architecture, including design activities per requirements for the environment, usage, and visualization, and presents specifically historical, cultural and symbolic meanings of architecture. The scope of Architecture Design includes Appearance Design and Interior Design and can be further extended to the relationship between architecture and environment. Interior design is then the recreation of the interior environment of architecture. In the area of residential space design, the style and preference of inhabitants are transformed into design concept and employed in the process of design, thus converting interior space to the value of life, emphasizing the taste of the family and individual, expressing the user's attitude toward life, and eventually providing a more cozy living space. Therefore, as far as functionality is concerned, Architectural Design provides an existing space, yet lifestyle and interior space need to be refined in detailed design. In other words, Interior Design is not only beautification of architectural interfaces, but more like a recreation of interior functionality and space form.

Besides, in providing innovative design service of interior design, innovation must take into consideration user's needs in order to reach consensus with the user. It is believed in this study that users should have access to sufficient information related to design in the course of communication, and they are hence allowed to understand the style elements of their needs and to participate in the provision of innovative service design. The time and the cost of communication can therefore be reduced, and the user may feel the sense of achievement. Therefore, how to build a service platform that can document the process of the user's joint participation in the design communication and visualize their life model and design requirement is worth of further study and development. Designers need more messages that influence the interaction between the user and design objects in order to produce a design object that complies with the user's experience and meets his/her expectations. By combining these massages with designers' expertise and knowledge, the designers not only are allowed to explore the user's experience and implicit needs which are introduced to design process, but also reap the benefit from exploring innovative design concepts in the early stage of design. For the purpose of saving designer's time in searching for design data and of emphasizing the method of converting the data acquired from a user's personal life model, data are visualized into design information that contains specific meaning. After the visualized design information is understood by the interior designer, it is further employed and converted to design knowledge, and eventually applied in the real service design. It is believed in this study a joint design method that involves users and interior designers should be developed to allow users' participation in design process. Users may also participate to the activity of creation through a joint design process, thus achieving the goal of service optimization.

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II. Related Studies

A. Technology Used in Information Visualization

Visualization can be expressed as a visual presentation of abstract data by using human's capacities of feeling and cognition. In-depth studies on information visualization technology in efficacy and representation type of visualization were made in many relevant case studies. Treemap type is the visualization technology proposed by Shneiderman [22]. The concept of this type is to present hierarchical data structure in

nested rectangles with skillful spatial allocation technique. The size of rectangle space expresses the relationship in size among certain attributes of information object. Sunburst type is one proposed by Stasko [28]. It is similar to a visualization technique called Spacing Filling and is used to present the information of file directory. The circle image in the center represents root directory or the top level of hierarchical information. This circle spreads outward from the center according to the level or the depth of directory while the angle of division of the circle corresponds to the sizes of the directories or documents. Hyperbolic Viewer type is a visualization technique proposed by Rao and Pirolli [11] et al. and is used to visualize a large hierarchy. In this technique visualization is employed by presenting data in a tree structure and placing them on a Hyperbolic Plane. Through interaction with the user, important information is moved to the center of the screen and magnified in Fisheye View. The relationship between objects in a hierarchy is thus clearly observed.

In fact, the so called Three Dimensional or Multiple Dimensional data structures are more compatible with human's visual perception; however data presentation in three dimensions or multiple dimensions on a two dimensional plane may create visual confusion. Moreover, time data which have the characteristics of being the beginning and the end of data are independent to one dimensional data structure. Tree structure data and network data differ in the existence of hierarchical relation between data items. In view of spatial information design object, Ljungblad, Redström and Skog et al. [15], [16], [18], [24], [25] announced, one after the other from 2000 to 2005, the concept of blending information into environment design. The information art expressed in weather forecast thus looks like a piece of work by Piet Cornelies Mondrian. Each rectangle represents one day, and the size of rectangle represents the temperature of the day. The color represents weather conditions with yellow for sunny day, blue for rainy day, and red for cloudy day. Date is calculated and displayed from left to right, from top to down, in the sequence of tomorrow, the day after tomorrow, and so on. Communicating message in the public space by using information display object makes artwork more than a pure display object. "7000 oaks and counting" [9] project developed by Holmes, T. G. is a piece of works that displays energy consumption by using information visualization technique. Values of various energy flows provided by a building's central control system are acquired through customized software, and then saved in a server, and the converted to the data of carbon footprint produced by human activity in real time. Electricity consumption is displayed metaphorically by the idea that trees can absorb carbon dioxide. The more electricity is consumed, the more trees are to be planted. Such an information image is presented in a display in the hall. This artwork intends to explore the methods of helping people see and understand the underlying information that is hidden in a building. From the analysis and comparison of visual information and the interviews with the residents, energy consumption information obtained from visualization can indeed help people understand the consumption of electricity and save the energy, thus helping promote the idea of sustainable development.

Compared to the typical Two Dimensional Information Visualization Technique, "We feel fine" [20], [21] is an interaction system for exploring human being's feelings worldwide. Since August 2005, the dynamic messages which contain the phrases "I feel" and "I am feeling" have been collected from each social networking site every few minutes. When such phrases were discovered and the corresponding complete sentences were recorded, those sentences were then confirmed to have expressed the "feeling" of the user, such as sadness, happiness and depression, etc. Because user profiles are stored in the social networking sites, the age, gender, the geographical locations of the authors are also saved with the sentences. Each selected and glowing particle represents a different person. When one particle on the screen is clicked, the sentence and the information of the author are displayed. The particle spreads around and will slow down gradually and eventually stop so that one may click at it easily. One can select other type of movement from the menu at the lower left of the screen. There are six interaction modes, which are: (1) Madness mode - Approximate 1,500 particles will be generated after execution of this mode and will spread outward from the center of the screen; each particle represents a single feeling while the color of the particle corresponds to the feeling expressed by the author through his/her sentence; the size of the particle represents the length of the sentence with bright yellow for being happy and positive, dark blue for being sad, cardinal red for being angry, and light green for being calm. (2) Murmur mode - Each particle float upwards toward the top of the screen after a user selects this mode. The words in the sentence that appear in the center of the screen will appear one after the other as if they are being typed out. Each sentence fades away gradually with time. (3) Mobs mode - This mode consisting of five modules uses the texture, shape, color, distribution, and configuration to express human's feeling, gender, age, weather, and geographical location. (4) Metrics mode - This mode consisting of five modules is used to present "most common" and "most outstanding" concepts for the expression of the user's most representative feeling. (5) Mounds mode - In this mode the frequency and sequence of each kind of feeling are shown in the database. Each feeling is depicted as a big mound whose color represents the feeling it corresponds to. The axes under the small mound represent the data of the whole feeling. (6) Montage mode - In this mode any picture is magnified on the screen at a mouse click. An author's sentence and message relevant to that picture are displayed as the picture is zoomed in or zoomed out. When it is zoomed out, a white and heart-like shape is located at the lower left of the screen. Clicking at this heart-like shape allows the user to save this picture. It is therefore concluded that "We feel fine" interaction system has unique characteristics in the areas such as information transformation processing at database end, aesthetic metaphor, interaction interface design, and method of information integration, and usage.

B. Definition of Life Model

Human develops close interaction with the environment

which consists of human's standing behaviors and the locations where such behaviors occur. Behaviors of the environment are thus multifaceted [12]. Barker [1] proposes that there are four factors in Behavior Settings, which are user, standing pattern of behavior, physical environment, and a period of specific time. Lang [10] also proposes that Behavior Settings are standing patterns of behavior which appear repeatedly in a specific place and time. If different users access this place, Behavior Settings do not disappear as a result. They will disappear only when physical environment changes. In other words, the standing pattern of behavior in Behavior Settings has close relationship with time. Wicker [31] makes a further discourse from the perspective of time, proposing a dynamic change model of Behavior Settings. He describes the behavior arrangement for the Behavior Settings in the time segment with Behavior Settings segmented in the time sequence and with composition factors as the major entry point of view. From initial gathering, standing pattern of behavior, to ending behavior, this process may be considered as a dynamic change process of Behavior Settings.

Based on the above description, it is concluded that the time for which Behavior Settings appear may be short or lengthy. For the benefit of analysis, the records obtained during the study must be well controlled during investigation. Wicker [32] and Schoggen [19] also point out that if confirmed Behavior Settings are to be described objectively, Behavior Settings must be divided into four parts for discussion of relationship between all parts and all information must be recorded. These four parts are user's frequent behavior and classification, amount and attributes of Behavior Settings, times and duration of occurrence, and the location and the size of the dimensions. The life model in this study is thus defined as a cycle that consists of generation, growth, change, fading, ending of user's behavior in a residential environment in a time sequence. On the other hands, in the study of the value of life model in a society and a culture, Højrup [8] stresses that designers should not only focus on understanding a user's life model, but also integrate the preferences of the user, family, and future demands with the characteristic information of a house, thus creating a complete map of user's life model. Overall speaking, in order to develop a joint design service based on a life model it is mandatory for users to share their ideas and opinions, particularly in the initial design phase. Communication and reflection are crucial to the core of design. In summary, this study employs the theory of Behavior Settings as the infrastructure for investigation, thus enabling space users to record behaviors that occur at home and the locations where such behaviors occur during test period. The user's life models in one day and in a period are analyzed accordingly.

C. Life Model-Based Information Visualization Model

Reviewing the history of human being, we can discover that human converted and presented duplicate and tedious data in a form that can be understood. These data were then turned to knowledge and eventually refined to wisdom. Such a transformation process has become the focus of human's research [27]. There has been huge amount of information involved in the development of human's cognitive ability. As a result, Card, Mackinlay and Shneiderman [3] have created a term called Information Visualization which involves a process of organizing mass data properly so that one can gain insights in some ways, dig out answers for questions, discover various correlations among data, even understand certain things that are otherwise hard to perceive. In summary of the study results of Miller [17], Wills [33], Spence [26], Bederson, and Shneiderman [2], Colin [5], and Shneiderman [23], it is then concluded that Information Visualization is a process that improves a cognition system's ability of understanding by presenting interactive visibility of the abstract data. These studies also point out that Perception System understands much faster than Cognition System while visual capacity is one that gives understanding in the shortest time. Exploring visualization data allows human to participate the process of Data Mining. One may draw a conclusion from the insights gained from visualized data and thus interact with data directly. Through visual interface, one can interact instantly with mass data and dig out implicit characteristics, modes, and future change and trend of data. As a result, relevant subjects of study, such as Architecture Data Mining, Architecture Design Knowledge Mining Knowledge [13], [14], thus emerge. For the benefits of design analysis and decision-making [4], Design Data Visualization can assist in Architecture Design Data Mining and Knowledge Mining through data classification and capture by using methods like cross examination, statistic analysis, etc.

Ancient Roman Architect Vitruvius, in his book titled *The Ten Books on Architecture* (*De Architectura)* [30], mentions three architectural design principles that should be adhered to: Completeness, Practicality, and Aesthetics. VandeMoere, A. and Purchase H, in their co-authored book, titled *On the Role of Design in Information Visualization* [29], point out that these three principles may be applied in Information Design and various applications that are suitable for Information Design. They also indicate that good visualized content should be very complete. In other words, the form of the design must match with the information described by the design. Moreover, visualized content should be practical so that the user may derive meanings from it. Finally, like any design, Information Design should be aesthetically appealing, draw attention from the user, and provide pleasant visual experience. The three design principles that VandeMoere, A. and Purchase H propose serve as a solid foundation for our judgment of the value of information visualization. This study is built upon above-mentioned view points, and the four steps of visualization by Colin [5] which are, respectively, collecting and storing data, pre-processing and converting data to an intelligible form, displaying, on the screen, image generated by the graphical engine, and human's observing and cognizing the image. There are also feedbacks existing between these steps whose correlation is shown in Fig. 1. Quantified data are used to express certain characteristics with symbols in lieu of digital expression of data. In term of visual meanings and perception, a project interior designer is more inclined to accept symbols than text mainly because he/she can quickly understand the data

and grasp their characteristics with the help of symbols. In term of data itself, the area scale, color, length, and quantity of the image are used to express content. The created image symbols replace the explanation in language in way of visual metaphor. Project interior designer can thus review digital data, provide opinions, and propose design service with better quality.

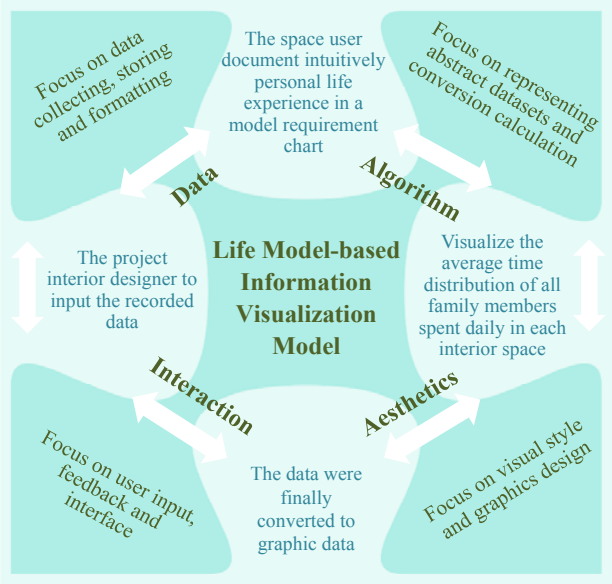


Fig. 1 Life Model-Based Information Visualization Model

III. Research Content

A. Background of Client

Due to tediousness and complexity involved in interior design, the interior designer provides design expertise and service based on design knowledge, builds up the framework of user requirement, and analyzes the attributes of style and design elements so that re-creation conditions of design elements in service combination may be met. This study first uses a nuclear family in a case study. There are three members in this family – Mr. Peng, Mrs. Peng and their son who is a student of senior year in high school. Mr. Peng, 47 years old, is the owner of a medium sized company. His hobbies are reading and travel. His friends often visit him at home. He likes to have a chat over coffee and spend most of his time before a computer. Occasionally he plays basketball. Mrs. Peng, 45 years old, stays home most of the time. She is a very good cooker. Occasionally she would invite friends over for a meal. She likes coffee, arts, and crafts. She often goes for a walk in the country and travels overseas. The house of the Peng family is located at the Main Street. The total floor area of their two-floored house is 1,800 square feet. The main amenities such as living room, dining room, kitchen, rest room and yard are on the first floor while master bed room, their son's bed room, study room, bathroom and balcony are on the second floor.

B. Space Encoding

For human being, different space forms account for different cultures under different environments. Any space has sphere depth and defined sphere is the result of encompassed boundary. The definition of Space Sphere Depth in this study is given according to the theory of sphere structure given in the study of Hiller [6], [7]. Hiller's study indicates that the sphere depth in space is obtained from observing physical environment, and from walking distance in space and accessibility of visual permeability. His study also indicates the relation in space is not geometrical, but topological. The study of space structure is thus rid of plane-based study, and the space encoding is symbolized and numeralized into symbols and mathematical system with single meaning for better exploration of correlation between spaces. As a result, we can conclude that the lower one's accessibility to a space is and the more private a behavior is, the deeper the sphere depth is. On the contrary, the more the people who share the control over a space are and the higher one's accessibility to such a space is and the more open a behavior is, the shallower the sphere depth is.

Therefore, this study is guided by the degree of privacy of a behavior and divides the sphere structure of living space in the case study into four levels (i.e., space coding) on a scale from "private" to "open." Living space thus includes several independent space units: rest room, master bed room, child bed room, kitchen, study room, dining room, living room, balcony, and yard. Each room is described as below. Bathroom and bed rooms are space-encoded as No. 1 because they are considered spaces under the same category and with the highest level of privacy. Kitchen and study room are spaces where independent behaviors occur, but they may be shared by members of the family, thus leading to cooperative behavior. They are space-encoded as No. 2. Dining room and living room are where family members gather and visitors stay for cooperative behaviors; they are space-encoded as No. 3. Balcony or yard can be seen by pedestrians; they are space-encoded as No. 4. Behavior settings for holidays or weekends, such as school, office, park, and market, are space-encoded as No. 5. Space levels encoded from No. 1 to 4 are the main subjects in this study. Space outside of the house (No. 5) is not considered for information conversion. Definitions for each level are shown in Table I as below.

TABLE I
Interior Space Encoding for the House

Sphere Characteristics	Sphere Encoding	Name of Space
The larger the Number, the lower the privacy is	1.	Bathroom, bed rooms
	2.	Kitchen, study room
	3.	Dining room, living room
	4.	Balcony, yard
	5. not included	Space outside the house

C. Journal Encoding

Family is the starting point of a community life and the most basic unit of a society. Everyone's daily life is filled with people, events, times, things, and places. This study begins with a space user's daily life sphere. Various conditions caused by each factor of a space user are used to create task description on a case study basis. Unlike ordinary questionnaire and interview,

a space user records his/her own daily activities and uses a journal and a camera to complete recording of his/her own daily behaviors. Keeping journal allows us to receive details of a space user's daily life. The descriptions of a space user's preferences, activities, environment, and use of an object are hence received through this mechanism. The interior designer then obtains a complete script of life. With camera exploration, family members are required to record videos of the locations of their activities, environment, or equipment used so that the interior designer may observe the environment and conditions in real life. Journal is recorded every one hour, 24 hours a day, and for 14 days (two week). During the period of recording, family members are required to record the behaviors that occur in daily activities, and where and when they happen. The samples of journal encoding are listed in Table II.

TABLE II
JOURNAL ENCODING: A DAY IN THE MR.PENG'S

Time	Activity	Name of Space	Duration (hrs)	Sphere Encoding
12:00 AM	Sleeping	Bed room	1	1
1:00	Sleeping	Bed room	1	1
2:00	Sleeping	Bed room	1	1
3:00	Sleeping	Bed room	1	1
4:00	Sleeping	Bed room	1	1
5:00	Sleeping	Bed room	1	1
6:00	Sleeping	Bed room	1	1
7:00	Get up and wash up	Bathroom	1	1
8:00	Prepare breakfast	Kitchen	1	2
9:00	Eat breakfast	Dining room	1	3
10:00	Visit customers	Space outside the house	1	5
11:00	Visit customers	Space outside the house	1	5
12:00 PM	Visit customers	Space outside the house	1	5
1:00	Eat lunch	Space outside the house	1	5
2:00	Go to work	Space outside the house	1	5
3:00	Go to work	Space outside the house	1	5
4:00	Go to work	Space outside the house	1	5
5:00	Go to work	Space outside the house	1	5
6:00	Prepare dinner	Kitchen	1	2
7:00	Eat dinner	Dining room	1	3
8:00	Eat dinner	Dining room	1	3
9:00	Prepare project report	Study room	1	2
10:00	Prepare project report	Study room	1	2
11:00	Take a bath and get ready for bed	Bathroom	1	1

D. Changes in Life Sphere in a Day

In this section, journal codes collected from the daily records in the case study are analyzed. A visualization analysis is performed for changes in life sphere in a day, and for numeric data about members' sphere distribution records during test period. Family member's activities in the environment are presented by the hour, as shown in Fig. 2 (base on Table II) which is the map of sphere change in a day during test period of case study. The measurement scale of life sphere change in a day is defined according to three principles:

1) The line coordinate of concentric circles has 24 gradations with each representing one hour. The number increases clockwise. One circle represents one day.
2) Concentric circles are indicative of degree of privacy. The farther the circle is away from the center, the more open the sphere characteristic of the space it represents is and the bigger the number is.
3) Colored area indicates that some family members were using that space at that particular time.

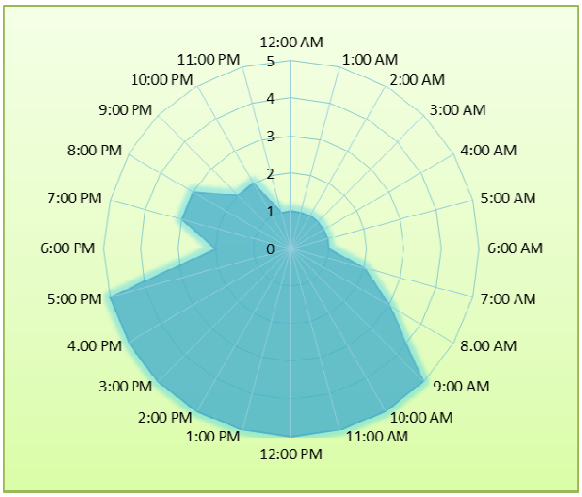


Fig. 2 The map of Mr. Peng's life sphere change in each space

IV. ANALYSIS - LIFE MODEL INFORMATION TREE

A. Sphere Activity Change Index in the Test Period

Continued from the member's map of life sphere change in the previous section, a two-week numerical analysis for the Peng's sphere activity change was performed. The results are shown in Table III. In this process, two assessment indexes were derived, which are Duration-Days (D.D.) and Frequency-Days (F.D.) respectively. These two indexes can show the sphere change of the family members, the space sphere where each spends most of his/her time, and the frequency of visit to the bathroom, bed room, kitchen, study room, dining room, living room, balcony, and yard. The formulas of index D.D. and F.D. are indicated as below:

1) Duration-Days (**D.D.**) $=\Sigma d$D/Days $\rightarrow \Sigma$Total time used for the space during the period of recording/Days of recording. This index is used to estimate the time the family members spend in the space per day.
2) Frequency-Days (**F.D.**) $=\Sigma d$F/Days $\rightarrow \Sigma$ Total visits to the space during the period of recording/Days of recording. This index is used to estimate family members' number of visits to the space per day.

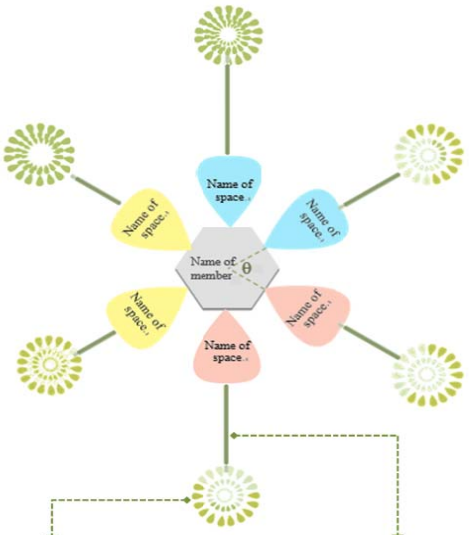
TABLE III
NUMERICAL ANALYSIS FOR MR. PENG'S SPHERE CHANGES DURING A TWO-WEEK (14-DAY) PERIOD

Name of Space	∑ Total visits	F.D. Total visits/ 14 days	∑ Total time of usage (hours)	D.D. Total time/ 14 days
Bathroom	29	2.07	14.5	1.04
Bed room	19	1.36	97.0	6.93
kitchen	20	1.43	22.0	1.57
Study room	8	0.57	16.5	1.18
Dining room	23	1.64	19.5	1.39
Living room	7	0.50	9.5	0.68
Balcony	3	0.21	1.5	0.11

B. Visualization of Sphere Activity in the Period

Generally speaking, Illustration Design is preferred in a narrative type of information map while the presentation of objective observation is required in a study type information map; thus there are fewer illustrations used in the latter. A good visualization design not only expresses the value of aesthetics, but also makes it easier to read for analysis and comparison of charts. In this section, the distribution of average usage time of the family members in each space sphere has been visually simulated and then converted to graphic information according to sphere activity change indexes D.D. and F.D. as mentioned above. Like plants which have different outlook under different conditions of light, water, and soil, Family members' "Life Model Information Tree" developed through this process also behaves similarly. The structure of the growth model is detailed as below:

1) Tree trunk: This is the center as well as the beginning of growth.
2) Branch: This refers to the direction of growth. The number of spaces varies from one interior design project to another. The degree of privacy of a space sphere is indicated by different colors. The change and calculation of angle bear relationship with the number of spaces, thus generating different patterns.
3) Number of leaves: D.D. index is indicated by the number of leaves which represents average amount of the time the family members spend in the space. The more the leaves are, the more the time spent in the space is.
4) Segments of branch: F.D. index is indicated by the length of the segment of branch. The length of a segment represents the total visits to a space. The longer a segment is, the more frequent of visitation to the space is.
5) Rule of growth: The growth model is divided into two basic elements – Core and Direction. A polygon represents the originating core of a tree trunk while the text inside the polygon represents the appellation of the family members. The number of sides of polygon (N) depends on the number of spaces in the interior design project, as indicated in Table IV. An example of hexagon is shown in Fig. 3. The rule of growth of single member's Life Model Information Tree is defined as follows: Multiple branch axes are generated and extended from the center with the direction of each axis representing a space. The angle of each branch (θ) is obtained by evenly dividing 360 degrees by the number of space in the interior design project (θ = 360 degrees/6 = 60 degrees).The length of a branch axis (F.D.) is derived from such a member's frequency of visitation to each space while the number of leaves at the end of the branch axis is derived from the average amount of time spent in the space (D.D.).

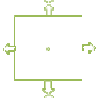
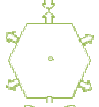
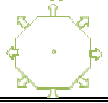


No. of leaves (**D.D.**):
This indicates the time the family members spend in the space per day. The area of the circle is scaled as 100%. The area occupied by the leaves indicates the percentage. The more the leaves are, the more the time spent in the space is.

Length of branch segment (**F.D.**):
This indicates the total visits to a space. The total length of the segments is scaled as 100%. The whole length is then divided into sections in proportion to the percentage of each part. The length of each segment indicates the percentage of each part. The longer a segment is, the more frequent the visit to the space is

Fig. 3 Representation of the Life Model Information Tree

TABLE IV
GROWTH PATTERN OF LIFE MODEL INFORMATION TREE

polygon (N)	Direction of Growth
Triangle	
Square	
Pentagon	
Hexagon	
Heptagon	
Octagon	

V. Conclusion

The life sphere change map in a day defined and developed in this study can help interior designer understand family members' change of space sphere, from which their life model may be concluded. The preference and habit of space usage of the family members may be determined in accordance with combination of these types. Two indexes D.D. and F.D. created by change of sphere activity in the period can further highlight the space sphere in which individual family member lay particular stress, and then visualize the distribution of average time spent by family members in each space sphere in a day.

Follow-up studies will build on the current result and develop an algorithm for building an interactive information system platform with the visualized model of Life Model Information Tree as the foundation. Different images may be created based on the visits to the space and may vary with time. The images presented this way can display sharply the characteristics of data and the differences among them, thus assisting interior designer in easily interpreting information related to the design.

Moreover, interior designer may extract information more efficiently through the space user journal records he/she enters and in the model of exported visualized result. More interior design service case studies may be recorded for further analysis of the space user's favorite data. The results may be stored in the experience base of case study for future reference when making decision for follow-up design elements and used as the basis for improvement and to determine whether the best result that fit user's purpose of customization is produced.

Acknowledgment

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