User experience-centered information design in dynamic data graphics

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Due to the mass information production the method of conveying information is in pursuit of the effects of interest and emotional factors. This paper suggests the factors of user experience-centered information design, and takes an example of project in dynamic statistical data graphics, which is not just static but interactive format.

The structure of user experience-centered information design consists of sensitive stimuli, cognitive interest, and experiential amusement. The Sensitive stimuli are realized with visual attention in ways of applying the design principles such as harmony, rhythm, and emphasis. It also consists of visual interest by using metaphors, visual pun, dynamic style utilizing multimedia or animation, and sound effects. Cognitive interest is fulfilled with applying the structure of storytelling, the experience of surprising events, and the interaction that makes user control the information for themselves. Experiential amusement is related to the game elements such as competition, exploration, mimic, and discovery. It's also related with human sensory and motor organ, and humor with combination of unrelated and unexpected things.

I tried to apply some of the factors to the project of dynamic data graphics. The project is about how people spend their time in a day, what is called "Time Use of a Day" created in the type of dynamic data graphics. User can speculate his own time use and compare to other people's or country's use. The project also has the elements of sound, animation, and interactive graphics for user experience-centered information design. I find that appropriately designed dynamic data graphics significantly improve graphical perception at both syntactic and semantic levels of analysis. Futhermore, I felt that it facilitated both improved understanding and increased engagement. So the dynamic data graphics can be utilized in user experience-centered information design.

Keywords : information design, user experience, Dynamic data graphics
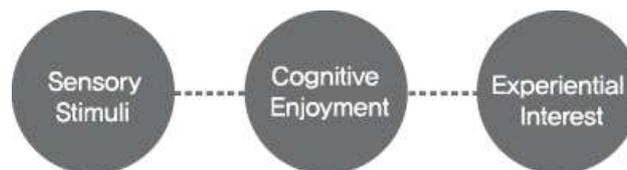
1. User Experience

Humans encounter the world through experiences. The process of experiencing is not the experience of the already given and determined world but the satisfaction of human desire of reconstructing the world by interacting with it. According to John Dewey, an experience is the result as well as sign and result of the interaction between organism and environment that changes the interaction through participation and communication when the interaction is completely carried out. In experiencing environment or object through emotional perception or emotional cognition, sensing physically through the sensory organs of seeing, listening and feeling is called 'primary experience'. The internal experience through this such as thinking and judging emotionally is called 'secondary experience'. The experience verified through direct and sensory primary experience once again upon expanding its meaning from primary experience to

secondary experience can be seen as total circulation process. The reason why experience is important in design is because user participation that can be seen as the characteristics of experience was actively conducted through the digital media. Information users have the primary experience of sensory level for information through the digital media that becomes similar to human senses. The meaning of information is expanded from the information experience in sensory level to the secondary experience of cognitive level, and such process is continued on to the stage of interpretation and recollection of information.

  Therefore, the meaning of user experience - centered information design is in increasing the effectiveness of information delivery through the experience, which is high level value of information user. Especially, the playful experience application, which is a factor that allows users to feel interest or enjoyment, is more effective. It was said that enjoyment is an instant, pleasant and delightful experience created by doing something. The delightful experience of information delivery process through this can increase the effectiveness of information delivery, and understanding by increasing positive mental energy. Therefore, it can be said that the utilization of the factor that induce enjoyment and interest in information design is an essential factor of user experience.

2. The Characteristics of user experience- centered information design

The main characteristics of user experience- centered information design can be conceptualized into first, the sensory stimuli of auditory excitement or visual interest, second, the cognitive enjoyment of information such as story structure, third, the experiential interest of dynamic liveliness or newness. Therefore, the characteristics of user experience centered- information design can be summarized into three concepts of sensory stimuli, cognitive enjoyment, and experiential interest.

[figure1] The characteristics of user experience- centered information design

2.1 Sensory Stimuli

Sensory stimuli is possible through seeing, listening, touching, and feeling of users, as it can arouse emotions. The degree of response to the stimulations that are coming in from outside is called sensory characteristic. Through this, the receiver can have a new experience and form sympathetic feeling with it by bringing out emotions or recollecting memories or experiences. Therefore, the sensory stimuli of visual and auditory factor can be said as the factors of interest that induce user interest. As such sensory stimuli factor influence the obtaining of information through the sensory organs of users, it acts as the information design factor of user experience according to its degree and form.

① **Visual Factor**

Chroma, brightness, color, texture, shape, location, direction, and size are the factors that allow the visual expression of information, and play a visual guidance role to allow information to be understood easily by operating perceptual system through the sensory stimuli of user in the delivery process. Especially, the visual induction of interest and stimuli through color or shape treatment are

main measures of inducing the sight of users.

② **Auditory Factor**

In auditory factor, narration and dialogue are included in voice, background sound, and sound effects play assistant role. The effect auditory factor are volume, tone, color, pitch, length and orientation of voice, and the factors are also related to the meaning of visual expressive terms such as size, shade, color, length, height, and direction. Such Along with visual factor, auditory factor is the factor that gives dynamic or delightful feel as the expression method that stimulates the senses.

③ **Dynamic Factor**

Dynamic information is used as the meaning that comprehensively includes all words such as movement, transfer, vibration, continuity, and kinetic. Since the expression of the content of information is fixed in print media, users obtain information by moving their sight. On the contrary, dynamic expression of information can be more stimulating in the process of receiving information as the sight of users is fixed and the contents of information is moving.

2.2 Cognitive Enjoyment

Being cognitive is the process of mental thinking to obtain conclusion by examining all kinds of objects and recollecting them, figuring them out, and solving problems that occur from them. Cognitive enjoyment in the process of information delivery occurs in the process of interpreting a certain information upon confronting the information for the first time. It's similar to intellectual curiosity. It can be understood as the emotion obtained in the process of resolving congestive effect through the already known the experience of process, namely, a clue as mental congestion can occur due to the failure of cognition. In order to increase cognitive activities for enjoyment, additional factors are needed in addition to pure information. It's because the level of immersion decreases and interests cannot be gained in featureless and plain information when considering the aspects of personal attitude, understanding or utilization of the users of information even though delivery of accurate information without additional expressions is also needed. Storytelling or narrative is expressing and delivering through respectively different methods, and they are reproduced through novel, cartoon, motive, and play and, allow the reader or spectator to have enjoyment and immersion according to its method of composition.

2.3 Experiential Interest

Experiential interest can be seen as something that occurs from totalistic factor in the process of an interest being aroused through sensory stimuli when users contact with information and going across to the cognitive stage of being able to communication with information through this. Although interest can be aroused through sensory stimuli, this is only inducing interest for short period of time and the continuation of experiential factor is needed to maintain interest. If cognitive enjoyment is inward enjoyment related to the thinking and imagination of user, experiential interest is outwardly revealed in the process of information delivery thereby users can directly experience it. An interest exists when an unexpected contradictory event occurs in a perceived environment , or when there is a difference between the current knowledge state and desired knowledge state. Alexander, P. A. divided interest into 'situational interest' and 'personal interest'. She researched the relation between situational interest and personal interest of student to study research the effect

interest has on educational effect. The result revealed that situational interest had more effect on the students with fewer prior knowledge than personal interest, and personal interest had more effect on the students professional level areas of knowledge. It can be analogically inferred that personal interest is important to the users with high level of interest for the original information and situational interest is important to the users with low level of interest also in the objects of information delivery. Also, the continuity of the user experience of situation is influenced from the density of the situation and the intensity of the experience. The continuation of interest users have in certain situations is related to the experience factor of the situation and characteristic of the time felt accordingly is also different. For example, objective time is determined from the physical phenomenon of nature like the circulation of day and night. On the other hand, subjective time means the times that we feel psychologically. The subjective time of feeling a certain situation is impossible to measure. It can be seen that the length of subjective time extends when immersion effect on a certain thing occurs.

3. User Experience Centered- Information Design

3.1 Factors

The class of information process of humans can be divided into physical stage in which the law of physics applies, logical stage in which logic or grammar is in effect and emotional stage in which subjective feel is in effect. The design factor of user experience- centered information design can also be divided into physical factor of physical stage that users can experience sensually in information delivery process, structural factor of logical stage that is related to the method of composing the content of information and psychological factor of emotional stage that receivers feel subjectively.
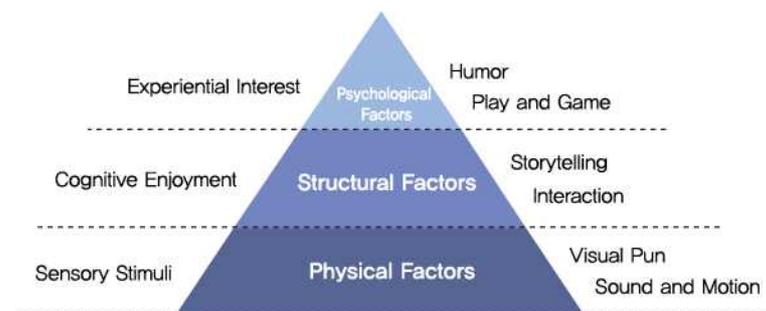
[Figure2] The correlativity between design factors and user centered- information design

3.1.1 Physical Factors

The expressive element of physical factors are image, color, sound, dynamic, light, and text, and are made concrete through static, motion, and interactive form in the information visualization process. Physical factors are mostly in effect in the instinct of human and stimulate the senses to have interests. Among the characteristics of user experience centered- information design, it works as the factor of sensory stimuli as it provides aesthetic experience such as gorgeous and fantastic feeling, or dynamic and lively feeling in the information delivery process by utilizing visual, sound, and motion.

① **Visual Analogy and Visual Pun**

For the things that create interest from manipulation using visual expression element through physical factor, the concept of visual analogy, or visual pun can be mentioned. Visual analogy can be interpreted as visual analogical inference, and it is delivering message through the use of visual element rather than language through the visual shape or form that contains certain meanings. Visual pun is one of the concept of having visual interest by expressing unexpectedness or humor through the combination or manipulation of images that contain symbols.

② **Sound and Motion**

The voice, music, sound effect, and motion image are the elements of sensory stimuli. Although the static expression of text and image traditionally depended only on sight among the senses, multimedia is something added with sound and video expression, and works as the element of perceptual stimuli of the information receiver.

3.1.2 Structural Factors

The structural factor of user experience- centered information design is made concrete mainly through dynamic or interactive form such as storytelling, interaction, and event, etc. It can be said that structural factor is the enjoyment that occurs in the process of information interpretation according to the composition such as story line, as it is in effect to the human cognition.

① **Storytelling**

It is composing information like the flow of event, personalities and responses of the characters and background in a novel leading a story with complex relation of cause and effect. If the purpose of information design is various equipment to allow users to better understand. Storytelling is the expression that allows to feel the relation of cause and effect, sequence more in detail, and concretely for effective delivery of information message.

② **Interaction**

The interaction for information delivery in digital environment is not simply delivering data and information to users but expanding and deepening the relation between information and users through the responses according to the actions or manipulations of information user, expansion of senses, and changes of information visualization.

3.1.3 Psychological Factors

Psychological factor becomes concrete through the forms such as static, dynamic, and interactive through play or game elements and the use of humor. Psychological factor is like the psychological satisfaction or emotional effect felt in the process of seeking enjoyment through play, game or aesthetic object according to the original nature of humans of play instinct as it mainly affects human psychology. Thrilling, passionate, and exciting feelings can be given through the humor expressing unexpectedness, plays involving intellect and emotion, and games involving competition and speed.

① **Humor**

Humor is a method of allowing the receiver to understand with a more open mind. Visual pun mentioned earlier is something that can be used for the expression of humor as a visual element,

and it can arouse interest by using illustration or the combination of images.

② **Play and Game**

The characteristics of play can increase the level of interest of the receiver of information. In his book 'Die Spiele der Tiere', Karl Groos categorized the play as the plays of sensory organ, locomotive organ, and intellect, or emotionl. Also, in 'Homo Ludens', Johan Huizinga analyzed the basic characteristics of play, and Roger Caillois critically succeeded this. He divided it into four roles of competition (Agon), chance (Alea), role playing (Mimesis), and vertigo (Ilinx) for play to accomplish its purposes.

3.2 Principle of user experience- centered information design

It was described earlier that the characteristics of user experience- centered information design are composed of sensory stimuli, cognitive enjoyment, and experiential interest. The design factors include physical, structural, and psychological factor. In the actual user experience- centered information design, not every one of these factors can be applied. Therefore, each factor can be applied by classifying the level of user experience.

Stage 1: Sensitive Stimuli

- Visual attention in ways of applying the design principles such as harmony, rhythm, and emphasis to the graphic elements of colors, images, and types.
- Visual interest by visual pun using metaphor related to the information
- expression for dynamic information utilizing multimedia and animation

Stage 2: Application of Cognitive Enjoyment

- Providing the cognitive enjoyment of listening to and watching abundant storytelling structure
- Introduction of the interaction giving the feel of the users directly manipulating the information
- Apply different and surprising event element in interaction and storytelling structure

Stage 3: Application of Experiential Interest

- Apply game elements such as competition, exploration, imitation, story and rule discovery
- Apply the play elements for senses, locomotive organ, intellect and emotion
- Expressing humor such as unexpectedness and combination with nonrelated objects

4. User Experience Centered Dynamic Data Graphic

Based on the theoretical foundation of user experience- centered information design, the information design that considers the process of organization and visualization of information and user context was proceeded. The subject is "Time Use of a Day" using the data on how people use their day of 24 hours. Upon collecting the data about the time use of people, the information was organized by classifying and arranging it. Dynamic data graphic design was conducted by visualizing the organized information through mapping with visual elements and reflecting user experience- centered information design element.

4.1 Structure of Information

- Your Time Use

Users can directly control through graph by deducing their own time use, and the result can be compared with the time use of average people who are above their teens in Korea. Other time use information of people in Korea can be compared according to patterns.

- World's Time Use

The frequently used time patterns in everyday lives such as sleep, work, leisure, watching TV, meal, child care can be compared according to countries in each continent. The organization of time use information is undergone through the collection and classification of the data on time use. The stage of systemization is conducted as follows.

[figure3] The process of information organization

4.1.1 Data

① Time Use Date of Korea

In Korea, national time use survey was conducted by Korea National Statistical Office twice thus far in 1999 and 2004. In 2004, time use survey was conducted for about 32,000 people using household as its survey unit in which the interview survey method of surveyor visiting and interviewing with the household members was selected.

② Time Use Date of Other Countries

The countries in the continents of Asia, Africa, America, Europe and Oceania were arranged, and researched for collecting data from various parts of the world. The time use data made from public web site of the national statistical office of each country and U.N. statics division were collected.

4.1.2 Grouping

The data regarding time use can be divided into 9 major items and classified into the patterns according to each item and its detailed content, and its contents are shown in the [table].

Items	Categories
1. PERSONAL CARE ACTIVITIES	Sleeping, Eating/drinking, Personal hygiene, Health care
2. EMPLOYMENT RELATED ACTIVITIES	Employed work/ Self-employed work, Unpaid work in family business, Unpaid work on family farm, Job seeking
3. EDUCATION ACTIVITIES	School/University, Purchasing education related goods
4. DOMESTIC ACTIVITIES	Food preparation/cleanup, Cleaning dwelling and arrangements, Purchasing domestic goods
5. FAMILY CARE	51.Preschool child care, Spouse care, Parents care
6. VOLUNTARY WORK AND COMMUNITY PARTICIPATION	Helping/doing favors, Civic obligations, ceremonies
7. SOCIAL LIFE / RECREATION AND LEISURE	711.Telephone conversations, media, Religious activities, Hobbies, games and other leisure activities
8. TRAVEL (by purpose)	Domestic activities, Family care, Voluntary work and community participation, Social activity, Recreation and leisure
9. OTHERS	Filling in time use diary

[table1] The type of time use

There might be a small margin of error in comparing the time use of each country according to the standards since there are some differences in the standards of time use pattern according to countries. For example, in the case of the U.S. or New Zealand revealed in the data, they did not separately classify travel time and included other time use items in their calculations, and it is speculated that some differences exist according to the measuring standards of each country.

	Korea	UK	USA	Madagascar	Norway	New Zealand	Mongolia
Personal care	10:34	11:03	10:33	13:05	10:21	11:36	10:36
Employment	3:44	3:30	3:43	2:53	3:21	3:11	4:57
Study	0:10	0:11	0:28	1:45	0:14	0:46	1:08
Household care	1:40	1:47	2:38	2:25	2:46	2:09	2:48
Family care	0:30	0:36	1:11	0:20	0:21	0:31	0:31
Voluntary services	0:04	0:03	0:08	–	0:09	0:09	0:11
Leisure & social life	5:05	5:48	5:28	3:00	6:00	5:37	3:19
Travel(by purpose)	1:42	1:27	–	0:50	1:15	–	–
Others	0:13	0:14	–	–	0:05	0:01	–

[table2] The sorting of time use of each country

4.1.3 Arranging & Rearranging

The time use data of Korea already researched according to the classified standard items are arranged by location, order, time, and hierarchy. They were then rearranged to allow comparison according to countries by selecting certain subjects to reveal meaningful information from the time use data of the arranged countries. They were rearranged according to the comparison of time for the work for compensation, watching TV, leisure activities, sleeping, child care, and meal.

4.2 Visualization of Data Graphic

4.2.1 Graphic Variable

① Point/Line/Surface

For the visualization of statistical values, graphic variables of point, line and plane that are the basics of every visual form are used. Using the basics of every shape of point, line and plane, numerical information can be visualized through their characteristics of the variables of location, length and dimension. Point indicates the size of time use according to its location, and order according to pattern can also be indicated. The characteristics of line is that is has a length and there is not dimension even though the location can be designated. The line graph used in statistical graph is displayed with data on the two axes. For the thing that shows surface, amoeba shape was selected. It is because numerical information can be compared through the widths of surfaces by applying the changing numerical values to the flexible shape of amoeba.

② Color

Color was used to classify time pattern and countries as it can express classificational information such as categories. From the classificational information such as categories through brightness and chroma, it was used for sub detailed classifications once again.

4.2.2 Components of Time Use Information and Graphic Variables

The constitutional components of time use information are pattern, size and order, and each graphic variable for them were defined and visualized as seen in the [table].

- **Pattern of Time Use:** classified through the colors for the patterns of time use, the detailed classification of the classified pattern was done through brightness and chroma, and classified through 12 icon shapes for the pattern classification of time use.
- **Size of Time Use:** time use sizes were expressed according to the height of point, length of line and

dimension of surface.

- **Order of Time Use:** order of size according to the location of data and size comparisons.

4.2.3 Dynamic Data Graphic

- **Main Screen:** metaphor of clock and expression of icon image for the main patterns of time use, the menu for 'your time use' and 'world's time use' can be selected and moved.

- **Try Your Time Use:** users can deduce how they are spending their day of 24 hours according to patterns by directly controlling the graph.

[Figure4] Interface design - Main & user's time use checking

- **Comparison of User Time Use:** users can experience a new understanding of the time use concept by comparing their own estimated time use and the mean of statistical time use of others.

- **Time Use Comparison 1**: comparison of the time use difference according to gender, weekdays and weekend, inside and outside the house.

[Figure5] Interface design - comparison of time use

- **World's Time Use 1-1:** point chart expressed with the graphic variable of points, the height of points raised from below display the amount of time use.

- **World's Time Use 1-2:** time use information comparison according to each country. The deduction of the pattern of life or time use culture of each country is possible through this.

- **World's Time Use 2-1:** express time use according to pattern of each country from the length of line through the length of dynamically moving line through Line Chart form expressed with graphic of line variable.

- **World's Time Use 3-1:** animation of the introductory part of time use information of each country that are expressed through graphic of surface variable.

- **World's Time Use 3-2:** Area chart form expressed through graphic of surface variable, the time use information according to patterns of each country can be seen through the length and width

of amoeba tentacle shape.

[Figure6] Interface design - comparison with point chart and line chart and area chart

5. Conclusion

The composition of user experience- centered information design is mainly classified into sensory stimuli, cognitive enjoyment and experiential interest, and the according design factors were classified into Physical Factor that users can experience sensually in the process of information delivery, Structural Factor related to the method of composing the content of information and Psychological Factor that the receivers feel. In the case of dynamic data graphic design, the information of "Time Use of a Day" was designed using the data on how people around the world are using their day of 24 hours.

Through this, first, appling dynamic movement and sound to allow users to have interest in statistical values unlike the existing graph or chart that show statistical value. Second, appling interaction through which users can compared statistical information according to their intentions.

Third, utilizing background music and sound effect for sensory stimuli and interest, Fourth, giving visual interest through color and shape. Fifth, users compare their mean time use with that of others thereby allow them to have experiential interest.

As seen in the above example of user experience- centered design was presented by adding user experience centered audio-visual interest and the sensory stimuli, cognitive enjoyment and interest of experience in Dynamic data graphic.

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