

The Improvement of Usability for Train Toilet Design

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Abstract: Design for improved usability is to understand products from the user's point of view so eventually to enhance the pleasantness users by reflecting it into the design. The philosophy of user-oriented design is an essence of human-centered product planning, and its application is more important for railway vehicle design, which is closely connected with everyday life. This study focused to define basic elements of train interior design concept, which considers convenience and comfort for passengers, by extracting and interpreting ergonomic requirements, as usability factors, of train toilet design. The study on user-oriented design of trains consists of the practice of sensibility engineering for the management of customers' emotions and its harmonious use on design, and aims on the embodiment of new ergonomic design. In the center, it has analyzed the criteria and characteristics of the user-oriented design and has concluded the design direction and components to a concrete idea and proposed prototypes, which may become a good example for train interior design later on. In addition, it proposes a direction, which may become a guideline of ergonomic design, to secure competition capacity. Moreover this study is concentrated on the physical environment and human behavior of train toilet users, on the analysis of factors necessary for adequate toilet design, and on the understanding of interface between its users. What is more, it proposes a module of development process and methods of approaching the interface. The study presents a design standard, under which the concrete data of the characteristics and practicable range and the convergent demands accelerate to the module could be confirmed and criticized. The study on the usability is going to contribute to more pleasant and comfortable train environments and consequently, it's going to create new values of increased railway competitiveness by design.

Keywords: *Toilet Design, Usability, Ergonomics, User Oriented*

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1. Introduction

Recent important issues in vehicle design are human centered design approach, which is a philosophy of UOD(user-oriented design)¹ and ergonomic design, which considers the characteristics, potential demands and psychological satisfaction of various passengers. Therefore, demand for the enhancement of utility must be reflected together with humanism, which emphasizes comfort than function, as well as physical convenience.

In addition, with the rapid progress of culture society and because of the importance of technology, value and culture, design came to be dealt with in association with productivity and competitiveness and, in railway industry as well, neo-plasticism and sensibility are required in train design. That is, the application of sensibility engineering and the harmonious adaptation of design are emerging as a new design concept different from existing methods. Train design is an area of system application that provides functions and roles necessary for transportation in consideration of necessities and conditions for passengers' travel scene with the optimal value factors. Accordingly, the implementation of user-oriented concept in planning & design will provide a turning point for the development of the railway industry and contribute the enhancement of the economical standing of the industry through high quality tourism culture.

This will promote the advancement of the future railway industry and transportation means, and bring new added values for the realization of new design paradigm. User-oriented design is a concept that gives the top priority to the relation with users, by giving safety, usability, aesthetic feeling and amenity. This concept is consistent not only with the basic concept of universal design and ergonomic design but also with new identity fit for pluralistic culture and the age of sensibility. Furthermore, it is required to change the train toilet from existing technoware-centered space to humanware-centered and design-centered pleasant and convenient space.

1.1 Objective and method of research

The concept of UOD, which is called human technology, is composed of amenity, comfort, enjoyment and emotion. Thus, the objective of the research on improving the usability of toilet through implementing values that impress customers is to investigate passengers' behavior and to improve values for the use of toilet as an optimal space. The basic direction for the implementation of advanced toilet design is an ergonomic approach, which is user-oriented design philosophy.

Train toilet design is a task related not only to a basic facility element but also passengers'

¹ Chul-Ho Kim, Core Competence study of the In-house Design Management, Japan: Chiba University, Doctorial Thesis(2002). p.73.

physiological condition and functional sanitation of the space. Therefore, this study analyzed the relation between users and the convenience of the toilet, and approached through the concept of UOD that satisfies users' needs and demands.² For this, we derived the structure of existing problems from analyzing the prototypes of toilet design in domestic and foreign cases.

2. Understanding the concept of UOD

Contemporary railway vehicle design tends to evolve from uniformity to diversity, breaking away from technological limitations and focusing on newness, intelligence, and environment-friendliness. That is, users' preferences are satisfied through the combination of advanced technologies and sensibility, various functions, the expansion of high quality service, the use of high tech materials and the provision of new values as in Figure 1. Future trains must be intelligent space that is designed as distinguished images and functions based on users' sensibility. The concept coincides with users' interest that prefers practical and aesthetic attributes of coaches Figure 2.

Thus, the implementation of user-oriented design aims at satisfying the conditions and characteristics. That is, it is to realize ultimate purposes by understanding facilities and environment from users' viewpoint and reflecting them in design. In other words, the essence of UOD in toilet design is human-centered design philosophy. Consequently, the direction of toilet design is to derive universal elements for improving the usability of design focused on friendliness, amenity, sensibility, recognition and safety that can prepare logical grounds for establishing a model of objective evaluation system.

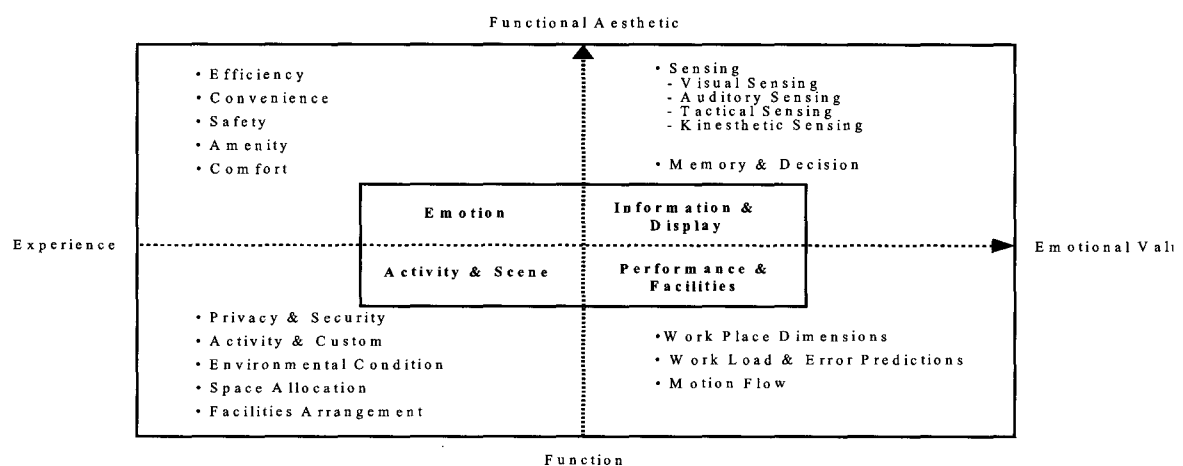


Fig.1 Direction for the enhancement of toilet design value

² Han Seok-woo, Jin Mi-ja., Design Prototype of Train Interior for Improvement of Usability, Proceedings of Korean Society for Railway. (2003), p.218.

Because the evaluation of design must verify the formative element of the object to be evaluated, it must satisfy various factors of usability. Therefore it is important to optimize design process that conveys sensible contents and visual information and accommodates users' consciousness and values. It is because such an attempt can be the base of evaluation and verification on how user-oriented design can be materialized.

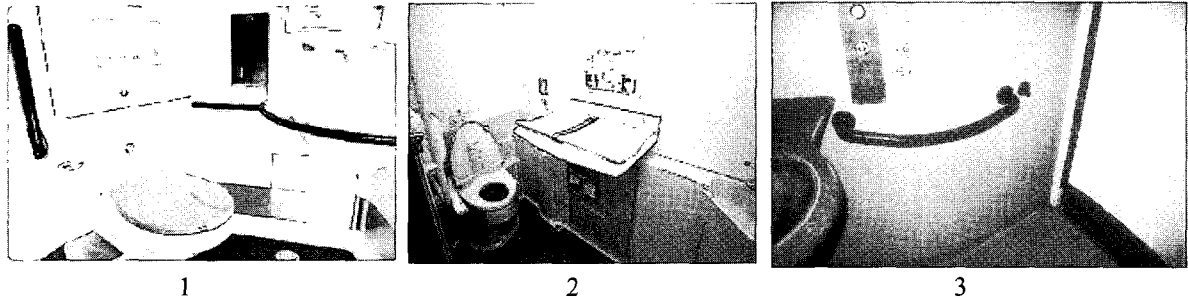


Fig.2 User oriented toilet design
 1: Virgin(UK) 2: Dongbuk Shinkansen Hayate E2(Japan) 3 : Ter(France)

3. Toilet user interface

The improvement of users' physical, physiological, intellectual and psychological abilities for design does not simply mean the improvement of function and reliability as a system but the improvement of interface based on the characteristics of users. This is a process that analyzes users' physical environment and human behaviors, identifies elements necessary for rational facilities, and understands the mutually functional relations of them with users.

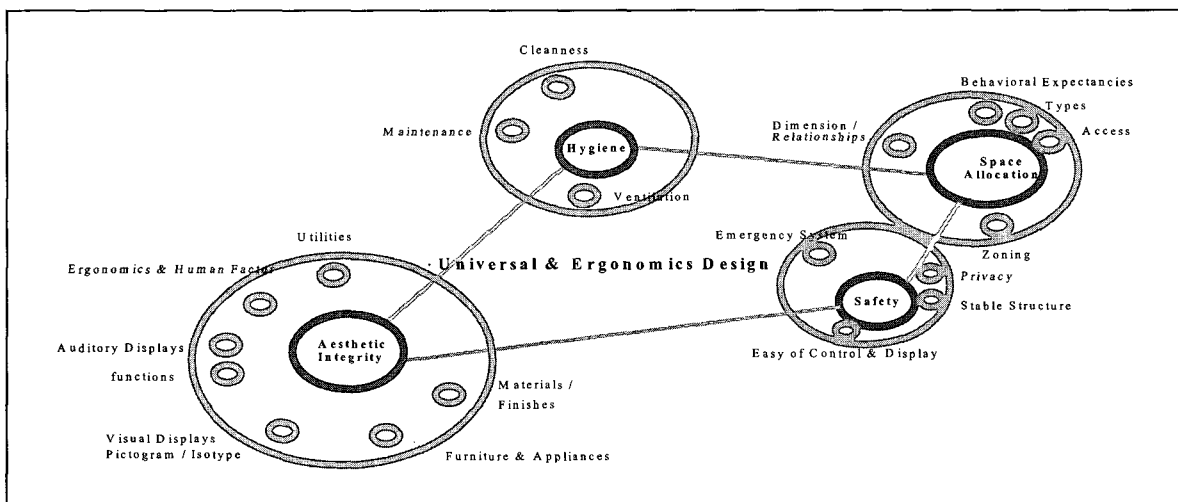


Fig.3 Architecture of integrated TUI

Interface basically means a space where different systems meet each other and actions are made against each other. Therefore in Figure 3, the usability of user-oriented toilet includes functional efficiency for passengers. In addition, the understanding of design interface must comprehend from the instrumental concept of trains to cognitive concept. Accordingly, TUI (Toilet User Interface) includes the analysis of various factors to design, manufacture and adjust spaces, facilities and environment fitfully to users based on the relation between facilities and users.³

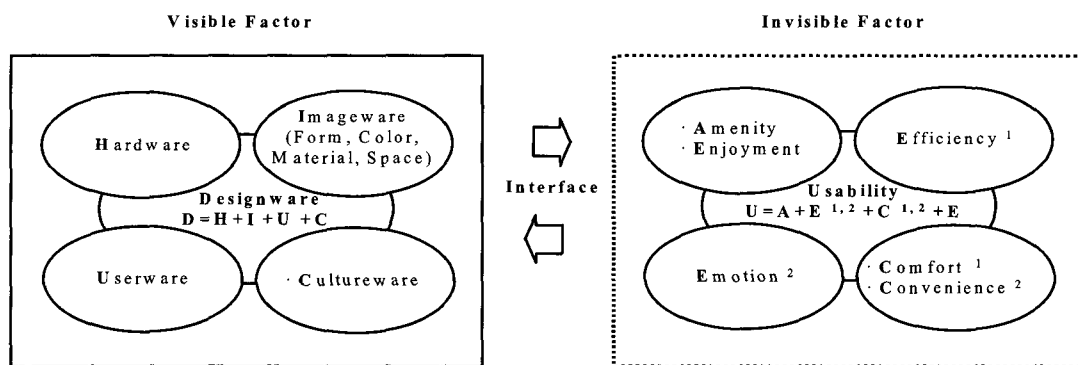


Fig. 4 TUI interface implementation technology system

That is, tasks in enhancing design usability are to consider the relation between design objects and surrounding environment centering on users' characteristics, to interpret and utilize in user-oriented position, to achieve the optimum and to maximize utility of visible and invisible factors in Figure 4.



Fig.5 Universal Concept
Kyushu Shinkansen
Tsubame 800(Japan)



Fig.6 Built-in appliances unit system
1:ICE(Germany) / 2:Euostar(Italy) / 3:SNCF(France)

³ Han Seok-woo Han, "Railway Design & Technology", Korea: KRRI(2000). p.24.

TUI purposes to expand usability from users' position. Thus, study on interface is to determine whether the interface is desirable in consideration of users' needs.⁴ Therefore, it is composed of processes of examining users' inter-personal, inter-functional and inter-physical environment and their behavioral characteristics, analyzing elements necessary for toilet as a rational facility and understanding balanced and harmonious functional relations between users and the facility as in figure 6 and 7.⁵

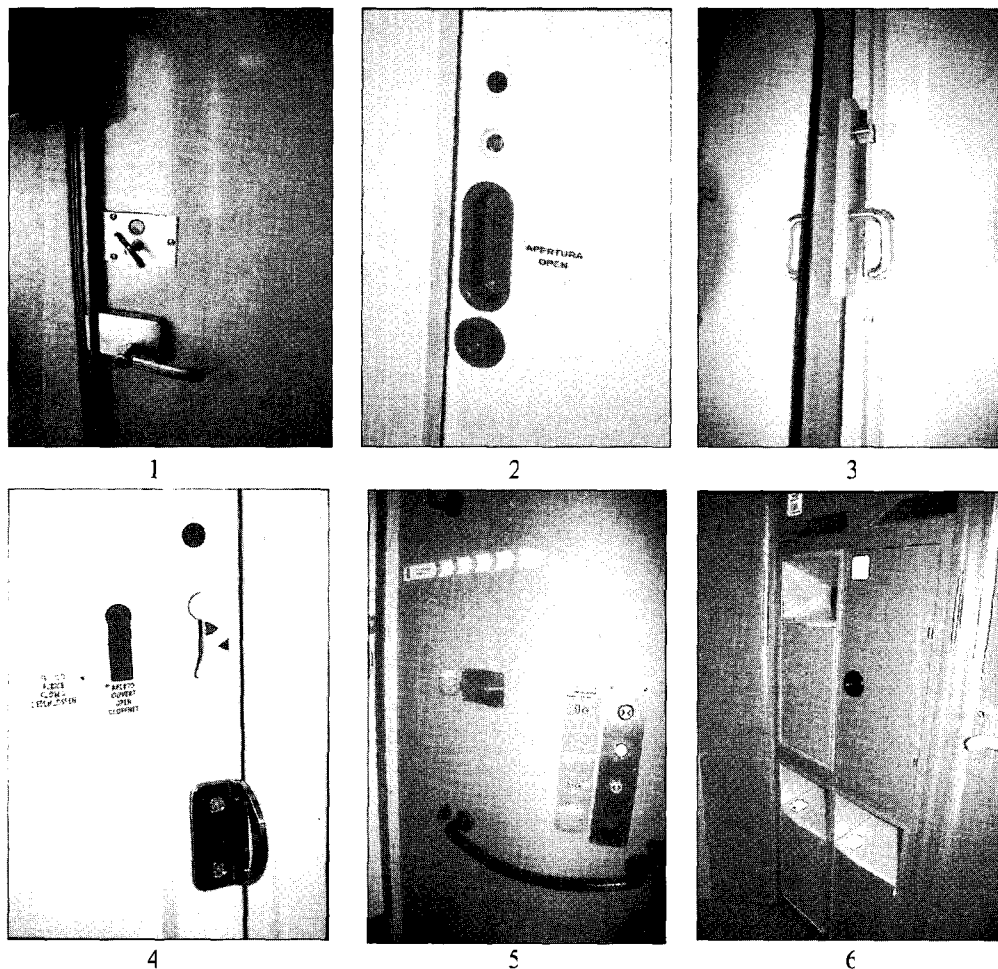


Fig.7 Locking types & handle of toilet door

1 : SNCF(France) 2, 4 : Eurostar(Italy) 3 : Eurostar(France) 5 : Ter(France) 6 : ICE(Germany)

⁴ Han Seok-woo, Design Ergonomics, Korea: Johyungsa. (2003). P.14.

⁵ Jin Mi-ja, Han Seok-woo., A Study on the Toilet Interface for Train Design, Korea: Proceedings of Korean Society for Railway. (2003). P.212.

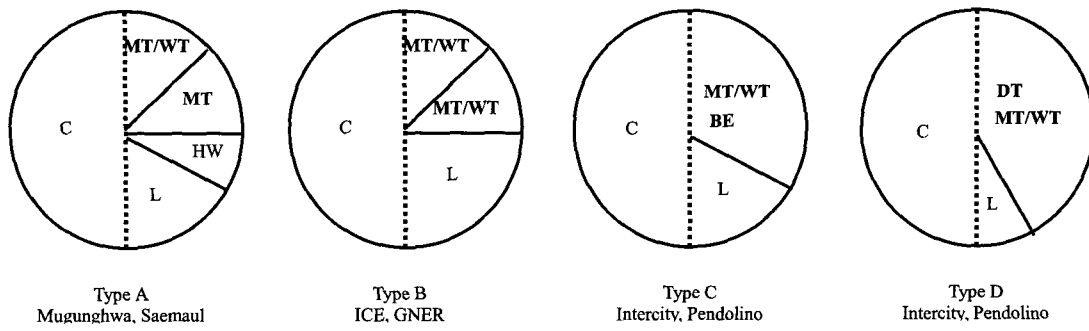


Fig.8 Composition & types

MT : Mens Toilet / WT : Womens Toilet / DT : Disabled Toilet
 HW : Hand Wash / BF : Baby Facilities / C : Coach / L : Luggage Stock

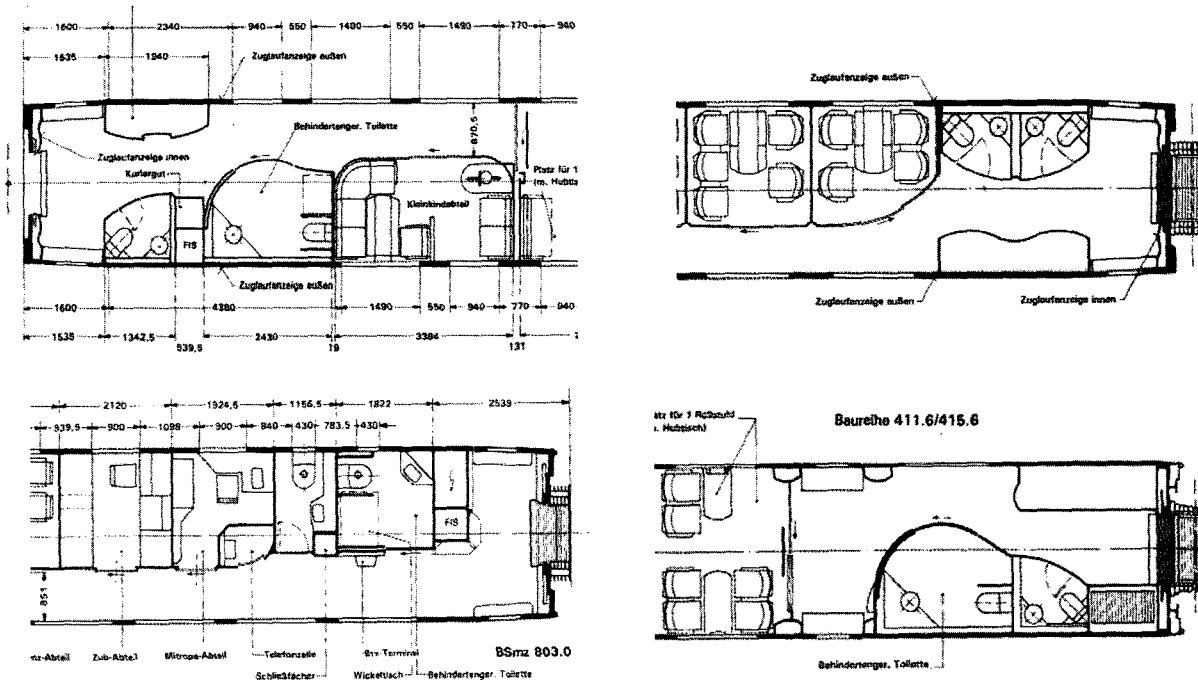


Fig.9 Toilet layout on ICE/Germany

Upper Left : ICE 3 2nd Class

Upper Right : ICE 3 1st Class

Lower Left : ICE 1 802, 803

Lower Right : ICE T 2nd Class

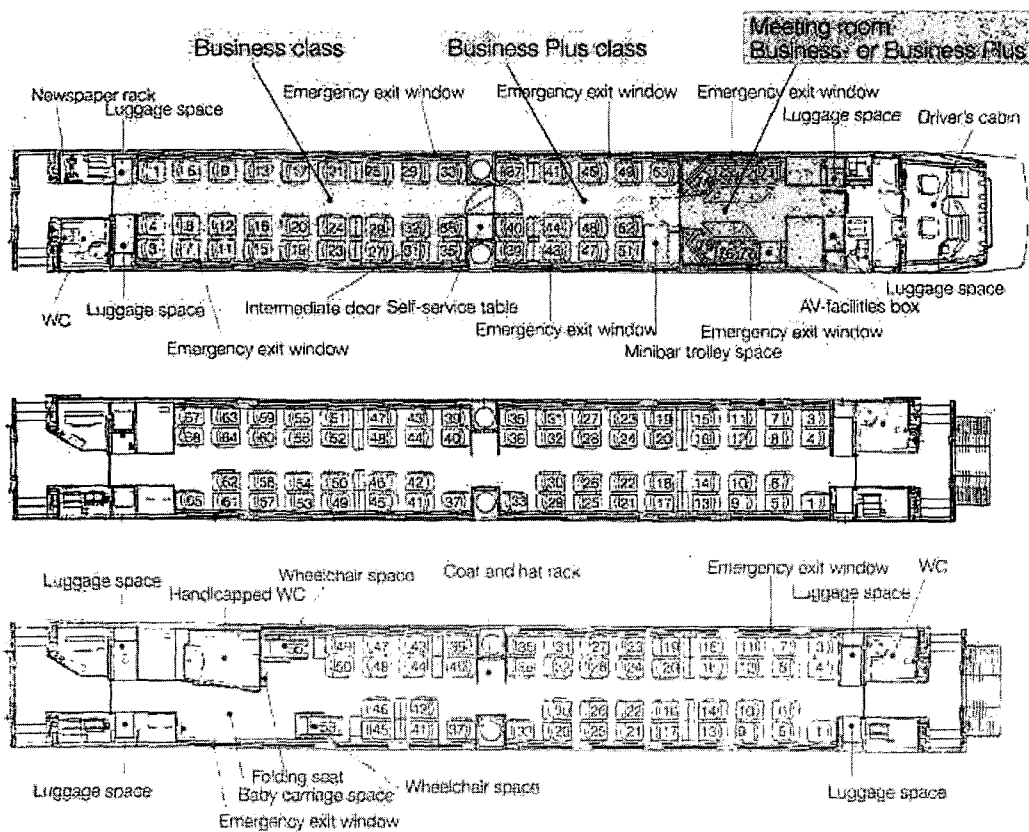


Fig.10 Location of WC on Pendolino / Finland

Major aspects of interface to be considered from users' viewpoint are as follows. First, the physical aspect of interface includes individual users' characteristics, their favorite routes and train type [Figure 8, 9, 10]. The position and size of toilet affect the flow line at the front and rear of each coach and movements around the doors. Furthermore, it includes the operability of indoor facilities and machines, their position and workspace. In addition, toilet users consist of various groups of passenger including the disabled using assists such as wheelchair, crutches, the aged, the pregnant and adults with young children. Thus, the pattern of use must be analyzed by each group of users to satisfy multi-purpose attribute and conditions in Figure 2 and 5.

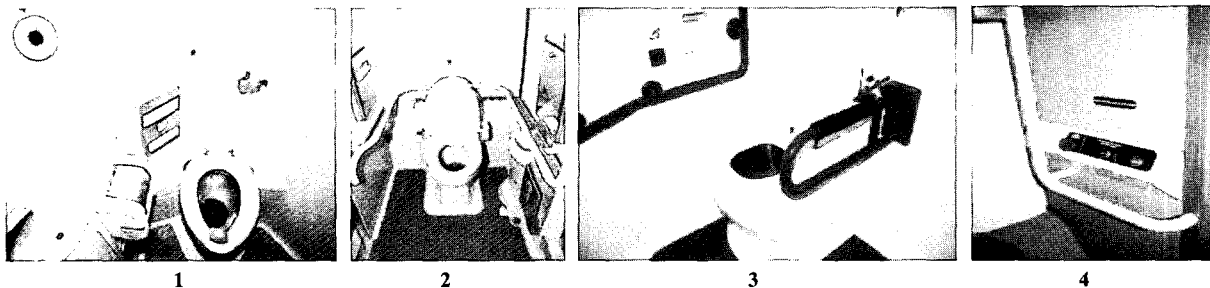


Fig.11 Facilities for the disabled

1, 2:Shinkansen 200(Japan) / 2:Eurostar(Italy) / 3:TGV(France)

Second, the objects of physiological interface includes the use of control equipment related to sight, hearing and the sense of touch, and the surface, quality, reflection and dazzling of raw and finishing materials. In addition, it includes the feeling of comfort as well as the removal of causes of physical stress and fatigue resulting from the signage, size and position of visual communication displays inside the coach. For example, safety bar must be fixed around the toilet bowl [Fig. 11], and the washing bowl and the door for the disabled. In addition, folder-type round edges for saving space, ergonomic position, size, shape, control, posture, the minimum area of action, etc. must be considered as in Figure 5. Furthermore, differences in the length of time, behavior and frequency of toilet uses between men and women must be reflected reasonably.

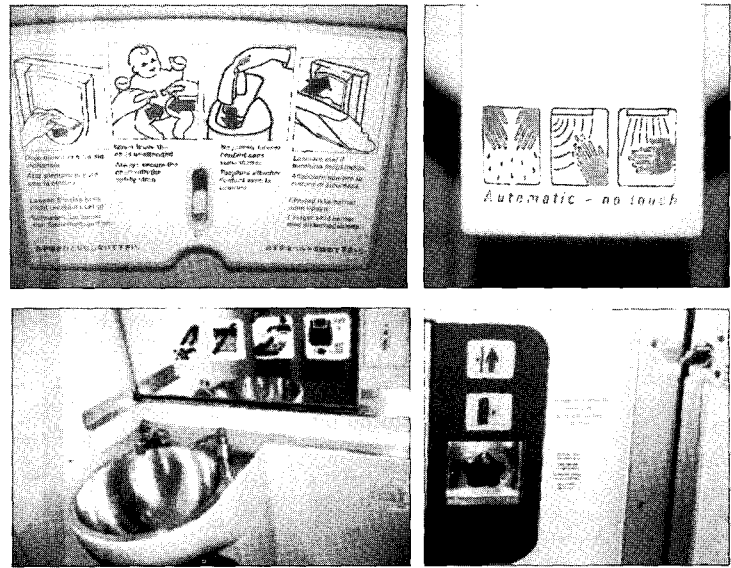


Fig.12 Isotype & pictogram

Third, intellectual aspects of interface include the level and recognition of convenience, the components of each object, their graphic signs, colors, surface finishing and effects. What is more, individual users' life style and customs need to be handled. In particular, isotype must maximize efficiency in opening/closing doors, emergency escape, the use of diapering stand, non-drinkable water, waste bin, flushing button, etc[Fig. 12, 13]. For these, simple illustration using silhouette is more efficient than explanation of situation using photographs.

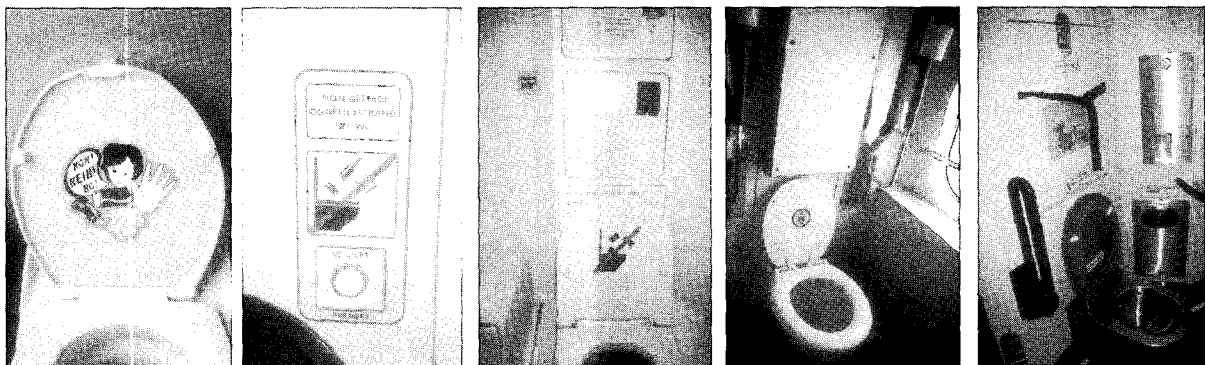


Fig.13 Pictograms for no foreign object in toilet

Fourth, the sensible aspects of interface include the aesthetics and images of indoor fixtures and chairs according to their arrangement. In particular, the production of environment through shape, material, direction, position and space and their harmony with coach environment are basic issues.

The toilet bowl must be comfortable for sitting on it, and its cover and body must have functions of unpleasant prevention and ozone deodorization using a hygienic trapping device. Soft and mild environment can be produced with right type and position of light source and lighting effect utilizing luminous intensity and color. If natural lighting is good, it also brings the effect of deodorization and hygienic.

4. Conclusions

Different from coach design, toilet design requires the consideration of ergonomic elements and facilities. Thus, it must secure safety, convenience and amenity based of UOD concept [Figure 14]. Furthermore, future railway coach design must be focused on creating high quality tourism culture and providing sensible services. Moreover, because toilet is a representative place used by the public, the design must be approached from the concept of barrier free design.

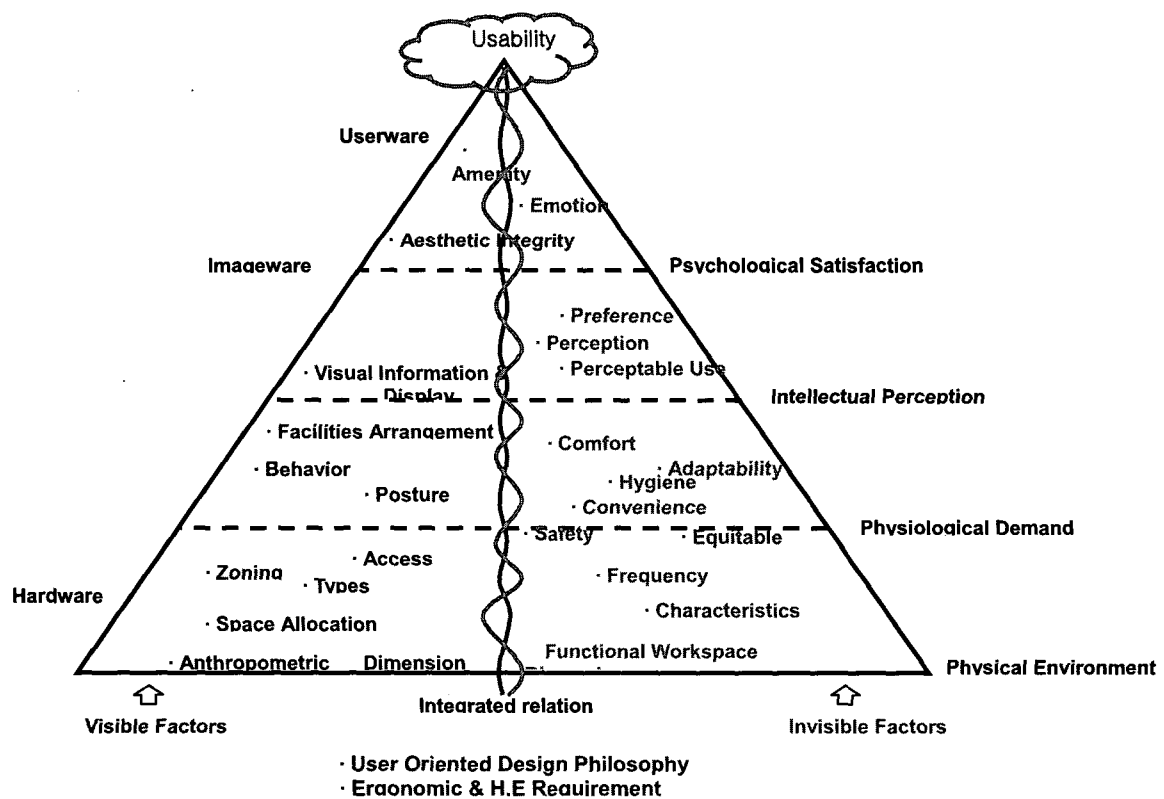


Fig.14 Hierarchy for conception of usability

That is, as pointed out by Bennet and C.A Schneier,⁶ toilet must be produced as a space of convenience and enjoyment. Enjoyment, namely, satisfaction is an important feature and the ultimate attribute of usability. The competitiveness and influence of train can contribute to the development of the railway industry and welfare society, and its effects realized by design based on humanism may bring pride in industry, technology and transportation culture.

The major results of this study are as follows.

- The key factors of usability are convenience, operability, the efficiency of equipment, sanitation, and the environment of use and ultimately the improvement of value. The future direction of toilet design should be changed from necessary functions required in a functional space of the minimum unit to sufficient functions required in a convenient space of the optimal unit.
- Conditions necessary for UOD are formed interactively by metaphysical factors such as hardware, imageware and sceneware and physical factors such as usability.
- For the improvement of sanitation, maintenance/management and productivity, facilities should be transformed into units and modules and the pleasantness of service spaces should be secured.
- The layout of a toilet needs not only to secure a spare room but also to realize universal design with accessibility and admissibility in consideration of physically disabled persons' movement. Furthermore, it should be improved into an ergonomic facility reflecting the 3-dimensional workability, movement range and behavioral characteristics of passengers.
- The layout facilities should be curvilinear rather than rectilinear to secure the safety of the space. In addition, hygienic environment-friendly materials harmless to the human body must be used.

The major components of toilet design should be understood from the aspect of correlation between the object and users. Spatiality and mobility are related to physical interface, convenience to physiological interface, the contents of visual information and guidance to intellectual interface, and formative beauty to aesthetic interface. However, these components are in interdependent or integrated relations and exchange influence with one another. Accordingly, the basic philosophy of user-oriented design defines the future concepts of relations among users, vehicles and environment. Analysis of correlations among factors that describe the structure of TUI can be applied rationally to interface in areas related to train design.

⁶ Ministry of Commerce, Prototyping Technology Development & Design Evaluation System for User Interface Design , Korea: Industry and Energy. (1997). p.58.

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