

## **PROCEEDINGS OF THE 38<sup>TH</sup> ANNUAL CONFERENCE OF THE HUMAN ERGOLOGY SOCIETY**

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Secretary: Tetsuya Hasegawa  
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Iizuka, Japan

### **Comparison of the gait pattern on elderly people in farming, fishing, and urban areas**

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The purpose of this study was to investigate the effects of different life histories on the gait pattern, and the aging of the gait pattern. We compared the gait patterns of people in three areas, namely farming, fishing, and urban areas.

The farming area was in Yoshida Village, Shimane Prefecture, the fishing area was in Toshijima, Mie Prefecture, and the urban area was in Chiyoda, Tokyo. 307 elderly people participated in this study. The participants were instructed to walk at the natural daily walking speed. Using videotapes, we calculated walking speed, step length, and cadence. Walking speed and step length were divided by body height to standardize the difference of body height. Statistical comparisons between areas were calculated using an analysis of covariance.

Walking speed and step length significantly decreased with age; however, the cadence did not. Although there was no difference in step length between areas, walking speed and cadence showed significant differences between areas. In addition, walking speed and cadence showed significant interaction between age and area. Post-hoc testing indicated that people in Chiyoda urban area walked faster and in higher cadence than people in Toshijima fishing area.

Thus, we saw that walking speed and cadence varied in these different areas, that walking speed and step length decreased with age in every area tested, and that the decrease of walking speed with age varied in these different areas.

### **In-situ ergonomics usability evaluation for refrigerators**

Toshiaki Kumata, Atsushi Shinya, Takuo Matsunobe, Toshiki Yamaoka  
*University of Wakayama*

Most product evaluation tests are conventionally conducted in an in-vitro environment inside a laboratory, with the test subject removed from the normal product operation environment. While the data obtained in an in-vitro environment offers excellent repeatability, it is often difficult to apply the data to an actual product. Therefore, we investigated whether we could obtain the data from an actual life environment through in-situ ergonomics. This method acquires the in-situ operation information

of a product in its actual location, and it is used to evaluate the usability of a product.

As the realization means of in-situ ergonomics, we acquired the in-situ operation information through a sensor and several switches. The operation log obtained contains the following information.

- (1) Operating frequency of each door
- (2) Opening-and-closing time of a door
- (3) Opening-and-closing pattern of a door
- (4) Usage of the handle of a door

We installed a refrigerator with sensors attached to it in an ordinary home for approximately two weeks. During the experiment period, the subject used the refrigerator as usual. Following the experiment period, we extracted the data, we analyzed it, and we extracted the operation information regarding the operating frequency of each door, the opening-and-closing time of a door and the opening-and-closing pattern. In this way, we were able to check the validity of in-situ ergonomics.

Due to the fact that we conducted only one experiment, it is presently difficult to judge which data is effective. For this reason, we are planning to repeat the experiments in the future.

### **Analyzing usability using the Boolean algebra approach**

Toshiki Yamaoka  
*University of Wakayama*

This paper describes a method to sum up or minimize user requirements of usability by using the Boolean algebra approach and multiple regression analysis (quantification 1). To evaluate the validation of the Boolean algebra approach and the quantification 1, a correspondence analysis was conducted.

Four mechanical pens were selected to be evaluated from the viewpoint of usability. A questionnaire was given on: (A) the feeling of pushing the feed button, (B) weight, (C) balance, (D) thickness, (E) shape, (F) texture, as independent variables, and an overall evaluation of the mechanical pen as a dependent variable. After the items ((A)-(F)) were narrowed down by the quantification 1, the Boolean algebra approach was conducted using the items narrowed down. Finally, the Boolean algebra approach turned out to be able to show the relationship or minimization among user requirements or evaluation items.

### **A study on the relationship between the impression of a product form and its formal components**

Kibeom Bae and Haruhiko Sato  
*Kyushu Institute of Design*

The purpose of this study is to grasp the impression of a product form and its formal components, and to elucidate the relationship between the two. This will help designers to form a conceptual image and act as an effective source of information in enhancing their idea sketches.

Ten different models of digital cameras were used as products. Forty-four male and thirty-five female undergraduate and graduate students participated as subjects. The evaluation of product impression was made using the SD method with 21 adjective pairs. Factor analysis and cluster analysis were made for the results. The apprehension of formal components was divided into two areas, rating and measurement. Factor analysis was made on evaluation scores and measured findings of formal components.

Three factors were extracted by factor analysis for product impression and formal components, respectively: “massiveness”, “homeliness” and “softness” for product impression, and “size”, “round-

ness” and “position of lens” for formal components. The correlation analysis between product impression and formal components showed the most intimate correlation between “massiveness” and “size”, and next between “softness” and “roundness”. Features of three digital camera groups divided from cluster analysis were examined using the characteristics in both product impression and formal components.

### **A study on recognition of color and form in infants**

Yuko Hamaguchi and Haruhiko Sato  
*Kyushu Institute of Design*

Sex differences in the recognition of color and form have been reported in infants. However, recent education of infants tends not to distinguish gender differences. The purpose of the present study is to investigate the recognition of color and form in infants from the viewpoint of sex difference and to compare the results with the previous studies. The investigation consisted of a picture coloring test and a card classification test. Subjects were 78 infants aged 3 to 6 in a kindergarten in Fukuoka City.

As for the favorite color, female infants favored pink. No sex difference was observed in blue, though it has been said that male infants favored blue. For this reason, we believe that sex differences in respect to color preference have changed. As for image color per each gender, female color was pink, while male colors were blue and green. This result was similar to previous studies. The result of the card classification test showed that male infants classified cards by form, while female infants classified cards by color as well as by form. Consequently, the card classification showed sex difference. Considering the claim of previous studies that reaction to form reflects a higher level of development than reaction to color, we believe that this result is caused by the differences of development level in infants.

### **Secular change of population in the Eastern Territory of the Ainu society between 1809-1857**

Kozo Yoshida  
*Nihon University*

The secular change of population by Basho\* (Akinaiba) in the Ainu society between 1809-1857 was investigated in documents of the Matsumae Clan and the Edo Shogunate.

The materials used were as follows: “Higashiezochi-kakubasho-yousudaigaisho” (General Aspect of Eastern Territories by Basho) of 1809, “Bunseinenkan ezo-kokouhyou” (Document of Ainu Population and Families in the Bunsei Period) of 1822, “Nyuuhokuki” (Travels and Documents by Tamamushi Sadayu, an official of the Sendai Clan) of 1857. These materials were selected for their high reliability.

In the period of 1809-1822, which was considered a stable period, several “Basho” (Kunashiri, Etorofu, Akkishi, Nemuro) showed prominent population decrease. In the period of 1822-1854, which was considered a period with population decrease, many Basho showed population increase. These changes of population are related to the degree of change of subsistence of the Ainu people caused by the “Ukeoinin”\*\*, or “Basho-Ukeoi” system, which regulated the amount of “Unjoukin”, the taxes for trade privilege.

\* Basho were the area divisions of the Ezo territory for the officials of Matsumae Clan, where they were given the privilege of trade with Ainu people instead of rice stipends.

\*\*Ukeoinin was the contractor (merchant) with the officials of Matsumae Clan for trades with the

Ainu people.

### **Effect of partial body cooling on thermal responses during exercise**

E. Morimoto, K. Umeda, and M. Torii  
*Kyushu Institute of Technology*

In order to investigate whether partial body cooling was positively effective when thermoregulatory responses at a given work load were increased in a hot ambient condition (30°C, rh=45%), we measured rectal (Tre), tympanic (Tty), and skin (Tsk) temperatures, skin blood flow (SkBF), local and total sweat rate (SR), heart rate (HR) and thermal sensation in seven healthy young men (mean age 21.6±1.5 yr) during bicycle exercise for 40 minutes, with and without ice or fanning after 20 minutes from exercise initiation.

Local SR was significantly lower in both ice and fan cooling than in control. HR and SkBF were significantly lower in fanning than in control, but were not significantly lower in ice cooling than in control. After fanning, Tty and mean Tsk were significantly lower, while thermal sensation was significantly higher in comparison to control. After ice cooling, Tty and mean Tsk did not decrease. Tre was not affected either by ice or fan cooling in any of the cases. Local SR was significantly lower in both ice and fan cooling than in control. There was no significant difference of total SR between cooling types. However, effective sweating significantly increased with fanning at the upper half of the body. Sweat dripping during exercise was inhibited by fanning. The cooling effect of heat dissipation during exercise was different in carotid cooling with ice and fanning at the upper half of the body.

In conclusion, (1) the fan cooling effect of heat dissipation during exercise under heat stress helps to depress the increase of Tty and to facilitate evaporative heat loss. It is assumed that the action in the thermoregulatory center is modulated through both the afferent pathways from the peripheral receptors and by the central commands. (2) The present results suggest that the effect of the carotid cooling on the action in the thermoregulatory center may cause not only a decrease of wet-heat loss due to sweat evaporation but also a depression of increase in Tty.

### **Visual effects of data entry work using double displays**

Masahiro Hashimoto, Hiroyuki Izumi, Keiko Kasamatsu, Hideki Suzuki, Kayo Kusamatsu, Masaharu Kumashiro  
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The present study was designed to investigate the visual effects of data entry work requiring frequent eye movements by using double displays. Eight young male volunteers performed a data entry task on stock history graphs for 90 minutes. The task was performed either under a double-display condition (110-inch display and 15-inch display) or under a single display condition (15-inch display). Visual accommodation measures and questionnaires of eye symptoms were administered before and after the task.

The double-display condition caused a significant increase in eye symptoms as compared to the single-display condition, such as eye fatigue, eye pain, wet eye. Visual accommodation to the double-display condition deteriorated greater than accommodation to the single-display condition; ANOVA on eye reflection, maximum visual accommodation, resting states of visual accommodation, Cq values of Step responses revealed significant main effects of the display condition. These results indicate that data entry work requiring eye movement between different displays could produce a deterioration of visual accommodation, causing a greater eye strain.

## **An electromyographic study on shooting a bow**

Manabu Iwasa and Haruhiko Sato  
*Kyushu Institute of Design*

Muscle activities in shooting a bow were compared in expert and unskilled shooters, and between cases of hitting and missing a target in the same shooter. Bipolar surface electromyograms were recorded from the right and left biceps brachii, triceps brachii, brachioradialis and trapezius of the shooters.

In expert shooters the activity of the upper limb muscles was markedly smaller than that of the back muscle, which suggests that the back muscle plays the main role in drawing the bow while the upper limb muscles are used to aim the bow. In unskilled shooters the activity pattern of the muscles was unstable, and both the back muscle and the upper limb muscles were active to the same extent.

In expert shooters little difference was observed in the muscle activities between the cases of hitting or missing the target. The right triceps brachii acted somewhat earlier in the case of missing as compared with the case of hitting. In unskilled shooters there was no definite tendency relating to hitting/missing, and their muscle activity pattern varied from one shooting to another.

## **Effects of load mass and load distribution on body sway in supporting a load on the back**

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This study examined the effects of load mass and load distribution on body sway. Three healthy male subjects participated in this experiment. One of the subjects was a well experienced mountain climber, the others not. The subjects were asked to carry load masses of 23 kg, 33 kg, and 43 kg on their backs using a carrier frame, and then stand quietly for 75 seconds on a force platform with their eyes open. The time series data of center-of-pressure (COP) were collected at a sampling rate of 50 Hz during the latter 60 seconds of the test period. The COP was measured under three conditions in terms of the installation position of the load masses on the frame, i.e., lower (close to the hip), middle, and upper (close to the shoulder).

As a result, all subjects showed that the lower the installation position of the load, the more anterior the mean COP coordinate was located in the anteroposterior (AP) direction, and the slower the mean velocity of the COP. Regarding carrying the heavier load masses, each subject showed a specific tendency in the mean AP coordinate, depending on mountain climbing experience. These results suggest that the COP can represent the difference in skills to maintain stable posture when supporting a load on the back, or the influence of load support experience.

## **Characteristics of homecare worker's load involving trunk inclination angle**

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This study aimed at revealing the characteristics of workloads and actual working conditions of

homecare workers. In order to evaluate the homecare workload on the low back of homecare workers, changes in the trunk inclination angles (TIAs) were continuously measured for 10 homecare workers while doing homecare. Measurement of working activities, assessment of working-living hours and in-depth interviews to workers were also conducted. We performed a direct observational study and time-budget-studies for homecare services in four cases.

It was found that the extent of upper body bending during homecare at the toilet, bath cleaning and vacuum-cleaning were significantly higher than for other homecare services. It was clear that TIAs in the physical-care type work were higher than those in housework-help type work. These results suggest that there were recurrent works involving deep TIA in homecare services. Thus, the workloads of homecare workers were high in spite of their work similarity with housekeeper's works.

### **A study of working environment and workload in small and medium-sized manufactures with an example from cast iron industry**

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The cast iron industry holds an image of "dirty, hard and dangerous work". Recently, the young population in Japan has been decreasing. In addition, young people are keeping their distance from the cast iron industry, because of its image of "dirty, hard and dangerous work". The purpose of this study is to investigate the working environment and workload in small and medium-sized cast iron manufactures from an ergonomic approach.

A field investigation was performed from July 29 to August 3, 2002 in smaller enterprises involving 49 employees. In the field investigation, conditions of working environment such as temperature, noise, and light were measured. A questionnaire included subjective symptoms and tired body parts. The observation of the workers was recorded by the time study method. The average temperature, relative humidity and noise were 32.7 ( $\pm 2.3$ ) °C, 59 ( $\pm 10$ ) %, and more than the average of 80dB.

We believe it is most important to protect the workers from the sources of occurrence of heat, noise and dust as much as possible. As effective measures for the immediate improvement of the working environment, we could recommend the use of dust masks and ear stopples.

### **The independent era shifting from a sub-optimization of agricultural work conditions toward an integrated optimization of production agriculture as business**

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There are three major trends in the business arena: globalization of economic activities, environmental protection through rather matured than growing economic activities, and high information and communication technology. Because of the traditional characteristics offered by the government to production agriculture, the effects of these economic trends have been less in agriculture than in other industries. The new round of the World Trade Organization (WTO) is scheduled to adopt a comprehensive agreement on agriculture issues by January 1, 2005. This movement indicates that production agriculture will no longer be under such conventional governmental supports as safeguard, tariff quota, and the like; thus, it has to be prepared to survive in business.

The purpose of the present study is to seek a sustainable way for production agriculture in its

future. The method used by this study is to review the issues in the annual research and project reports by Aichi-Ken Agricultural Research Center. Aichi Prefecture established an agricultural vision towards 2010 that indicates a requirement of ability to practice comprehensive management of production agriculture. The present study discusses the importance on the implementation of 2010 visions of human ergological intervention, which is essential for the production agriculture in order to become independent.

## **PROCEEDINGS OF THE 39<sup>TH</sup> ANNUAL CONFERENCE OF THE HUMAN ERGOLOGY SOCIETY**

Narashino, June 12 - 13, 2004

Secretary: Kuninori Kimotsuki  
Chiba Institute of Technology  
Narashino, Japan

### **Analysis of accidents from the viewpoint of management system: a study of recent accidents**

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Yoshihiro Katou, Toshiki Yamaoka  
*University of Wakayama*

Recently, organization accidents are often reported in newspapers, on TV and so on. When organization accidents occur, there is a wide range of causes involving preventional problems. Also, there is a wide range of causes where problems lie in the emergency countermeasures after the accident. If the management of the organization is successfully conducted, accidents of this kind should be prevented. We investigated four accidents focusing on how organizations managed the accidents, from the viewpoint of management system.

An organization accident is an accident whose consequences reach not only an individual level but also the whole organization or society. In the context, we chose four most recent organization accidents. These are: the accidents of a playground equipment, of Mitsubishi fusou, of a revolving door and of avian influenza. We conducted investigations based on the newspaper articles or reports of the accidents on the Internet. In each accident, we analyzed the problem from the viewpoint of management system. The causes common to each accident were the fact that “there was not enough recognition of the accident”, and “the delay of information transfer.”

We were able to find common points in all accidents. We believe that it is important to keep the transparency of a system when the system becomes large. Furthermore, it is necessary to perform risk management from a synthetic viewpoint when configuring systems structures.

### **Analysis of actual sleep condition in students**

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In order to investigate what kind of sleep is better, we analyzed a questionnaire collected from 172 young students. The questionnaire consisted of questions regarding actual feeling and postures at wake-up and in-bed time. We especially took interest in the variation of postures during sleep.

All students answered that they had felt nervous fatigue a few days before the questionnaire was carried out. Actual feelings of the nervous fatigue were “Sleepy” (75.6%), “Feeling tired” (61.9%), and “Dull” (53.1%). There was a strong correlation between the time needed to fall asleep and the depth of sleeping. Also, a strong correlation was observed between the time needed to fall asleep and the feeling of the students while awake. Half of the students went to bed between 0:00 am and 2:00



am and nearly 40 % of the students got up between 6:00 am and 7:00 am. The patterns of sleeping postures were classified into sleeping on one's face, sleeping sideway and sleeping on one's back. Furthermore, we classified in detail the patterns of sleeping posture according to the position of the face, arms and legs.

### **A study on the usability of Shinkansen ticket vending machines**

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The JR East Japan Takasaki branch (henceforth, JR) shifted to install automatic ticket vending machines for most ticketing. JR decided that special discount tickets for students were to be sold at the ticket office. Under these circumstances, the Shinkansen ticket vending machine was introduced in March 2002. Compared to the old model vending machines, this Shinkansen ticket vending machine showed a functional progress, such as exchange for Shinkansen tickets of Japan Railways group companies, purchase of reserved seats, purchase of coupon tickets, and usage of credit cards other than the JR card. In this research, the usability of automatic ticket vending machines was evaluated by conducting a time study of users' behavior and catching users' feelings regarding the introduction of the Shinkansen ticket vending machine.

The present study was conducted as follows.

- (1) Survey period: Saturday, August 17, 2002 – Monday, August 19, 2002
- (2) Place: JR Takasaki Station, East and West entrances.
- (3) Observation time: 6:00 a.m. to 11:00 p.m.(17 hours/day)
- (4) Ticket vending machines observed: 1) East entrance: 2 new Shinkansen ticket vending machines and 1 old type ticket vending machine.
  - 2) West entrance: 1 new Shinkansen ticket vending machine and 2 old type ticket vending machines.
- (5) Contents of observation: Users' operation time was recorded by time study. After purchasing the tickets, users were interviewed on the machine's usability.

The number of passengers observed was 5506 in three days. The users interviewed were 1515 persons (Shinkansen ticket vending machines 448 persons, old type ticket vending machines 1067 persons). Consequently, more than 80% of the users supported the introduction of the automatic ticket vending machines. Problems in the overall station business were pointed out.

In this survey, JR wanted to know the feasibility of the introduction of Shinkansen automatic ticket vending machines. An interesting result was detected regarding the frequency of use of Shinkansen ticket vending machines. The number of novice users was almost one-half of all users. The number of users of two or more times also covered almost one-half of all users. Novice users required more operational time than others on average. The operational time for the passengers who used the Shinkansen ticket vending machine a second time or more showed no difference among them. JR should analyze and improve its service quality as a transporting industry based on the evaluation provided by its users. A reform to contribute to the users' advantages is expected.

## **Body consciousness of athletes in mental training**

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In recent years, the effect and importance of mental training (MT) are recognized in sport sciences. However, there are a lot of problems in executing mental training (e.g. individual differences, difference between contents of mental training and sport environment). Especially, it is a serious concern that relaxation training (which is the main content of mental training) and image training have not been satisfactorily connected to experiential image and sensory-motor image, due to the fact that relaxation training is often misunderstood as simple body relaxation, and that priority in image training is given to visual image. For this reason, how body consciousness is performed becomes a critical issue.

As a key for solving this problem, the purpose of this study was to examine the inner focus-of-attention state of the body from the perspective of body consciousness, in relation to the sensations of warmth and cold used in the autogenic training. Generally, the approach to human ergology from the viewpoint of physical education has been adapted to the fields of biomechanics and exercise physiology. In this study, the influence of MT on the human body was clarified from the physiological perspective. Consequently, the implications of this study will contribute to industrial effectiveness because it focuses on physical and psychological conditions for human nature and living activities.

Subjects were 134 students of one high school (98 males, 36 females belonging to seven athletic clubs). Furthermore, another 10 male students belonging to athletic clubs were sampled in order to examine differences between athletic clubs. 7 sessions of MT(s) were carried out during a period of about two months. The mental training consisted of Assessment and Questionnaire (DIPCA, version 3), Relaxation Training (DOUSA-HOU: Motor Action Training), Psyching-Up (Qigong, Vocalization Technique), Meditation (Autogenic Training), Image Training (Triangle-Image Psychotherapy, Mental Rehearsal). The sensations of warmth and cold which were experienced through autogenic training in the last session were recorded on a body map. Based on it, a body map showing the sensations of warmth and cold was cumulatively visualized for analysis.

In the front body map, the warmth sensation concentrated on the upper half of the body except head and face; one third of the subjects felt warmth on the fingers (right), palms (right and left), and wrists (right and left); one fourth felt it on breast side (right). On the back, it concentrated on the upper half of the body as well, and for one fourth of the subjects it moved to the shoulder (right). The cold sensation concentrated on the upper limbs and legs, and 1/10 of subjects felt it especially on the knees (right and left) in the front body map. On the back, it concentrated on the leg under the knee. Although the warmth sensation was the same, one fourth of the subjects, of the soccer club especially, felt the cold sensation at the waist on the back. Moreover, although the number was small, this tendency was seen in every club.

Although subjects were high school students in the middle of body formation in their growth phase, the result was supported by the study on college student sport players by Iijima et al. (1996, 1998). We believe that the differences between the warmth and cold sensation depend on the subject's type of sport and his injury history, and therefore these aspects should be taken into consideration for the achievement of a more effective mental training. In conclusion, body consciousness is important for effective warming-up or effective motor control and image training. Also, the fact that body consciousness is appropriately directed towards the body parts less sensitive to temperature or sensitive to cold could suggest a key to solving the problem.

## **Relationship between walking independence and isometric knee extension muscle force in elderly patients over 75 years old with pulmonary or heart disease**

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Walking is one of the important activities for independent living in elderly people. It is reported in literature that close relationship between walking of elderly people and leg muscle force is one of the physical fitness indexes. The increase of elderly population over 75 years old is remarkable even compared to the elderly people as a group. The walking ability of older elderly people should be limited in comparison to that of younger elderly people. It seems useful to examine the relationship between walking and leg muscle force in older elderly people, in order to enable their independent life. The purpose of this study was to investigate the relationship between walking independence and isometric knee extension muscle force in elderly patients over 75 years old with pulmonary or heart disease.

Subjects were 34 female patients and 87 male patients with pulmonary disease or heart disease over 75 years old. They were classified into two groups according to their ability to walk: those who were able to walk a distance over 200 m safely without using any walking auxiliary tool (the group of walking independence, n=91), and those who were not able to walk a distance over 200 m safely (the group of walking dependence, n=30). The isometric knee extension muscle force was measured at the 90° angular flexion with a hand-held dynamometer. For analytic purposes, knee extension muscle force/body mass ratio was calculated. The logistic regression analysis was made to select the significant factors (age, height, body mass index, isometric knee extension muscle force, total protein, hemoglobin and medication) which associated with independent walking. The Receiver Operating Characteristic (ROC) curve was used in order to examine the isometric knee extension muscle force value for distinguishing the group of walking independence.

In the logistic regression analysis, only the isometric knee extension muscle force was a significant factor to determine the subjects' walking ability. As a result of a ROC curve, the group of walking independence showed 34% isometric knee extension muscle force in female patients. In the male patients, the group of walking independence recorded over 30% isometric knee extension muscle force.

Isometric knee extension muscle force is an important factor for determining the walking independency. It is important to consider that the walking independence of the elderly patient over 75 years old can be determined by the isometric knee extension muscle force value.

## **Prevention methods of unsafe behaviors at construction work sites**

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The number of labor accidents in the construction industry in Japan has become lower than in previous years. However, the speed of reduction has been decreasing in the last several years. In order to effectively reduce the number of accidents, much attention should be paid to the human factor and human behavior in addition to the adjustments. The purpose of this study was to examine the causes of accidents and to seek effective prevention methods of unsafe behavior at construction sites by means of interviews and questionnaires.

As a result, it was revealed that more accidents at work sites were caused by workers' unsafe behaviors rather than by machine malfunctions or imperfect equipments. A conceptual structure

model was constructed, consisting of six major causes of unsafe behaviors, i.e. workers' factor, work situation factor, work environment factor, management factor, organizational factor and other factors. Group work at work sites such as KY activities or 4 Ss plays an important role in work site safety, not only by establishing safe working environment, but also by promoting workers' safety attitudes and safe behaviors.

Further survey will help modify the conceptual model by taking more variables, such as work site climate and workers' attitudes, and also help clarify what is effective to make the workers behave safely and to make construction work safe.

### **Use of measurement software of motion space in human ergology**

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A measurement software of motion space (for Windows) has been developed. Measurement in this software consists of the following four steps. (1) Recording an image of an empty background. (2) Recording an image of a target (human) on the background. (3) Extraction of the outline of the target by comparing the images of (1) and (2). (4) Target outlines are overlapped and the coordinate of object positions is specified as motion space by pointing with a cursor on the screen. However, shadows caused by addition of targets and shadows on corners sometimes make the recognition of the object impossible.

Although the software is designed for the measurement of motion space, the following functions are added for use in the field of ergology. (A) Listing of pictures in a movie file at selected intervals. (B) Output of the coordinate of points on pictures to a file. (C) Angle measurement on pictures. (D) Making simple overlap pictures of objects. (E) Extraction of intended parts by coloring the parts. (F) Calculation of the existence probability of extracted parts. These functions can be used for the evaluation of posture and behavior analysis. (This study is supported by a Grant-in-Aid no. C14540663 for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology of Japan.)

### **Effects of the eye movement on the accuracy of future position prediction of a moving object**

Hua Feng and Hideyuki Tanaka  
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Predicting the future position of a moving object is a common task in our daily life. Errors in prediction of the future position can often cause serious accidents. For instance, a collision of two cars at an intersection may be attributed to driver's inaccurate prediction of time-to-contact and/or distance-to-contact with the approaching car. Rosenbaum (1975) claimed that eye movements play an important role in position prediction. He hypothesized that subjects attempt to continue eye-tracking a moving object after it has disappeared. Peterken et al. (1991) emphasized that eye movements are not necessary to predict object's motion accurately. These studies focused on time-to-contact judgments, but not on position judgments.

We examined the effects of eye movements on the ability to accurately predict the future position of a moving target. Experiments were performed on a computer display. A target moved horizontally across the display at constant velocities (28.8 and 36.0 cm/s), and then disappeared behind a cover at the center of the display. A visual stimulus was given at particular times (167, 333, 500 ms) after the disappearance of the target. Seven subjects were asked to judge the position of the target when the stimulus was presented, under two conditions in terms of eye movements (eye-tracking and

fixation). Eye movements were monitored by electro-oculograms.

The subjects considerably underestimated the distances that the objects would travel after disappearance, in spite of the eye movement conditions. Linear regression analyses were applied to the data of the mean distance vs. time after disappearance. The mean intercepts under the eye-tracking condition were statistically significant larger than those under the fixation condition ( $p < 0.05$ ). There was no significant difference in the mean slopes between the eye movement conditions.

These results suggest that eye-tracking could influence the accuracy of prediction of the future position. The larger interception indicates that the motor command originated from eye movements pursuing the target might induce forward shifts in the processes to represent the target's motion. Nevertheless, it appears that the different modes of eye movements have no strong effect on the substantial tendency of underestimation of the object's velocity showed when subjects predict the objects' future position.

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## PROCEEDINGS OF THE 40<sup>TH</sup> ANNUAL CONFERENCE OF THE HUMAN ERGOLOGY SOCIETY

Osaka, June 18 - 19, 2005

Secretary: Hiroo Kumakura  
Laboratory of Biological Anthropology  
Graduate School of Human Sciences, Osaka University  
Osaka, Japan

### Grasping products quantitatively from the viewpoint of universal design: proposal of a degree of universal design

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Usually, universal design (UD) is evaluated by using an intuitive checklist. Consequently, the results of evaluation are not always the same. The proposed method is designed to evaluate products by using the table of UD quantitative degree. The method evaluates tasks based on the characteristics of 15 diverse user groups and concrete criteria. The table for the degree of UD consists of a sequence of task or objects as rows, and the diverse users as columns. The method to calculate the degree of UD is as follows.

- (1) Each task is evaluated from the viewpoint of 15 classified diverse user groups.
- (2) If a task is well designed for a user group, 1 is expressed in the cell of the matrix. If it is not so well designed, 0.5 is expressed. If it is not well designed at all, 0 is expressed.
- (3) The degree of UD is calculated as:  
(number × 1 + number × 0.5) / number of all cells.
- (4) The degree of a task suitable for diverse user groups is calculated as:  
(number × 1 + number × 0.5 in a line) / number of all cells.
- (5) The degree of diverse user groups suitable for tasks is calculated as:  
(number × 1 + number × 0.5 in a column) / number of all cells.

### Design consideration of a guideline for sound expression of public sound signs

Shiuan-Ruei Yang<sup>1</sup> and Akihiro Hotta<sup>2</sup>

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This study aims to find out the functions of public sound signs and the relationship with sound expression. The SD method was used to evaluate sound elements (pitch, duration, and intensity) and sound function. 22 subjects were asked to evaluate 41 test tones using 25 pairs of adjectives derived from 5 functions (position, guidance, notification, information, regulation).

From the result of the average value and the factor analysis, we found out that in the case of position, the 'low' position was expressed by a bass, and the 'high' position was expressed by a high pitch. For the guidance of direction, 'ascending' was expressed by a low-high pitch, and 'descending' was expressed by a high-low pitch. For notification, 'start' and 'executing' were expressed by a short

sound, and ‘attention’ was expressed by a short interval sound. For the information of gender, ‘man’ was expressed by a bass, and ‘woman’ was expressed by a high pitch. ‘Movement’ and ‘reaction’ were expressed by sound strength. For regulation, ‘danger’ and ‘prohibition’ were expressed by sound strength. In this way, the suitable sound for each function became clear, and the results are effective as basic data for making a guideline.

### **Attempt of touch sign design for beverage and food packages for the visually impaired**

Yoshihiro Sugizaki<sup>1</sup> and Akihiro Hotta<sup>2</sup>

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In this study, an investigation and an experiment concerning touch signs and meaning characteristics were carried out in order to find out a package that could help visually impaired persons to identify many kinds of foods more easily. Upon investigating documents and internet websites and conducting interviews with visually impaired persons, it became clear that the identification of food paper packages was particularly difficult due to their similarity in appearance.

As measures, it was thought that it would be effective to show the difference of contents by adding touch signs; also, it was thought it would be effective to use geometry figures based on the images obtained from the sense of touch as a result of the investigation. Therefore, an experiment in which 80 people were asked to evaluate images of sample touch signs was carried out.

By analyzing this data using principal component analysis, three principal components, namely sharp-blunt, thick-thin and rough-smooth, were obtained as result. In addition, the principal component score of each sample was calculated, and the factor of each principal component was clarified from a physical characteristic of each sample. Based on these results, new touch signs that showed the content of the food packages were designed, and their effectiveness was confirmed by a verification experiment.

### **Analysis of a design for supporting and nursing in welfare equipment for bathing**

Shogo Arai<sup>1</sup> and Akihiro Hotta<sup>2</sup>

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The manpower for nursing care of elderly people in our rapidly aging country has become insufficient. One of the causes of the insufficiency is the heavy load upon the mind and body of the nurse. A variety of welfare equipment and systems are developed to reduce such a load.

In this research, bathing equipment was investigated to clarify the current tendency of welfare equipment and to examine the welfare equipment design in order to reduce the nursing load more effectively. The investigation was done using the welfare equipment database open to the public on the Health and Welfare Information Association web page. Data was classified depending on the extent to which the developed equipment gave consideration to the user and usage condition.

From this investigation, it became clear that the welfare equipment did not consider enough the change in patients’ physical strength and in their life environment. This lack of consideration of the change causes a lack of adjustment to the characteristics of the patients and their life environments, and there is a possibility of causing the patients to further lose their physical strength. Therefore, in the future it is necessary for the welfare equipment design to show flexibility to the changes in the patients’ condition and their life environment.



## **Application of a software for measuring motion space to the evaluation of posture**

Jun-ya Ohashi  
*Kinki University*

The software for measuring motion space has been developed to have some additional functions for the investigation of the causes that determine the motion space. Plural objects and restricted parts of whole objects can be selected for analysis. Information on the presence of objects at each pixel can be outputted as image and numeric data files. These functions were applied to evaluate postures.

Postures during sleep, playing with a handheld LCD game machine, and during small electric assembly work were evaluated. During sleep, movement area and main still position could be measured, but the number of turnings in bed could not be determined. During playing with the game machine, the positions of eyes (or head), shoulders, game screen and arms were measured. The detection of eye movement often failed. The changes in posture were determined from the change of these positions. During the small assembly work, the positions of the head, limbs and body were measured. The changes in these positions reflected the character of the work in its moving frequency and area. (This study was supported by a Grant-in-Aid #C14540663 for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology of Japan).

## **Investigation of human error and mental barriers in aged users of home electric appliances**

Eiko Fukuda, Ryoko Sasaki and Akira Okada  
*Osaka City University*

An investigation of human error and mental barriers in aged users of home electric appliances was conducted for the purpose of improving the safety and usability of product design.

The investigation involved three steps. First, product accident reports from the National Institute of Technology and Evaluation were consulted; they showed that major accidents were due to careless use of heaters and cooking stoves, but rarely mentioned the detailed causes or processes of such accidents. As the second step, a questionnaire for 99 Osaka City families that included aged family members was conducted. The results showed that there are several home electric appliances that are unsafe for the elderly to use, or pose a mental barrier to them.

The reasons for such problems, however, were not made clear from the questionnaire. Interviews followed as the third step of the investigation. We visited 14 aged users' homes. Our findings reinforced those of the questionnaire and provided more detailed information about the unsafe use of home electric appliances and the mental barriers to them among the elderly.

## **A model of educational cooperation for children with disabilities in Indonesia**

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The purpose of this study was to develop a model for educational cooperation in special education by applying the experience of practical cooperative research in Indonesia. In December 2004, we held lesson studies together with Indonesian teachers at a school for children with intellectual disabilities and a school for children with hearing impairments in the Indonesia city of Bandung. The term



“lesson study” is a direct translation for the Japanese word “jugyokenkyu.” First, both Japanese and Indonesian teachers conducted lessons in accordance with their lesson plans for children with intellectual disabilities or hearing impairments. Second, Indonesian educators (university faculties, school principals, teachers, and parents) had review meetings immediately after the lessons to clarify the features of good practice. Third, we conducted questionnaire surveys after the review meetings.

The results of the surveys showed that the “lesson study approach” was viewed very favorably by our Indonesian counterparts. In this study, we developed the following model for educational cooperation based on the “lesson study approach.” 1) Acceptance of foreign students and training future coordinators in Japan. 2) Building cooperative relationship with educational institutions in developing countries. 3) Conducting collaborative lesson studies and establishing a school-based research center. 4) Supporting teacher training courses for special education in universities and holding workshops to increase coordinators in developing countries.

### **An attempt to analyze the action of text-input on a Japanese mobile phone using a pressure mat**

E. Hirasaki, Y. Murakami, Y. Yoshida, and H. Kumakura  
*Osaka University*

In this study we examined the performance of text-input in Japanese on a mobile phone. A pressure mat instrumented on the mobile phone enabled us to measure repeat-press time, movement time and press force, which had not accurately been estimated with previous methods using video images. Spatial effects of key positions on text-input performance were also studied. Subjects (3 males and 3 females, aged 22-24) were asked to press ten keys from 1 to 0 sequentially as fast as possible, from once each key in Task 1, to five times each in a way of multi-tap text entry in Task 5. Their performance was measured using a pressure mat (by Nitta, Japan) at 120 Hz with a resolution of 5 mm.

Based on their whole entry time (elapsed time), the six subjects were divided into two groups, skilled and not-skilled. Results showed that skilled users shortened their text-input time by shortening movement time rather than repeat input time. Movement time of skilled subjects was relatively stable over the key positions and different tasks. No significant difference was found in press force between groups. A spatial effect analysis revealed that both groups seemed to have difficulties to press keys at right corners (3, 9) and the left-top key (1). In contrast, left keys on 2<sup>nd</sup> and 3<sup>rd</sup> rows seemed to be easy to press.

### **Difference among nurses on the technique of bronchial drainage**

Kaoru Fujiie, Yoshito Ehara, Ryuji Katamoto, Misao Arimatsu, Yuko Fujiki, Yoshiteru Terashi, and Hiromitsu Kobayashi  
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Patients with cervical injuries put on artificial ventilators cannot cough out phlegm by themselves. For this reason, nurses assist them to cough out phlegm by pressing their chest. The chest pressing brings a high flow of expired gas, and makes it easy to cough out phlegm.

Ten nurses were asked to press the chest of an imitation patient (able-bodied young male) who lied on a bed which was set up on a force plate. The press force and expired gas velocity (PEF) were measured. The mean force was  $57.6 \pm 16.4$  kgf and the mean PEF was  $5.6 \pm 1.0$  l/sec.

A great difference in press force and PEF was seen among the nurses. The press force waveform showed several vibrations in the case of long-careered nurses, but did not show vibration in the case of short-careered nurses. There also was a difference between long-careered nurses and short-careered nurses in the technique of chest pressing. In the case of long-careered nurses, PEF reached

the plateau (6 l/sec) when the force of chest pressing was about 50 kgf. Then, PEF did not increase any more when the force of chest pressing was increased. In conclusion, long-careered nurses performed more efficiently than short-careered nurses.

### **A method of canceling the relative age effect in soccer player selection, from the viewpoint of human biology**

Akiyoshi Matsumura

*National Defense Medical College*

Among the soccer players representing Japan, those who were born in the first half of an academic year (from April to September) have a higher percentage than those who were born in the second half (from October to March). Such phenomenon might be resulting from a selection system that does not take into consideration the influence of the relative age effect. The purpose of this study is to consider a suitable timing and system for the selection of Japanese national soccer team players from the viewpoint of human biology.

The development curves of physical strength and athletic abilities were analyzed based on the data of the Ministry of Education, Culture, Sports, Science and Technology of Japan. Consequently, the measured values of the items relevant to explosive power, endurance, and muscular power showed a rapid development until around 14-17 years of age, progressed slowly after that, and reached the peak around 19-24 years of age.

The results indicate that at least after the age of 19-24, suitable national team players can be selected without considering the effect of birth date difference. However, under 19 years of age, the maintenance of the motivation for training should be important for players born in the second half of an academic year. If the number of players selected by the JFA training center in each age category is equally divided into two groups, i.e. those born in the first half of the academic year and those born in the second half, their motivation will be effectively maintained.

### **Influence of individual attributes on the results of evaluation of trees in various fields**

Yoshikazu Konya, Hitoshi Yamashita, Satoshi Sasaki, Akiko Sunaga, Hazuki Fujii, Masahiro Shimoda, and Teruo Uetake

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A new law aiming at the preservation of beautiful scenery was enforced in 2004. Trees in towns, especially in metropolis, are functionally important in respect to the urban landscape. We have investigated how people evaluated trees in various fields, from metropolis to deep forest.

The subjects were a total of 276 students (199 males and 77 females), categorized into 8 groups based on their attributes, gender, growing-up environment, and faculty affiliation. After seeing 20 photographs representing trees, taken in various fields, every individual evaluated them by their own impressions on 20 viewpoints. The results were analyzed statistically using factor analysis. The 20 photographs were classified into three groups based on similarity or dissimilarity of a pattern of factor score, namely scenery in daily living space, scenery in resort space and scenery in deep forest space.

An interesting fact became clear: all subject groups had a favorable impression about the trees in daily living space which looked like those they used to see in their growing-up environment. All subject groups had a favorable impression about the trees in resort spaces but their evaluation viewpoint differed from group to group. In addition, several of the groups had a negative impression about the trees in deep forest space.

## **Effects of hand-reaching movement direction on visual attention**

Hiroshi Naito and Toshiaki Miura

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In order to select a particular object among several others, selective attention plays an important role. Previous findings have proposed a viewer-centered representation which assumed that a greater amount of attentional resource was allocated to the space near to the observer than to far space. The purpose of the present study is to examine how selective attention operates when we act, and to investigate the effects of hand-reaching direction on visual attention. Participants were required to reach a target stimulus on a graphics tablet using a stylus pen. Nine blue target placeholders were displayed on a 3 by 3 matrix and one of them was turned red as a target.

The reaching movement was either from near to far or the reverse. The result showed that when reaching from a near starting position, the reaction time of the hand movement to near raw targets was the same as the reaction time of movement to far raw targets. On the other hand, when reaching from a far start position, the reaction time to near raw targets was shorter than to far raw targets. This indicated that attention distribution depends on the hand-reaching movement direction. Based on the results, we assumed that a greater amount of attentional resource might be allocated to the area far from the hand start position, and the viewer-centered representation may interact with the representation which depends on the movement direction.

## **Proposal of a manual description test for grasping the user's mental model**

Yosuke Hotta

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In the process of product designing, grasping a user's mental model depends on the experience and knowledge of the developer and designer. In this research a method using an "instructions manual" is proposed in order to extract the user's mental model. Why is an instructions manual used in the test? Because of the similarity between "mental models" and "instructions manuals". This similarity is the core of this research, and it is the common characteristic that is referred to at the time of product use.

The test is conducted in interview form. The test subject is given the task to "create an instructions manual for a product", and the examiner records the subject's speech. The recorded data is checked by a subject each time. At this time, the instructions manual format which the subject describes consists of three items, namely "product outline", "usage", and "cautions". The object of the verification test of this study is an elevator. Data which can be interpreted as a mental model was obtained by a verification test. The future step in the study will be the systematic processing of the data obtained.

## **A work improvement training kit based on local good examples: Experiences in Malaysia**

Kazutaka Kogi

*Institute for Science of Labour*

A new training kit for work improvement relying on local good practices was developed jointly with local experts in Malaysia. The kit applied the participatory action-oriented training methodology based on learning local good practices and selecting practicable improvements through serial group work steps. The methodology, spreading to many work settings in Asian countries, including small

enterprises and agriculture, was found useful in developing a training kit for facilitating the cooperation of local people working in difficult conditions.

The steps for developing the kit comprised (1) collection of good examples from five local factories, (2) design of a 24-item checklist listing locally practicable improvement actions and PowerPoint slides presenting low-cost improvement rules corresponding to these examples, (3) inserting photographs of typical local examples to the checklist and preparing an improvement guide explaining these rules and corresponding photographs, (4) a two-day workshop utilizing the draft kit and (5) evaluation of the kit and finalizing it. These steps were undertaken jointly during a period of 15 days. The new kit comprised an action checklist, PowerPoint files with many local good examples for technical areas and an improvement guide. The technical areas included materials handling, workstation design and teamwork environment.

The kit was effective in training local trainees in learning the ways to propose practicable improvements based on the knowledge about local good practices. The workshop trainees evaluated the kit positively. These experiences confirmed the effectiveness of developing a participatory action training kit by focusing on good practices, action tools incorporating example photographs and group work steps. This demonstrated the advantage of sharing knowledge about local practices in facilitating participatory improvement by local people.

### **Differences in methods of holding bags from the viewpoint of oxygen consumption**

Yoshihiko Nakano, Takuhiro Mori, Yasuo Higurashi, and Hiroo Kumakura  
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When walking in our daily life, we walk while holding something in our hands more often than we walk with our hands empty. However, we most certainly chose an efficient load carrying method, involving optimal energy consumption. In this study we aimed to evaluate load carrying efficiency by measuring oxygen consumption. In order to acquire basic data of everyday load carrying, we asked subjects to walk while holding a bag, and we compared the differences of energy consumption for each carrying method.

The subjects of the experiment were six healthy adult students of 22 or 23 years old. They had an expiration gas analyzer K4b2 (by COSMED, Italy) installed, and at first we measured the amount of oxygen consumed at rest. Next, the subjects were made to walk while carrying a bag (10 kg) for about six times in total. The trials included one time without anything to hold and five different holding methods: "forearm", "backpack", "both hands", "one shoulder", and "one hand" on the treadmill, and the oxygen consumption was measured in each case. The speed of the treadmill was assumed to be 4 km/h.

In the results, the mean value of oxygen consumption showed an increase, in the following order: "backpack", "both hands", "one shoulder", "one hand", "forearm". The possibility that right and left equability of the load influences the efficiency of transportation is shown in the results for "backpack" and "both hands", which indicated low oxygen consumption values. Furthermore, the fact that "backpack" and "one shoulder" carrying methods showed low values supports the empirically known fact that carrying a load on the shoulder is more effective than carrying it on the arm. In addition, it was shown that there was a wide variation in holding methods.

**Forum for young researchers: Introduction to Human Ergological Studies****Ergological approach to roadway design: Can installation of roundabout intersections really give us benefits?**

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This forum focuses on driving behaviors at roundabout intersections. Transportation by driving a vehicle is interpreted as an extension of human locomotion such as walking and running. Human locomotion behaviors are adaptable to changes of circumstances. For instance, people usually alter walking direction or speed to avoid collision with other pedestrians or obstacles. It seems to be a conscious or unconscious response to prevent injuries. In the same way, driving behaviors are also adapted to traffic circumstances and roadway structures in order to keep the driving individual safe. The idea of intersections unfamiliar in Japan can provide us with a cue to comprehend some aspects of the behavioral adaptation to the roadway structure. Our primary goal is to introduce a new approach to consider roadway design and planning for traffic control. This forum also intends to facilitate research activities for scientists who are working in the area of Human Ergology, particularly for young researchers.