HUTOP

Human Sensory Factors for Total Product Life Cycle

Final Report

March 2003

Contributors: The HUTOP Consortium

Editor: Hiroshi Tomita/ SANYO Electric Co., Ltd.

- Table of Contents -

1. Executive Summery

In this research project, we have adopted the viewpoints of both customer and producer (worker) to present a new product life cycle (called the "HUTOP" cycle) that respects the human nature of individuals, and we have aimed to establish the elemental technologies necessary for acquiring, modeling, and evaluating various human factors (sensory, functional, knowledge, and intellectual) in an effort to achieve the HUTOP cycle, as well as the system technologies that reflect the elemental technologies in all of the production-environment-supporting systems that comprise the HUTOP cycle.

This project was officially approved by the ISC (International Steering Committee) as the international HUTOP (**Hu**man Sensory Factors for **To**tal **P**roduct Life Cycle) project in September 1997. The research and development for the project was conducted according to five work packages (5 WPs) shown below.

- WP1 Basic Research
- WP2 Human Factors in Design
- WP3 Human Factors in Manufacturing (WP3-1: Virtual Factory, WP3-2: Cyber Factory)
- WP4 Human Factors in Service
- WP5 Integration

HUTOP consortium was composed in four areas of EU, Switzerland, Canada and Japan. The international organization is shown in Chapter 6, 7 in detail.

To promote internationalization, we reviewed the framework for the international steering committee that would serve the core function in international collaboration in the kick-off meeting. In its meeting, the attending members presented their research activities, and joint research in each work package (WP) was proposed, followed by the discussion concerning concrete collaborative activities. In Canada, it was decided to collaborate in WP2. In Switzerland, it was decided to examine the details of concrete activities that would enable an early start of collaboration in WP2 and WP5. On the other hand, although official agreement was not formed with the EU partners, follow-up activities would be made for the commencement of collaboration in WP3, WP4 and WP5. Finally, the international joint research was vitalized and got many research results among them.

While advancing our HUTOP activities, we made active efforts to exchange and communicate information with external organizations through research presentations at domestic and overseas academic meetings in pertinent fields, and through attendance at lectures, according to our basic policy that research achievements should be disclosed openly.

Because the HUTOP international joint research was launched for 2 years since the holding of kick-off meeting and scheduled to come to an end in March 2003, we planned to organize the past research achievements, to hold a project completion meeting, and to make adjustments for the follow-up project in the first half of November 2002, as requested by our overseas partners.

2. Introduction

The form of manufacture is expected to change to ultrasmall-lot, diverse-product production to produce products that satisfy individual customer demands. The production system is likely to move from the age of mechanization and labor saving to an era that demands cooperation between the features of human and machine.

In such circumstances, the fundamental technology supporting next-generation production systems that fuse human and machine requires further development of machine and information technologies to establish "human technology" and a fusing of these technologies together.

This project has focused mainly on next-generation production systems from the “human technology” approach. The project aim is to propose a new product life cycle concept from the viewpoints of both customer and producer (worker) and to establish the framework for it.

2.1 New concept of total product life cycle (HUTOP cycle)

We have proposed a new product life cycle (called the "HUTOP" cycle) shown in Fig. 2.1. The key point of this life cycle is the collaboration between customer and company and between producer and machine.

The diagram illustrates the product envisioned in the "planning" stage is tailor-made in accordance with individual customer requests in the "personal design" and "virtual prototyping"

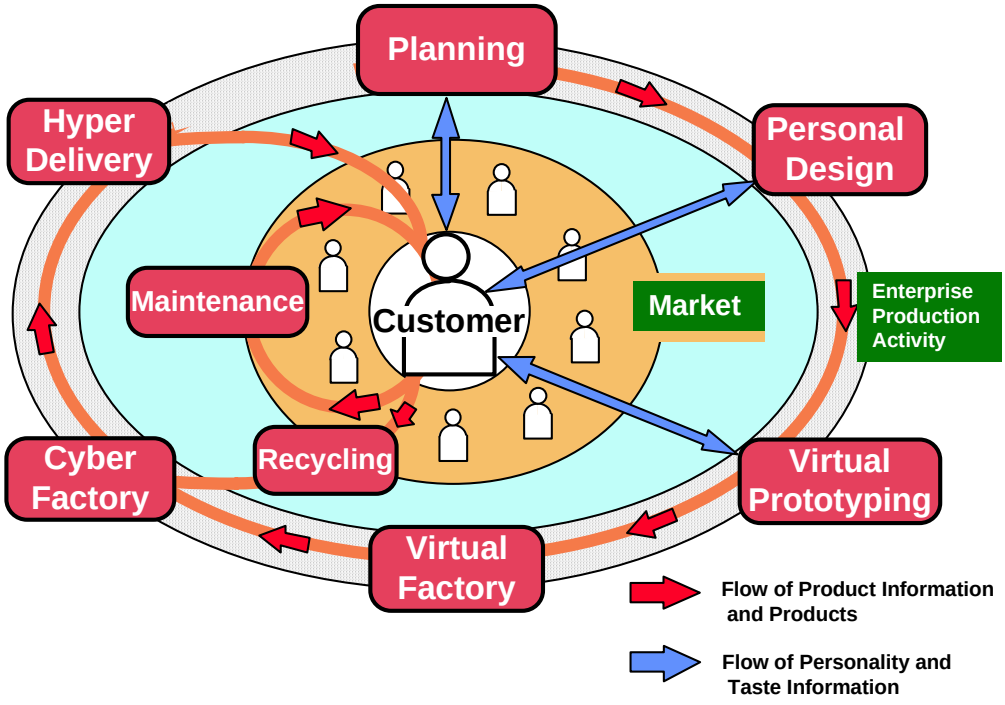

Fig. 2.1 New concept of total product life cycle

stages. Then, the product undergoes the "virtual factory" and "cyber factory" stages, to incorporate information. The product is delivered to the customer through "hyper delivery" based on a next-generation traffic system. The "maintenance" stage provides repair and function upgrade services. In the "recycling" stage, disposed products are sorted and disassembled, and recovered materials are reused in a new product cycle.

2.2 Project overview

To achieve the final HUTOP cycle, a research sub-system function image was envisioned for each WP, as shown below, and research was conducted into the concept investigations, system functions, and the relationship between sub-systems and modules.

(1) WP1: We organized human factors in an effort to ensure clarification and commonality of the technological and functional concepts used in the project.

- Planning for system architectures based on human technologies, classification of human factors, relation between the functions of HUTOP life cycle and human factors

(2) WP2: To supply products that satisfy the likes of individual customers, an actual system concept plan was promoted for KANSEI information acquisition and KANSEI design and each research was conducted.

- Creating functions to support the creative design processes to supply products that satisfy the intangible likes and demands of individual customers and which are easy to use in their intended environment

(3) WP3: To develop a system that flexibly responds to that change while providing a human-friendly production environment, we set up two sub-systems: a "virtual factory" which optimizes the production schedule and manufacturing processes centered on the workers, and a "cyber factory" which supports human-machine coordination activities in the manufacturing and inspection processes. The two corresponding sub-WPs were established in WP3, and the respective system concept designs were formulated in a joint effort.

- WP3-1: Achieving human-centered production that satisfies both customers and workers by modeling humans and human-machine coordination, and creating optimal support functions for the construction and operation of production systems
- WP3-2: Implementing functions that rapidly transmit flexible human thoughts to machines to support joint tasks between humans and machines

(4) WP4: The distribution and sales systems, which will become highly complex due to the implementation of ultrasmall-lot, diverse production, were examined together in WP3-1 as a supply-chain system, and the distribution and sales functions that are necessary for supporting human work were investigated.

- To achieve customer satisfaction by creating functions to support decision-making related to distribution, maintenance, and recycling and to support the transmission of product information that incorporates customer KANSEI in complex distribution systems

(5) WP5: We promoted the integration and systematic organization of the technologies developed in WP1 through WP4 as human technologies and, also examined the methods of product life cycle modeling and total life cycle evaluation in the production stage.

3. Research of each Work Package

At first, as basic research on human factors (WP1), we extracted and organized human factors in the design, production and service phases of the product life cycle in order to clarify the relationship between these factors and the HUTOP product life cycle.

Meanwhile, we divided the life cycle of HUTOP into the three fields of design, manufacture, and service. Research and development was conducted in work packages (WP) that correspond to these fields. WP2 corresponds to KANSEI planning, personal design, and virtual prototyping; WP3 to virtual factory and cyber factory; and WP4 to other processes and the functions related to all information for the HUTOP cycle and goods management, which is equivalent to SCM. Because of the differing directionality of the topics related to the virtual factory and cyber factory, WP3 is further divided into corresponding sub-WPs. In addition, WP5 was studied for the purpose of integrating the human technologies accumulated through the research on the HUTOP cycle and for reevaluating the HUTOP cycle.

3.1 Basic research on human factors (WP1)

3.1.1 Outline of the research

The theme of major importance in the new product life cycle (HUTOP cycle) is the establishment of both the basic technologies needed to acquire, model, and evaluate various human factors (such as sensitivity/organic functions and recognition), and of the technologies by which systems based on the application of these factors can be created. As the importance of basic research such as classifying the human factors and extracting the common technologies of these factors prior to the establishment of these technologies was advocated, examination of the following points was pursued. And also, analysis of HUTOP cycle, data processing model for human factors and classification were provided by means of IDEF0 diagram and the related investigations.

(1) Clarification of the overall structure of the HUTOP cycle, and the interrelationships between the parts

(2) Identification of the human factors individually and clarification of the concepts they have in common

(3) Systematic classification of the human technologies

(4) Organization of the relationship between the functions of the product life cycle and the human factors/common technologies

3.1.2 Common technology on Human Technology

We divided human technology that we need to work on, into 3 divisions as to their individual functions, which are interface, sensing, and modeling. We extracted the technological elements from each division, and developed the description of relations between HUTOP process and the common technology (figure 3.1.2-1). Finally common technologies to fabricate human factors into HUTOP process were clarified and classified along Planning, Personal Design, Virtual Prototyping, Virtual Factory, Cyber Factory and Delivery/Recycling/Maintenance processes.

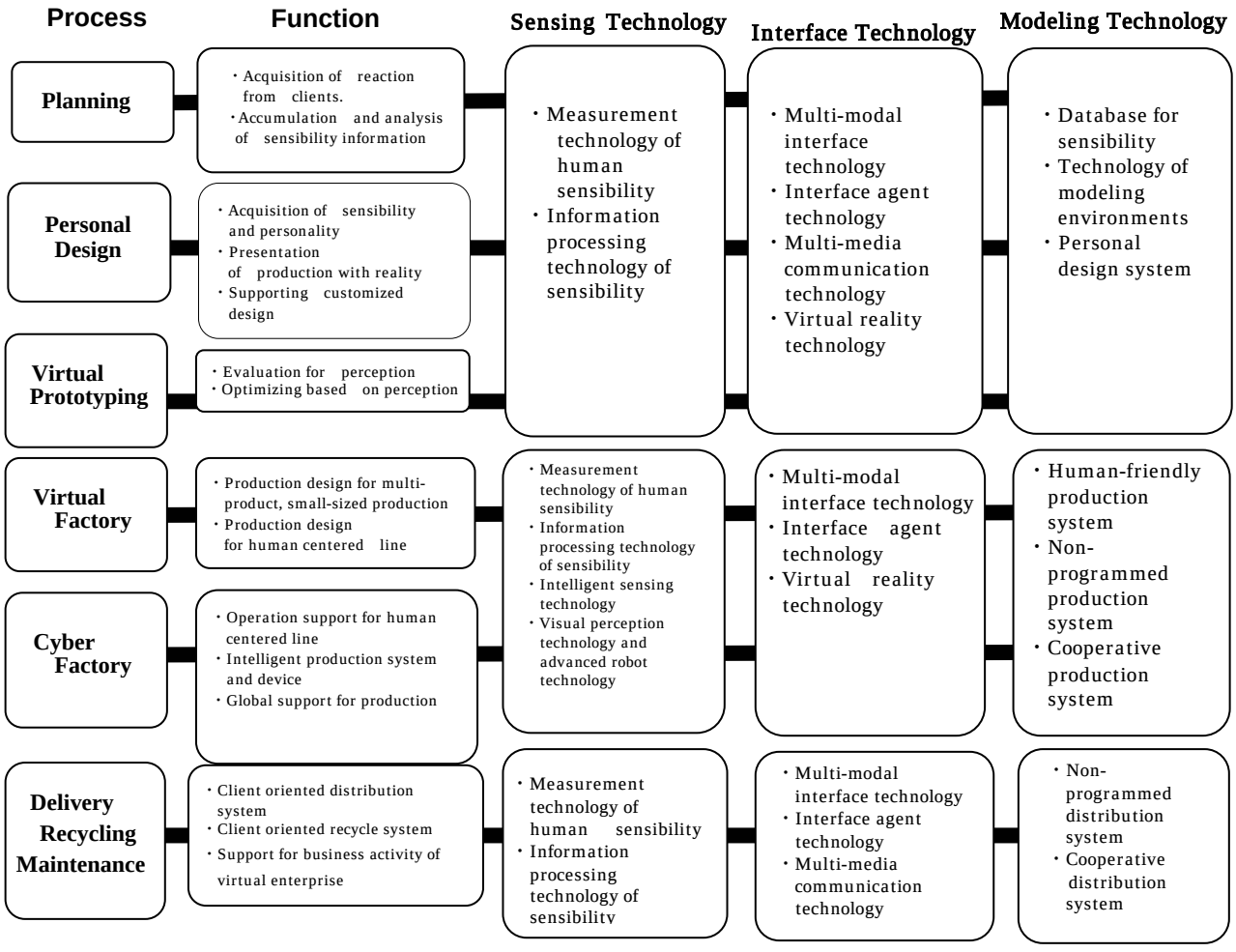

Fig. 3.1.2-1 HUTOP process and human technology

3.2 Human factors in design (WP2)

3.2.1 Outline of the research

WP2 presented a concept of a personal design environment that would allow the incorporation of customer/ designer's KANSEI into product design (Figure 3.2-1).

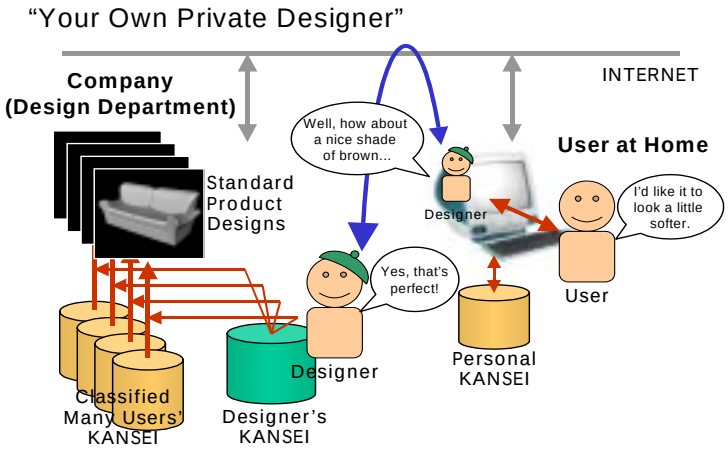

Fig. 3.2-1 Concept of a personal design

Elemental technologies to be developed were (1) interface technology for acquiring customers' requests/evaluations through the presentation of products in various media, (2) KANSEI modeling technology that creates a relational model of the customer/designer's KANSEI and product design, and (3) design generation technology for producing a design based on the obtained customer requirements and by taking designer KANSEI and production-related restrictions into consideration. According to these, the following three sub-systems were established: (1) a design advisor incorporating the customer's KANSEI, (2) a designer/customer interactive interface using facial expressions, and (3) a product design evaluation system using indoor models and based on gesture-based instruction. We promoted these research activities while working to interconnect the three sub-systems.

The Swiss project aimed to construct a next-generation teleconference system, which would require a new interface medium for smoother communication. Canadian partner researched 3-D modeling technologies including human figures, and it started cooperating in the field of environment modeling and design systems, although the scope of collaboration was limited to information exchange.

3.2.2 Summary of the results

To establish the elemental technologies of the prototype system, we focused on the following themes in each region.

(1) KANSEI acquisition to 3D shape design (SCREEN, Japan)

In order to control KANSEI information on the shape of the product, a method of the deformation by the personal KANSEI was proposed and a prototype system allowing the direct input of KANSEI factors during the design process was created. This system was applied to the design simulation of sofa and 3D catalog systems.

- Development of cooperative design function and practical verification of developed

KANSEI design system by its database

- Development of 3D catalog systems based on the novel method of 3D reconstruction that uses single view room images

(2) Extraction and generation of KANSEI information in human face images (Chukyo Univ., Japan)

In order to introduce KANSEI interface media in HUTOP cycle, a method for facial part recognition (eyes, nose, mouth, etc) was proposed and it was applied to several prototype systems. And some possibility of the new facial media in HUTOP production cycle could be shown.

- Applicable development of facial image media eye-contacting to the partner
- Face tracking and acquisition of high resolution face image by cameras

(3) Products evaluation system under personal environment (Kagawa Univ., Japan)

In order to evaluate the products under the personal environment, a display device called intuition-driven monitor, which enables users to explore virtual space and manipulate virtual environment with users's sense of haptics was developed.

- Development of room modeling formation by using CAD and model indication by gesture instruction
- Development of gesture interface for the products evaluation system under personal environment

(4) Intelligent systems for interactive design and visualization (Univ. of Western Ontario, Canada)

To enable for product designers and engineers to quickly modify the shape, style and functionality of a product concept, it is required intelligent computer-aided design and graphical visualization tools.

- Development of SOFM, deformable spherical self-organizing feature map, which is a versatile modeling tool that is able to create 3D shapes from numerous arbitrarily ordered N-dimensional data vectors.

(5) Distributed co-operative design systems supporting human factors with "*Communicate-It*" (IHA-ETHZ, Switzerland)

Group-ware designed for distributed co-operation, as well as videoconferencing technologies have the potential to make co-operation independent from time and space. The integration of videoconferencing in CSCW(computer-supported collaborative work)-tools would be an improvement, but also raise many questions.

- Presenting aspects related to transmission of sound and image in videoconferencing, videoconference as a support for communication, and the possibility of videoconferencing to enhance collaboration among distributed partners.

3.3 Human factors in manufacturing (WP3-1 : Virtual Factory)

3.3.1 Outline of the research

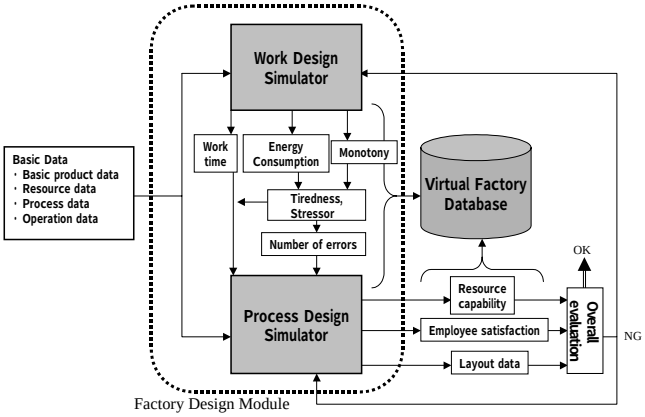

Fig. 3.2.2-1 Organization Scenario prototype model

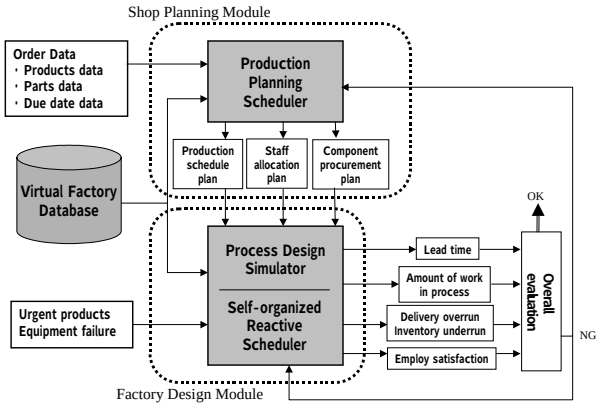

Fig. 3.2.2-2 Operation Scenario prototype model

The functions, technologies and system configuration required by the basic architecture of the virtual factory sub-system were reexamined, and the two prototype systems shown in Figures 3.2.2-1 and 3.2.2-2 were defined. They represent an "organization scenario" for pre-operation verification and planning for factory and process construction, and an "operation scenario" for the optimization of resources based on the dynamically changing conditions of the product and information in factory operation.

WP3-1 was worked to develop simulation and scheduling technologies, which were elemental technologies necessary for the construction of these models. It was also examined the input/output parameters and the interface for the models and promoted the prototype system development.

In the EU region, research activities for the IMAP project was planned. This project, which carried the theme of "human-friendly production environments," focused on the technological application to semiconductor wafer manufacture and regeneration process.

3.3.2 Summary of the results

As a common study among WP3-1 members, we were engaged in working on the concept of sub-systems for study of virtual factory.

(1) Study on human-friendly work design and assistance (SHARP, Japan)
(2) Study on the integrated human-oriented production process (SANYO, Japan)

As for work design for assessment of working amenity and safety in human-oriented production line, we studied evaluation methods, based on human factors. For a U-shaped production line, we conducted some simulation experiments considering some human factors and improved it more practical by considering each workers' individual variation and so on.

- Development of prototyping about highly diverse, small-lot production factory simulator for human-oriented production, and also, of a work design system to evaluate the work details of individual workers

- In human-oriented production, improvement of the simulation model more practical by considering each workers' individual variation and by constructing parameter input/output interface to integrate the virtual factory

(3) Study on biological-type production scheduling systems (Kobe Univ., Japan)

- Application into cooperation algorithms characteristics for biological-type production scheduling models

3.4 Human factors in manufacturing (WP3-2 : Cyber Factory)

3.4.1 Outline of the research

In a cyber factory, work support from the viewpoint of workers is extremely important. This calls for the presentation of information and guidance in accordance with worker abilities and fatigue levels, and an easy-to-understand information display of the production process status and work process conditions in accordance with worker conditions. To enable all workers to effectively use the displayed information, it is necessary to develop advanced interfaces for the manufacturing machines and tools operated by the workers. Realization of a comprehensive work support system will provide the workers with the satisfaction of controlling the machines based on accurate information and proper judgment, and, at the same time, improve manufacturing reliability and efficiency.

In an effort to establish a system that supports human-machine coordination activities, we conducted research on three concrete topics: (1) development of worker-friendly program-less visual recognition technology, (2) development of a judgment criteria evaluation support system for human-oriented lines, and (3) development of KANSEI-oriented interface technology based on gesture and touch.

These elemental technologies are closely related to those in the field of semiconductor manufacturing processes, which are the main research area of the EU project.

3.4.2 Summary of the results

We conducted research and development on the following specific issues in an effort to develop a system that would support joint work between people and machines.

(1) Worker-friendly visual recognition technology that does not require programming

(Matsushita, Japan)

We proposed a program-less visual inspection system that first used a conversational inspection program generating system, and then used a self-learning auto-tuning system and a dynamic preprocessing system at the factory.

- Development of program-less (programming-free) visual recognition technology, a core technology used in inspection equipment

(2) Sensibility-type interface technology based on gestures and pressure sensing

(Waseda Univ., Japan)

It is important and effective to introduce haptic and gesture interface into production processes such as display, design, modeling, teaching and control. Therefore, we constructed new experimental systems for haptic interface and gesture imitation to be used in human-robot interaction.

- Development of hand-shaped force interface for the autonomous mobile robot that is designed to take physical communication with the user via haptic/force interaction
- Development of multi-modal interface and force sensor/display system

3.5 Human factors in service (WP4)

3.5.1 Outline of the research

Service field, which includes four sub-areas: distribution, recycle, maintenance and advertisement, is regarded as the final contact point between products and customers. Human factors of supplier and demanders should be mainly handled at this field in the total product life cycle. Important subjects in those sub-areas are 1) efficient supply chain management (SCM) amongst various business units 2) recycling in part level as well as in products 3) service parts management 4) marketing and advertisement, respectively. Human factor technology in the service field is classified into the following three parts:

1) Sensing technologies to acquire human factors from customers and operators involved in the service fields
2) Interface technologies to enable friendly communication using the acquired human factors between the customers and the operators
3) Modeling technologies to analyze and systematize the architecture of human factors in the service field

Also, EU's research on logistics operation was expected to integrate with research on distribution systems using multi-agents to consolidate optimum-Pareto product allocation planning and efficient delivery planning. As a result, it would achieve higher customer satisfaction on a global scale.

3.5.2 Summary of the results

We focused on the following 2 research themes. The first research was concerned with the sensing technology of the products so as to develop multimedia based one-to-one advertisement system. On the other hand, supply chain management based on the modeling technology was the main subject in the second research item.

(1) Study on the audio-visual communication of product information in multimedia

(Kyushu I.D., Japan)

The purpose of our study was to clarify the effects of various combinations of musical and image elements on impression of the audio-visual contents. The targets of the study were the density of visual objects and their speed, and the tempo and tonality of music. We conducted a rating experiment of the impression of various kinds of audio-visual combination.

- Systematization of a synchronous effect by some sound and image of products information
- Analysis of combination of switching patterns of picture and sound effects

(2) Study on the operational methodology in distribution, manufacturing system, supply chain management (SCM) and recycle flow management (Kobe Univ., Japan)

We formulated SCM as distributed resource allocation systems, based on general equilibrium theory with several strategies. It was confirmed by simulation experiments that careful constructions of the decision process according to economic principles could lead to efficient distributed resource allocation in SCM, and the behavior of the system could be analyzed in economic terms.

- Prototyping and simulation experiments of allocation algorithm of distributed system under dynamic environment, and integration with recycle system

3.6 Integration of human factors (WP5)

3.6.1 Integration of human technology

We promoted the study on basic human technologies, dividing into three fields of “design”, “manufacturing” and “service”. We examined the total integration for verification of effectiveness of HUTOP concept, and promoted the examinations concerning preparation of evaluation indexes and standards, with “what sensitivity data to be handled here” and “what sensitivity data to be handled in what manners” as the examination points.

We introduced the concept of SCM into the HUTOP cycle as platform functions to promote integration and systematization of tasks separately in each field. And, we studied the matter of integration from the “customers’ viewpoint” and “workers’ viewpoint”.

3.6.2 Summary of the results

It was summarized the results of study about directionality of integration in each field of “design”, “manufacturing” and “service” from the viewpoints of “customer satisfaction” and “worker satisfaction”. We investigated the integration of human technology and integration of the whole to verify the effectiveness of the HUTOP concept.

- Verification of integration and systematization of human technology and evaluation of total products life cycle

4. Achievement Summary

Through the two-year international collaboration since the kick-off meetings, we revised and managed the international project organization. We placed a high priority on functionality, and ensured the independence of each region so the members could operate flexibly. For regional collaboration, WPs was established in each region, and partners promoting the technology development pertaining to each WP exchanged information and conducted other coordinating activities. Some sub-themes of the tasks in WP1 to WP4 were researched and WP5 was initiated to further promote the integration of human technologies related to the HUTOP cycle.

In worldwide relevant academic conferences, we succeeded to make an effort to announce and publicize HUTOP research achievements actively. In that consequence, we announced totally more than 80 HUTOP research reports in 15 international academic conferences. And also, active efforts were made for the exchange and communication of information with external organizations through research presentations at domestic and overseas academic meetings in pertinent fields, lecture attendance, and visits to relevant research institutions.

These were summarized as below, respectively.

4.1 Project results

4.1.1 Research results

- Clarification of the overall structure of the HUTOP cycle, identification of the human factors individually and systematic classification of the human technologies were accomplished. (WP1)
- The prototype system allowing the direct input of KANSEI factors during the design process was created. (WP2)
- The deformable spherical self-organizing feature map(SOFM) was introduced as a geometric modeling tool for creating and transforming 3D shapes. (WP2 in CA)
- Proposed a novel method of 3D reconstruction, and developed a 3D catalog system based on the method (WP2 in JP)
- Extraction of significant requirements for the integration of videoconference technologies in the manufacturing industry (WP2 in CH)
- Under the sub-theme of the extraction and generation of KANSEI information in human facial images, a face tracking system was obtained. (WP2 in JP)
- Development of prototype of products evaluation system under personal environment, and evaluation of intuition-driven monitor for various application (WP2 in JP)

- For the practical application of the simulator, the research results have helped plan a worker arrangement for optimum productivity and worker coordination balance. (WP3-1)
- Development of working optimization based on human factor for working evaluation system in human-oriented production (WP3-1)
- In order to improve inspection system function properly, we developed a self-tuning system called a "Program-less" visual inspection system. (WP3-2)
- Introduced haptics and gestures into human-machine interface, and intuitive handling of machine in production processes (WP3-2)
- By carrying out a series of empirical studies on audio-visual interaction, it was found out the implications for effective design of audio-visual material in multimedia communication. (WP4)
- Prototyping and verification of allocation algorithm of distributed system under dynamic environment (WP4)
- By simulation experiments, it was confirmed that careful constructions of the decision process could lead to efficient distributed resource allocation in SCM, and the behavior of the system could be analyzed in economic terms. (WP4)

4.1.2 General results

- Proposal of new product life cycle concept, ”HUTOP cycle”, based on the dual viewpoints of customers and producers
- Many presentations of research achievements in various academic meetings, that is, more than 80 HUTOP research reports in 15 international academic meetings in full terms (Shown in Chapter 4.2)
- Exchanging and communicating information with external organizations through research presentations at domestic and overseas academic meetings in pertinent fields
- Human network & studying worldwide research method by international collaboration
- Honored with the 3 domestic IMS Research Report Awards in 1999, 2001 and 2002
- Registered one US patent and some domestic patents, also appeared the article of WP4 introduction in “Nikkei Business Daily” domestic paper in Dec. 20 1999

4.2 Dissemination of research results

- **Participation in international academic conferences and the presentation of *HUTOP* research reports -**

1) The **QCAV1998** international conference
   Conference Name: International Conference on Quality Control by Artificial Vision
   Date and Venue**:** Nov.10-12, 1998, Takamatsu-City, Japan
   Number of presentations: 11
2) The **QCAV1999** international conference
   Conference Name: 5th International Conference on Quality Control by Artificial Vision
   Date and Venue**:** May19-21, 1999, Trois Rivieres, Canada
   Number of presentations: 6
3) The **RO-MAN1999** international conference
   Conference Name: 8th International Workshop on Robot and Human Interaction
   Date and Venue**:** Sep.27-29, 1999, Pisa, Italy
   Number of presentations: 7
4) The **FCV2000** international conference
   Conference Name: 6th Korea-Japan Joint Workshop on Computer Vision – Frontiers of Computer Vision 2000
   Date and Venue**:** Jan.21-22, 2000, Chukyo-University, Nagoya, Japan
   Number of presentations: 5
5) The **PCM2000** international conference
   Conference Name: Pacific Conference on Manufacturing 2000
   Date and Venue**:** Sep.06-09, 2000, Detroit, Michigan, USA
   Number of presentations: 1
6) The **SMC2000** international conference
   Conference Name: 2000 IEEE International Conference on Systems, Man and Cybernetics
   Date and Venue**:** Oct.08-11, 2000, Nashville, Tennessee, USA
   Number of presentations: 6
7) The **e2000** international conference
   Conference Name: e-Business and e-Work 2000 conference and exhibition
   Date and Venue**:** Oct.18-20, 2000, Madrid, Spain
   Number of presentations: 2
8) The **MMM2000** international conference
   Conference Name: Multimedia Modeling 2000
   Date and Venue**:** Nov.13-15, 2000, Nagano, Japan
   Number of presentations: 4
9) The **2001** National Convention Record I.E.E. Japan
   Conference Name: **2001** National Convention Record I.E.E. Japan
   Date and Venue**:** Mar.21-23, 2001, Nagoya University, Nagoya, Japan
   Number of presentations: 10
10) The **QCAV2001** international conference
   Conference Name: Quality Control by Artificial Vision 2001
   Date and Venue**:** May21-23, 2001, Le Creusot, Burgundy, France

Number of presentations: 5

11) The **ISHF2001** international conference

Conference Name: The First International Symposium on Measurement, Analysis and Modeling of Human Functions

Date and Venue**:** Sep.21-23, 2001, Hokkaido University, Sapporo, Japan

Number of presentations: 3

12) The **5th Franco-Japanese Congress on Mechatronics** international conference

Conference Name: The 5th Franco-Japanese Congress & 3rd European Asian Congress on Mechatronics

Date and Venue**:** Oct.09-11, 2001, Micropolis, Besancon, France

Number of presentations: 10

13) **International IMS Project Forum 2001** international conference

Conference Name: International IMS Project Forum 2001

Date and Venue**:** Oct.08-10, 2001, Ascona, Switzerland

Number of presentations: 1

14) **Korean International IMS Forum** international conference

Conference Name: 2nd SEOUL International IMS Forum

Date and Venue**:** Mar.15, 2002, COEX Inter-Continental, Seoul, Korea

Number of presentations: 1

15) The **IECON2002** international conference

Conference Name: The 28th Annual Conference of IEEE Industrial Electronics Society

Date and Venue**:** Nov.05-08, 2002, Melia Lebrelos Hotel, Sevilla, Spain

Number of presentations: 9

4.3 Conclusion

(1) We determined that two years would be necessary to produce achievements from the International joint research, and came to a successful end at March 2003.

(2) We got many effective research results in each WP worldwide, and also other general results such as many presentations of research achievements in academic meetings, patents and so on.

(3) An IMS-HUTOP completion meeting (international open day) was scheduled and held in the autumn of 2002. We planned to adopt a session style in an international academic meeting to promote participation of many people from all over the world.

(4) Regarding the request to the participation of Japanese partners in the second-phase project by a Swiss partner, we continued to examine some issues, review of research themes and participating members, within the "human technology" framework. We discussed with our overseas partners in international meetings to make concrete adjustments, and finally agreed to participate in 4 regions. Also, it was decided that ICP would be selected from Switzerland or EU, and one of the Swiss partners would make an effort to draw up the proposal to EU Commission.

5. Project History

Date	Events	Remarks
Feb,1997	Abstract of HUTOP Proposal	
May,1997	Full Proposal of HUTOP	
May.27,1997	1st IMS Domestic meeting, FY1997	Japan
Jun.23,1997	2nd IMS Domestic meeting, FY1997	Japan
Aug.04,1997	3rd IMS Domestic meeting, Steering Committee, FY1997	Japan
Sep.03,1997	4th IMS Domestic meeting, Technical Committee, FY1997	Japan
Sep,1997	Endorsed to International Project by ISC5	
Oct.13-14,1997	5th IMS Domestic meeting, FY1997	Japan
Nov.03,1997	Visit to University of BIRMINGHAM (Birmingham, UK)	International
Nov.04,1997	Visit to Lab D'Automatique de Besancon (Cedex, France)	International
Nov.06,1997	Visit to TU-Munchen(FORWISS, MVTec Software GmbH) (Munich, Germany)	International
Nov.07,1997	Visit to IMM(Institute of Micro-technology Mainz) (Mainz, Germany)	International
Nov.10,1997	Visit to University of Neuchatel (Neuchatel, Switzerland)	International
Nov.10,1997	Visit to CSEM(Centre suisse d'electronique et de microtechnique SA) (Neuchatel, Switzerland)	International
Dec.04-05,1997	6th IMS Domestic meeting, FY1997	Japan
Feb.19-20,1998	7th IMS Domestic meeting, FY1997	Japan
Mar.09,1998	8th IMS Domestic meeting, FY1997	Japan
Mar.20,1998	Visit to University of Southern California	International
Mar.23,1998	Visit to University of Western Ontario	International
Mar.24,1998	Visit to University of Toronto	International
Mar.24,1998	Visit to Carleton University	International
Mar.25,1998	Visit to Applied AI	International
May.21,1998	1st IMS Domestic meeting, FY1998	Japan
Jun.25,1998	Extra-IMS Domestic meeting, FY1998	Japan
Jul.20,1998	Visit to Imperial College(University of London) (London, UK)	International
Jul.22,1998	Visit to Alcatel Mietec (Zaventem, Belgium)	International
Jul.24,1998	Visit to CSEM(Centre suisse d'electronique et de microtechnique SA) (Neuchatel, Switzerland)	International
Jul.27,1998	Visit to IPA(Fraunhofer Institute Manufacturing Engineering and Automation) (Stuttgart, Germany)	International
Aug.27,1998	2nd IMS Domestic meeting, FY1998	Japan
Sep.09,1998	1st IMS Domestic WP3/WG1Technical meeting, FY1998	Japan
Sep.21,1998	2nd IMS Domestic WP3/WG1Technical meeting, FY1998	Japan
Oct.02,1998	3rd IMS Domestic WP3/WG1Technical meeting, FY1998	Japan
Oct.02,1998	1st IMS Domestic WP3/WG2 Technical meeting, FY1998	Japan
Oct.29-30,1998	3rd IMS Domestic meeting, FY1998	Japan
Nov.25,1998	2nd IMS Domestic WP3/WG2 Technical meeting, FY1998	Japan
Dec.17-18,1998	4th IMS Domestic meeting, FY1998	Japan
Feb.08,1999	Visit to University of Western Ontario (Ontario, Canada)	International
Feb.09,1999	Visit to University of Toronto (Ontario, Canada)	International
Feb.10,1999	Visit to National Research Council Canada (Ottawa, Canada)	International
Feb.11,1999	Visit to Carleton University (Ottawa, Canada)	International
Feb.12,1999	Visit to University of Quebec at Trois-Rivieres (Quebec, Canada)	International
Feb.18-19,1999	5th IMS Domestic meeting, FY1998	Japan
May.07,1999	1st IMS Domestic meeting, FY1999	Japan
May 21,1999	Discussion with Mr. F. Frederix (Alcatel Microelectronics) (Quebec, Canada)	International

Date	Events	Remarks
May.21,1999	Discussion with Dr. G. Knopf (University of Western Ontario) (Quebec, Canada)	International
Jul.08-09,1999	2nd IMS Domestic meeting, FY1999	Japan
Sep.09,1999	3rd IMS Domestic meeting, FY1999	Japan
Sep.28,1999	Discussion with Mr. F. Frederix (Alcatel Microelectronics) (Pisa, Italy)	International
Oct.01,1999	Visit to CSEM(Centre suisse d'electronique et de microtechnique SA) (Neuchatel, Switzerland)	International
Oct.04,1999	Visit to IHA/ETH (Institute for Hygiene and Applied Physiology/ETH) (Zurich, Switzerland)	International
Oct.05,1999	Visit to IPA(Fraunhofer Institute Manufacturing Engineering and Automation) (Stuttgart, Germany)	International
Oct.28-29,1999	4th IMS Domestic meeting, FY1999	Japan
Nov.16,1999	1st IMS Domestic WP3-1Technical meeting, FY1999	Japan
Nov.26,1999	2nd IMS Domestic WP3-1Technical meeting, FY1999	Japan
Dec.09,1999	Discussion with Prof. J. Efstathiou etc. (University of Oxford etc.) (Kobe, Japan)	International
Dec.16-17,1999	5th IMS Domestic meeting, FY1999	Japan
Feb.17-18,2000	6th IMS Domestic meeting, FY1999	Japan
Apr.20,2000	1st IMS Domestic meeting, FY2000	Japan
Jun.29-30,2000	2nd IMS Domestic meeting, FY2000	Japan
Aug.28-29,2000	3rd IMS Domestic meeting, FY2000	Japan
Oct.08,2000	Kick-off meeting with Canadian Region (Nashville, USA)	International
Oct.13,2000	Visit to National Research Council Canada (Ottawa, Canada)	International
Oct.16,2000	Visit to University of Oxford (Oxford, UK)	International
Oct.19,2000	Kick-off meeting with EU/Swiss Region (Madrid, Spain)	International
Dec.14-15,2000	4th IMS Domestic meeting, FY2000	Japan
Feb.19-20,2001	5th IMS Domestic meeting, FY2000	Japan
Apr.27,2001	1st IMS Domestic meeting, FY2001	Japan
Jun.14-15,2001	2nd IMS Domestic meeting, FY2001	Japan
Aug.22-23,2001	3rd IMS Domestic meeting, FY2001	Japan
Oct.12,2001	International HUTOP meeting - Suspended by Sep. 11 terrorism in USA-	International
Oct.29,2001	Extra-IMS Domestic meeting, FY2001	Japan
Dec.13-14,2001	4th IMS Domestic meeting, FY2001	Japan
Feb.21-22,2002	5th IMS Domestic meeting, FY2001	Japan
Apr.25,2002	1st IMS Domestic meeting, FY2002	Japan
Jun.13-14,2002	2nd IMS Domestic meeting, FY2002	Japan
Sept.19-20,2002	3rd IMS Domestic meeting, FY2002	Japan
Sept.19,2002	CSEM meeting for HUTOP Phase 2	International
Nov.05,2002	International HUTOP meeting (Sevilla, Spain)	International
Nov.11,2002	Visit to SOLINET (Stuttgart, Germany)	International
Nov.11,2002	Visit to Alcatel SEL (Stuttgart, Germany)	International
Nov.12,2002	Visit to IHA/ETH (Institute for Hygiene and Applied Physiology/ETH) (Zurich, Switzerland)	International
Nov.28-29,2002	4th IMS Domestic meeting, FY2002	Japan
Jan.16,2003	Extra-IMS-HUTOP Domestic Enterprise meeting, FY2002	Japan
Mar.13-14,2003	5th IMS Domestic meeting, FY2002	Japan

6. Project Administration

6.1 Project Management Structure

HUTOP project has been overseen by a Project Board Committee and a Technical Board Committee. A board member may nominate another person from his region to attend the board meeting and execute decisions with a written content. (Figure 6.1-1)

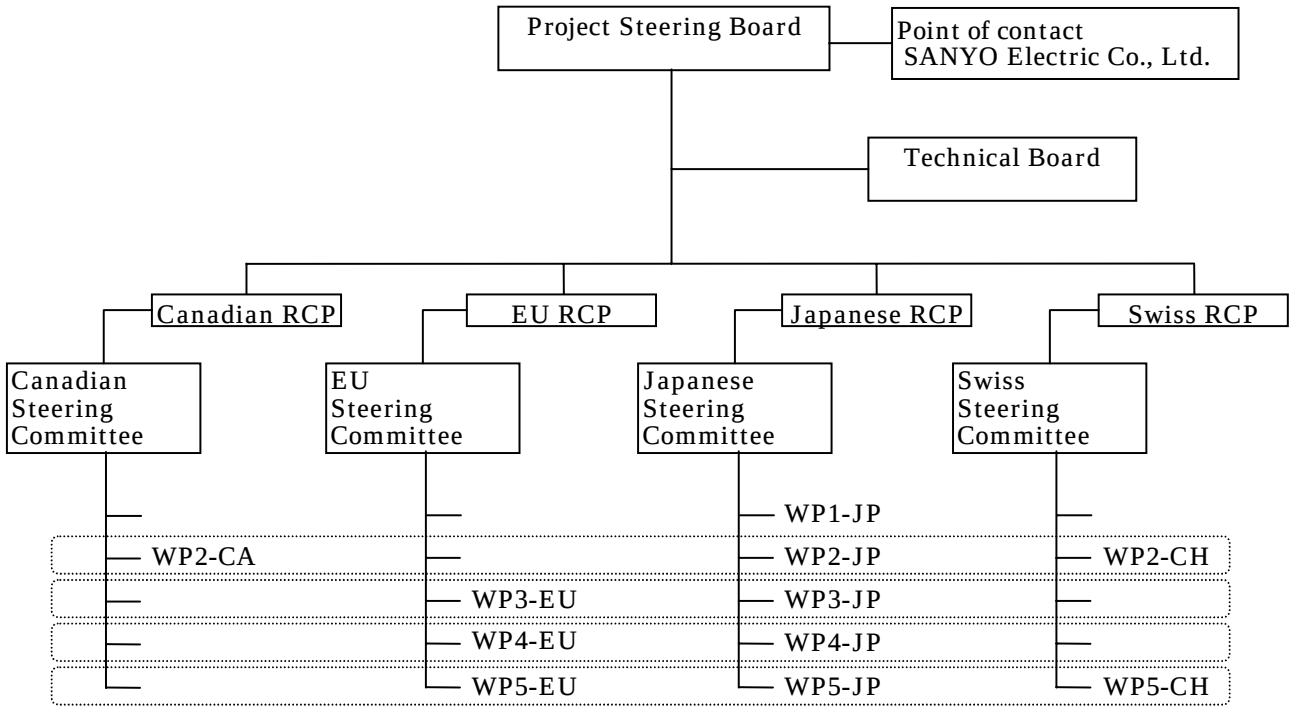

Fig. 6.1-1 International project organization

6.1.1 Project Board

The HUTOP project board has been responsible for the project by setting policy for the program and for overseeing the administrative and coordination structures.

6.1.2 Technical Board

The HUTOP Technical Board has taken responsibility for the technical agenda of the Project, oversight of the technical progress of the Work Packages, and ensuring coherence of the overall project objectives.

6.1.3 Work Package Leader

The work package leaders have been responsible for the technical progress of the activities of the individual work packages and report to Project Steering Board.

6.2 Communication Infrastructure

The Project Steering Board meetings have been planned once a year and Technical Board meeting twice a year. Also telecommunication media for discussions has been used as well as face-to-face communication between partners in order to accommodate the funding problems.

7. Consortium Composition

7.1 Regions Involved and ICP/RCP

Regions Involved : Japan, EU, Canada, Switzerland

International Coordinating Partner (ICP) : SANYO Electric Co., Ltd. (Japan)

Regional Coordinating Partners (RCP) :

Japanese Region : KAGAWA University

European Union(EU) Region : Fraunhofer-IPA

Canadian Region : University of Western Ontario (UWO)

Swiss Region : CSEM

7.2 Consortium Partners

[Japanese Region]

Industrial Partners :

- SANYO Electric Co., Ltd. (SANYO)
- DAINIPPON SCREEN Mfg. (SCREEN)
- Matsushita Electric Industrial (Matsushita)
- SHARP Corporation (SHARP)
- NEC Corporation (NEC)

Academic Partners :

- Kagawa University (Kagawa Univ.)
- Chukyo University (Chukyo Univ.)
- Waseda University (Waseda Univ.)
- Kyushu Institute of Design (Kyushu I.D.)
- Kobe University (Kobe Univ.)

[European Union(EU) Region]

Industrial Partners :

- Alcatel Microelectronics (AME)
- Innovative Silicon Technologies GmbH (ISilTec)
- SimCon (SimCon)
- TechnoSoft (TechnoSoft)

Academic Partners :

- Imperial College of Science Technology and Medicine (Imperial)

National Research Institutes :

- Fraunhofer Institut Produktionstechnik und Automatisierung (IPA)
- Laboratoire D'Automatique de BESANÇON (LAB)

[Canadian Region]

Academic Partners :

- University of Western Ontario (UWO)
- Carleton University (Carleton Univ.)
- University of Toronto (Univ. of Toronto)

[Swiss Region]

Industrial Partners :

- CableCom (CableCom)
- Switch (Switch)
- Symetria (Symetria)
- Tellware (Tellware)
- SwissCom (SwissCom)

Academic Partners :

- Swiss Federal Institute of Technology Institute for Hygiene and Applied Physiology (IHA-ETH)
- Swiss Federal Institute of Technology Institute for Construction and Design (IKB-ETH)
- Universite de Neuchatel (Neuchatel)

National Research Institutes :

- Centre Suisse d'Electronique et de Microtechnique (CSEM)

8. Consortium Cooperation Agreement (CCA)

This agreement was finally made and entered into as of January 15, 2001, by and among the 11 partners for the purpose of jointly performing the project within the IMS PROGRAM.

With the withdrawal of some partners, a few problems occurred regarding the original document. In particular, the bold parts in the following two items were requested to be re-examined and finally agreed as follows:

[ARTICLE Ⅸ - TERM AND TERMINATION]

SECTION 1 (Duration)
This COOPERATION AGREEMENT shall become effective as of the EFFECTIVE DATE and shall continue in effect **until the end of March, 2003**.
The SETTLEMENT of PROLONGED TERM shall be decided in accordance with agreement among all PARTNERS.
[ARTICLE X – MISCELLANEOUS]
SECTION 1 (Language and Law)
This COOPERATION AGREEMENT shall be interpreted in accordance with the laws of **the country of INTERNATIONAL COORDINATING PARTNER (ICP).**

APPENDIX

Reports, Bulletins

1) HUTOP:IMS Domestic Study IMS9619, 1996, IMS Promotion Center, 1997
2) HUTOP:IMS Domestic Study IMS9719, 1997, IMS Promotion Center, 1998
3) HUTOP:IMS Domestic Study IMS9819, 1998, IMS Promotion Center, 1999
4) HUTOP:IMS Domestic Study IMS9919, 1999, IMS Promotion Center, 2000
5) HUTOP:IMS Domestic Study IMS0019, 2000, IMS Promotion Center, 2001
6) HUTOP:IMS Domestic Study IMS0119, 2001, IMS Promotion Center, 2002
7) HUTOP:IMS Domestic Study IMS0219, 2002, IMS Promotion Center, 2003

Symposia, Conferences, Workshop Publications

1) [QCAV1998] Nov.10-12, 1998, Takamatsu City, Japan

[1] Overview of IMS Project: Human Sensory Factors for Total Product Life Cycle (NEC, Japan)
[2] Agility and Human Factors in the Virtual Enterprise (Alcatel-Mietec, Belgium)
[3] Factory Workers-Oriented Programless Visual Inspection System (Matsushita Electric Industrial, Japan)
[4] Optimization of Image Transmission Based on Visual Characteristics in Remote Control (Sharp, Japan)
[5] Processing Method of KANSEI Word Using the Context File Representing the Situation in which They are Used (Kubota, Japan)
[6] Modeling of KANSEI to 3D Shape for Personal Design (Dainippon Screen Mfg., Japan)
[7] Optimization of Decision-Making Parameters in Visual Inspection (NEC, Japan)
[8] The Effect of Accent Structure Synchronization between Music and Motion Pictures on the Feeling of Congruency (Kyushu Institute of Design, Japan)
[9] An Agent-Oriented Modeling Methodology on Scheduling in Manufacturing System (Univ. of Marketing & Distribution Sciences, Japan)
[10] Simulation of Human Cooperation for Human-Oriented Production Process (Sanyo, Japan)
[11] Haptic and Gesture Human-Machine Interface with Sensibility (Waseda Univ., Japan)

2) [QCAV1999] May19-21, 1999, Trois Rivieres, Canada

[1] A Simulation Methodology Using Worker's Cooperation Modelfor Human Oriented Production Process (SANYO Electric Co., Ltd., Japan)
[2] A Two Stage Extended Enterprise Optimization Methodology with Room for Human Decision Processes (Alcatel Microelectronics, Belgium)
[3] Personal Room Modeling System and Gesture Recognition System f or Personal Design Evaluation System (Kagawa University, Japan)

[4] Dynamic Scene Analysis Using Imprecise Information
(University of Western Ontario, Canada)

[5] Facial Caricaturing System with Concurrent Feedback Channel from Gallery
(Chukyo University, Japan)

[6] Gesture-Sensitive Interface for Human-Machine Interaction (Kagawa University, Japan)

3) [RO-MAN1999] Sep.27-29, 1999, Pisa, Italy

[1] General Aspects of Human Sensory Factors in Total Production Life Cycle
(Chukyo University, Japan)

[2] A Method of KANSEI Acquisition to 3D Shape Design and its Application
(DAINIPPON SCREEN MFG.CO., LTD., Japan)

[3] Factory Workers-oriented Program-less Visual Inspection System
(MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD., Japan)

[4] Simulation of Human-Oriented Production Systems Considering Workers' Cooperation
(SANYO Electric Co., Ltd., Japan)

[5] Experiences with a Control Architecture for the Virtual Factory
(Alcatel Microelectronics, Belgium)

[6] Supply Chain Management with Multi-agent Paradigm
(Univ. of Marketing & Distribution Sciences, Japan)

[7] Gesture Recognition for Human-friendly Interface in Designer-Consumer Cooperate Design System (Kagawa University and Waseda University, Japan)

4) [FCV2000] Jan.21-22, 2000, Nagoya, Japan

[1] Factory wokers-oriented programless visual inspection system
Takashi Anezaki (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD. , Japan)

[2] Visual Monitoring System for Highly Private Environment
Seiji Hata (Kagawa University, Japan) etc.

[3] Generating facial images eye-contacting with partner on TV conference environment
Hiroyasu Koshimizu (Chukyo University, Japan) etc.

[4] On the detection of feature points of 3D facial images and its application to 3D facial caricature Hiroyasu Koshimizu (Chukyo University, Japan) etc.

[5] Multi-modal Gesture Database and Gesture Recognition Using Wearable Devices
Shuji Hashimoto (Waseda University), Hideyuki Sawada (Kagawa University) etc

5) [PCM2000] Sep.06-09, 2000, Detroit, USA

[1] AN OVERVIEW OF IMS-HUTOP PROJECT
Ryo Yamada (DAINIPPON SCREEN MFG.CO., LTD., Japan)

6) [SMC2000] Oct.08-11, 2000, Nashville, USA

[1] General Aspects of Human Sensory Factors in Total Production Life Cycle
(Chukyo University, Japan)

[2] Re-generation of Facial Image Eye-Contacting with Partner on TV Conference Environment
(Chukyo University, Japan)

[3] Adaptive Reconstruction of Anatomical Surfaces from Human Body Measurements
(The University of Western Ontario, Canada)

[4] Automated Trend Diagnosis Using Neural Networks (Waseda University, Japan)

[5] Simulation of Human-oriented Production Processes Aimed at Providing Higher Worker Satisfaction (SANYO Electric Co., Ltd., Japan)

[6] The Effects of Synchronization of the Temporal Structure of Sound and Motion Picture on the Impression of Audio-visual Contents (Kyushu Institute of Design, Japan)

7) [e2000] Oct.18-20, 2000, Madrid, Spain

[1] An Overview of IMS-HUTOP project (SANYO Electric Co., Ltd., Japan)

[2] B to B e-commerce Server with virtual market
(University of Marketing and Distribution Sciences, Japan)

8) [MMM2000] Nov.13-15, 2000, Nagano, Japan

[1] The Effects of Audio-Visual Synchronization on the Attention to the Audio-Visual Materials (Kyushu Institute of Design, Japan)

[2] A Method for 3D Shape Design Utilizing KANSEI Input
(Dainippon Screen MFG. Co, Japan)

[3] Generating Facial Images Eye-Contacting with Partner on the TV Conference Environment (Chukyo University, Japan)

[4] Hand Shape Interface for Intuitive Human-Robot Communication Through Haptic Media (Waseda University, Japan)

9) [QCAV2001] May21-23, 2001, LeCreusot, Burgundy, France

[1] Design Evaluation of Products under Personal Environments (Kagawa University, Japan)

[2] Automatic Facial Caricaturing System Picasso for Profile (Chukyo University, Japan)

[3] Multi-Modal Gesture Database and its Retrieval by Gesture Inputs
(Kagawa University, Japan)

[4] A Method for Incorporating KANSEI in the 3D Shape Design Process
(Dainippon Screen MFG Co., Japan)

[5] Proposals of KANSEI Facial Image Media for Enforcing Human Interface on Network Environment (Chukyo University, Japan)

10) [ISHF2001] Sep.21-23, 2001, Sapporo, Japan

[1] The 3D Shape Design Support System Capable of Incorporating KANSEI"
(Dainippon Screen MFG. Co., Japan)

[2] Estimation and Modeling of Eye Movement by Facial Image Processing and its Applications (Chukyo University, Japan)

[3] Modeling of Interrelationship between Physical Feature of Face and its Impression
(Waseda University, Japan)

11) [5th Franco-Japanese Congress on Mechatronics] Oct.09-11, 2001, Besancon, France

[1] An Overview of IMS-HUTOP Project (DAINIPPON SCREEN, Japan)

[2] Proposals of KANSEI Human Facial Media on HUTOP Production Cycle
(Chukyo Univ., Japan)

[3] Display System of Personal Design Products in Personal Room Environment
(Kagawa Univ., Japan)

[4] Simulation Model for Human-Oriented Production Process in Consideration of Human Factors (SANYO, Japan)

[5] Elaboration and selection of optimal disassembly sequences (LAB, France)

[6] The Work Designing Technique With Human Factor Duly Considered (Sharp, Japan)

[7] A multi-agent based approach for multi-objective scheduling problems
(Kobe Univ., Japan)

[8] New Generation of Grippers for the Manipulation of Miniaturized Components
(CSEM, Switzerland)

[9] Online Inspection Logic Processing System (Panasonic, Japan)

[10]The Effects of Musical an Image Factors on the Impression of Audio-visual Contents
(Kyushu Inst. of Design, Japan)

12) [International IMS Project Forum 2001] Oct.08-10, 2001, Ascona, Switzerland

[1] An Overview of IMS-HUTOP project - Human Sensory Factors for Total Production Life Cycle - （SANYO Electric Co., Japan）

- Suspended presentation by Sept.11 terrorism in USA -

13) [Korean International IMS Forum] Mar.15, 2002, Seoul, Korea

[1] An Overview of IMS-HUTOP project - Human Sensory Factors for Total Production Life Cycle - （SANYO Electric Co., Japan）

14) [The IECON2002 international conference] Nov.05-08, 2002, Sevilla, Spain

[1] General Aspect of Human Sensory Factors in Total Product Life Cycle -HUTOP-
H.Tomita (SANYO, Japan)

[2] Basic Features of Human Factors in Total Production System
H.Koshimizu (Chukyo Univ., Japan)

[3] Intelligent Systems for Interactive Design and Visualization
Archana Sangole (Univ. of Western Ontario, Canada)

[4] Development of an Augmented Reality based 3D Catalog for Electronic Commerce
R.Yamada (DAINIPPON SCREEN, Japan)

[5] Distributed Co-operative Design Systems supporting Human Factors with *"Communicate- It"* S. Guttormsen Schär (SFIT, Switzerland)

[6] Recent Research in WP3-2 of HUTOP Project -Haptic Interface and Program-less Image Inspection- S.Hashimoto (Waseda Univ. Japan), K.Wakitani (Matsushita, Japan)

[7] Gestural Manipulation of Intuition-driven Monitor with the Detection of Human Sensory Factors H.Sawada (Kagawa University, Japan)

[8] Delivery and Service Systems with Human Sensory factors T.Kaihara (Kobe Univ., Japan), S.Iwamiya (Kyushu Insti. Design., Japan)

[9] Integration of Human Sensory Factors in Total production System M.Sasaki (SHARP, Japan)

Others

1)T.Kaihara:Supply Chain Management with Market Economics,Manufacturing for a global market,M.T.Hillery & H.J.Lewis Eds.,Vol.1,pp.659-662,1999

2)T.Kaihara,S.Fujii, and S.Kunimasa: A reactive self-organized scheduling based on Multi-agent paradigm, Global Production Management,K.Martins,O.Krause and B.Schallock Eds.,Kluwer Academic Publishers,Boston,pp.226-234,1999

3)Koshimizu.H,Suga.Y,Ishii.A :「Survey and General Report of Current Activities of Ad-hoc Research & Technical Committee on Image Processing of JSNDI」,Proc.2nd Japan-US Symposium on Advances in NDT,Jun.23,1999

4)H.Sawada, S.Hashimoto, "A Haptic Device Driven by Grasping Force For Hand Gesture Tele-Communication", Proceedings of Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems, ASME International Mechanical Engineering Congress and Exposition, 1999

5)K. Kato, T. Endo, K. Murakami, T. Toriu, H. Koshimizu:"Proposal of High-Speed Hough Transform Algorithm MRHT", Proc. ACCV 2000 (Taiwan)(Jan.2000)

6)Masafumi Tominaga. Kunihito Kato. Kazuhito Murakami and Hiroyasu Koshimizu: "Simulating Askant Glance Camera Vision System by Means of Extended Hough Transform". 5th Korea-Japan Joint Workshop on Computer Vision - Frontiers of Computer Vision - FCV'99, pp.109-114, Taegu Korea. 1999.1.23

7)Takayuki Fujiwara, Takeshi Nishihara, Masafumi Tominaga, Kunihito Kato, Kazuhito Murakami and Hiroyasu Koshimizu "On the Detection of Feature Points of 3D Facial Image and Its Application to 3D Facial Caricature" , Proc. of 3DIM'99,pp. 490-496 (Canada) (1999.10)

8)Seiji Hata,Katsuhiko Tsuboi,Hideyuki Sawada,Akira Ishii, "Personal Room Modeling System And Gesture Recognition System for Customer-Oriented Design System",IECON'99(1999), [CD-ROM]

9)Seiji Hata,Hideyuki Sawada,Katsuhiko Tsuboi,Skira Nagatomo, "Visual Monitoring System of Human Behaviors", China-Japan Workshop on Multidisciplinary Researches in Engineering(2000),pp.3-4

10)T. Kaihara: Supply Chain Management based on Market Mechanism in Virtual Enterprise, Infrastructures for Virtual Enterprises, L. M. Camarinha-Matos and H. Afsarmanesh Eds., Kluwer Academic Publishers, Boston, pp.399-408, 1999.

11)T. Kaihara: Multi-Agent based Supply Chain Management with Market Economics, Proceedings of International Workshop on Emergent Synthesis, K. Ueda Ed., pp263-270, 1999.

12)T. Kaihara: Supply Chain Management with Virtual Market Concept, Proceedings of International Conference on Advanced Manufacturing Systems and Manufacturing Automation, pp812-815, 2000.

13) T.Kaihara and S. Fujii: Multi-Agent based Auction Protocol for Decentralised Manufacturing Scheduling, The Proceedings of International Conference on Management and Control of Production and Logistics, CD-ROM, 2000.

14)T. Kaihara: Multi-agent based auction server for large-scale electronic commerce, Proceedings of International Sessions in SICE 2000, 313 A-1, 2000.

15)T. Kaihara: Supply Chain Management with Market Analogy, Information Technology in Business Management, R. Gan Ed., Publishing House of Electronics Industry, China, pp369-375, 2000.

16)R.Hikiji and S.Hashimoto, "Hand-shaped force interface for human-cooperative mobile robot", First International Workshop on Haptic Human-Computer Interaction, pp.113-118, 2000

17)T. Kaihara: Multi-Agent based Supply Chain Management with Market Emergence Phenomenon, Advances in Networked Enterprises, L. M. Camarinha-Matos, H. Afsarmanesh, H. Erbe Eds, Kluwer Academic Publishers, Boston, pp187-196, 2000.10.

18)T. Kaihara: Agent-based Double Auction Algorithm for Global Supply Chain System, The Proceedings of 2000 IEEE International Conference on Industrial Electronics, Control and Instrumentation (IECON-2000), pp.678-683, 2000.10.

19)T. Kaihara: Virtual market emergence for resource allocation in supply web, The Proceedings of 2000 IEEE International Conference on Industrial Electronics, Control and Instrumentation (IECON-2000:SEAL-2000), pp.2678-2683, 2000.10.

20)Fujiwara, T. Tominaga, M. Kato, K. Murakami, K. Koshimizu, H.: "Web-PICASSO: Internet Implementation of Facial Caricature System PICASSO", Proc. ICMI 2000, pp. 151-159 (China) (2000.10)

21)Fujiwara, T, Tominaga, M, Kato, K, Murakami, K and Koshimizu, H: "On the Detection of Feature Points of 3D Facial Image and Its Application to 3D Facial Caricature", Proc. MVA2000, pp. 111-114 (Tokyo) (2000. 11)

22)Tsuyoshi Yamaguchi, Masafumi Tominaga, Hiroyasu Koshimizu and Kazuhito Murakami: "Re-Generation of Facial Image Eye-Contacting with Partner on the TV Conference Environment", Proc. of MVA2000, 8-31, pp.371-374 (Tokyo, Japan) (Nov.2000).

23)Masafumi Tominaga, Tomokazu Asao, Kazuhito Murakami and Hiroyasu Koshimizu:Facial Caricaturing by Kansei Information from Gallery,7th Korea-Japan Joint Workshop on Computer Vision - Frontiers of Computer Vision - FCV2001, pp.47-52,2001.2.5

24)Masafumi Tominaga, Tomokazu Asao, Kazuhito Murakami and Hiroyasu Koshimizu:Facial Caricaturing System Controlled by the KANSEI of Gallery Through the Feedback from Eye-Camera, IAPR Workshop on Machine Vision Applications (MVA2000), pp.99- 102,

2000.11.28

25)Masafumi Tominaga, Tomokazu Asao, Kazuhito Murakami and Hiroyasu Koshimizu,KANSEI Facial Caricaturing based on the Eye-Camera Interface from Gallery,2000 IEEE International Conference on Industrial Electronics, Control and Instrumentation (IECON-2000), pp.307-312, 2000.10.25

26)S. Li, J. Hayashi, M. Tominaga, K. Kato, K. Murakami, H. Koshimizu: "Line Segment Detection by High performance Digital Template Hough Transform DTHT", Proc. of MVA 2000, pp.254-257 (2000.11)

27)T. Kaihara: Multi-Agent based Supply Chain Management with Market Emergence Phenomenon, Proceedings of the 4th IEEE/IFIP International Conference on Information Technology for Balanced Automation System, CD-ROM, 2000.9.

28)T. Kaihara, S. Fujii, and K. Harada: Clearing Price Dynamism with a Complex Virtual Market, Institute for Operations Research and the Management Sciences Annual Meeting 2000, pp.107, 2000.11.

29)N.Nagata, K.Sakaue, H.Koshimizu: Current State of Kansei Visual Sensing and Human Interface in Japanese Industries, Proc. of Knowledge-Based Intelligent Information Engineering Systems & Allied Technologies(KES2001),Vol.69,pp. (Osaka-Kyoiku University) KES2001(Sep.7, 2001)

30)Eye-camera and 3D PICASSO: 「Artificial intelligence, other brain」, Cutting Edge, AICHI VOICE, No.14, pp.18-21(2001)

31)Masafumi Tominaga, Hiroyasu Koshimizu: "MODELING OF EYE-MOVEMENT CAPTURED FROM EYE-CAMERA AND ITS UTILIZATIONTO INTERACTIVE FACIAL CARICATURING", IEEE 2002 International Conference on Image Processing 2002 (ICIP2002).

32)Jun-ichiro Hayashi, Ryan Stejskal, Hiroyasu Koshimizu : A Project for Automatic Facial Caricaturing System Profile PICASSO on PC, ICISP'2001 (Morocco) (May. 2001).

33)J. Hayashi, M. Yasumoto, H. Ito and H. Koshimizu: Age and Gender Estimation and Modeling by Means of Facial Image Processing, Knowledge-Based Intelligent Information Engineering Systems & Allied Technologies(KES2001), Vol.69,pp. 1128-1136 (Osaka-Kyoiku University) (Sep. 2001).

34)J. Hayashi, M. Yasumoto, H. Ito, and H. Koshimizu: A Method for Estimating and Modeling Age and Gender using Facial Image Processing, Proceedings of VSMM2001, pp. 439-448 (Berkeley, USA)(Oct. 2001).

35)Knopf, G.K. and Sangole,A., (2002), “Registration of closed free-form surfaces using deformable maps”, *Intelligent Engineering Systems Through Artificial Neural Networks: Vol. 12*, C.H. Dagli et al (Eds.), ASME Press [accepted – 6 pages].

36)Sangole,A., and Knopf, G.K., (2002) “Representing high-dimensional data sets as closed surfaces”, *Information Visualization Journal*, vol. 1, pp. 111-119.