ISSN 1340-8763

The Japan Society of Mechanical Engineers Vol.21, No.1 June 2010

Jsme News

URL http://www.jsme.or.jp/English

Recent Activities of Division of Manufacturing and Machine Tool

The JSME as a Center for the Human Resource Development in Science and Technology and Their Active Involvement

Yoichiro Matsumoto

President , JSME
Professor,
The University of Tokyo

Mechanical Engineering: Key to Building a Bright Future for Humanity

Mechanical engineering is a core field of engineering that contributes to the creation of a sustainable society and the resolution of social issues. Rooted in science and technology and covering a wide range of fields, mechanical engineering will play an important role in building a bright future for humanity.

Needless to say, science and technology are the source of Japan's economic competitiveness, and developing scientists and engineers is a national priority issue. It is widely recognized that it is science, technology, and research that have enabled Continued on page 2

Recent Activities of Division of Manufacturing and Machine Tool

Yoshimi Takeuchi

Professor,
Osaka University

International Conference of LEM21-Osaka

5th International Conference on Leading Edge Manufacturing in the 21st Century, entitled LEM21-Osaka, was held on December 2009. As I played a role of a chairman in the conference, I would like to take the opportunity of introducing the recent activities of Division of Manufacturing and Machine Tool, especially about international activities.

Division of Manufacturing and Machine Tool regularly Continued on page 4

A Key Challenge in Realizing Ideal Ultraprecision Machine Tool Structure

Hidenori Shinno

Professor,
Precision and Intelligence Laboratory
Tokyo Institute of Technology

1. Introduction

Demands for ultraprecision machining have increased in a wide range of industries, i.e., aerospace, semiconductor, optics, etc. In particular, structured surfaces with micro- and nano-sized patterns have recently been required for critical field. In order to meet such industrial requirements, it is necessary to develop an ultraprecision machine tool with both nanometer order machining accuracy and large machining-space. This article introduces a newly Continued on page 6

Advanced Manufacturing Software and System

Keiichi Nakamoto

Assistant Professor,
Dept. of Mechanical Engineering,
Osaka University

With increasingly diversifying customer's needs, the life cycle of products is shortened. Engineers are faced with the challenge of quickly producing a new product. Moreover, engineers should pay attention to increasingly complex environmental issues. In order to solve these problems, more effective and productive manufacturing system and software are required.

Recently, the manufacture of consumer goods such as automobiles, electronics, etc.is not necessarily active due to the economical recession. Continued on page 8

The JSME as a Center for the Human Resource Development in Science and Technology and Their Active Involvement

Yoichiro Matsumoto

President, JSME

Professor, The University of Tokyo

Continued from page 1 the nation to attain the economic prosperity and esteemed world position it enjoys today. The major driver behind Japan's current affluence and respected position in the international community is science and technology. Japan's population has already started to decline in number and is aging today at a speed not seen in other regions of the world. At the same time, Japan is exposed today to increasingly intense international competition in every field, and our Asian neighbors are making dramatic advances as they seek to catch up. It would be no exaggeration to say that science, technology, and research will determine whether Japan is able to enjoy sustained development and retain its respected position in the international community.

In this context, the Japan Society of Mechanical Engineers (JSME) must expand and enhance its infrastructure and improve its communication with society so that it can spearhead technological development and fulfill its responsibility to enhance human resource development as Japan's leading engineering society.

Enhancing the JSME's Infrastructure

Under the leadership of our past presidents, the JSME has implemented various concrete reforms over the past several years to achieve the abovementioned objectives and to enhance JSME operations. We established Machine Day and Machine Week. With an eye to strengthening operations at JSME headquarters, we introduced organizational changes, including creating new entities, as well as discontinuing, reorganizing, and improving others, resulting in today's Innovation Center, Center for Codes and Standards, and Center for Publications. In recognition of the fact that the baby-boomer generation is reaching mandatory retirement age, we have placed priority on facilitating the active participation of our senior members. In addition, we have taken measures to address the gradual decline in membership, a challenge that many academic societies face today. We have also contributed to the training of engineers, including measures to address the fact that fewer young people are pursuing engineering studies. Moreover, we have engaged in activities to enhance our presence and status as an organization of engineers. Our divisions have started issuing their own English-language electronic journals. We have also promoted measures to bridge the gap between research and technology in our bulletins of Japanese-language academic papers. Moreover, our initiatives in new fields are gaining momentum, as witnessed by our entry into the nanotechnology and biomedical fields.

In addition to initiating such reforms, it is important that we continue to make the fruits of these reforms tangible this business year as well. I would like to mention a few specific tasks that lie ahead of us.

In the area of human resource development over the long term, we will strengthen activities both within the JSME and with outside organizations. Measures to address the fact that young people are turning away from engineering in favor of other areas of study and the fact that fewer and fewer have international experience will include planning special programs at annual meetings and cooperating in the Consortium for the Development of Human Resources in Science and Technology, which is being set up by the Japan Federation of Engineering Societies. It is important that we conduct activities that leverage the experience and expertise of our senior members, including creating a senior association and facilitating their participation in various collaboration projects. As part of our efforts to address the decline in interest in science among elementary and junior high school students, we are now engaged in discussions spearheaded by the Business-University Forum of Japan regarding various new initiatives, including having engineers assist in educational settings. It would also be useful, however, for the JSME to consider independent initiatives it could undertake in this area as an engineering society.

Next, we must ensure our financial situation is sound. We face a decline in general finances as revenues have dropped from member and corporation member annual fees, publication sales, and advertising. We must endeavor to create sound finances from a medium- to long-term perspective, including securing new sources of revenues. In addition, we need to make a series of reforms as we look to shift our status to that of general incorporated association, a status very similar to that of nonprofit organization. These changes include making our accounting more transparent as we move toward applying accounting standards for public interest corporations. In managing our operations, we must keep in mind the balance between profitability and maintenance costs—namely, the revenues and expenditures in implementing each program. To do this, it is important that we evaluate each JSME program and look at whether it is something members want, whether it contributes to JSME finances, and whether it benefits society. We must then improve, discontinue, or reorganize programs based on the findings of our evaluation.

In addition, we will introduce radical reforms by further utilizing information technology. JSME journals, compendiums of Japanese papers, and other publications will be issued in electronic form and developed into Japanese and English journals that engineers and researchers can contribute to and use equally. As part of efforts to improve JSME administrative operations, we need to steadily promote the radical improvement of our information systems by harnessing IT.

Improving the JSME's Communication with Society

To steadily promote these measures, we will improve our various external relations activities, including Machine Day as well as lectures and workshops. It is important to enhance our communication with society in general and dramatically raise public awareness of mechanical engineering. Machine Day and Machine Week were launched in 2006 (our 84th business year) and have since been developed into major nationwide events through the full cooperation of our divisions and branches. We will not only continue these programs, but will make them into citizen events in cooperation with other machine-related academic societies and associations. Mechanical Engineering Heritage and JSME Technical Roadmaps which were created to commemorate the JSME's 110th anniversary have been covered by the mass media and others and received a favorable response from the public. I would like to continue these programs and develop them further. We need to get the word out to society about these programs more broadly and persuasively by building a cooperative framework with related organizations, including other academic societies and associations, the mass media, the business community, and administrative institutions.

Needless to say, communicating with the international community is also of growing importance. While using our international chapters (Indonesia and Thailand) and strengthening cooperative ties with mechanical engineering societies in China and Korea, we need to enhance our international activities, including building partnership with mechanical engineering societies in other countries and participating in related international conferences. Of these, further strengthening the close trilateral relationship among Japan, China, and Korea will be pivotal for our international ties.

Building More Partnerships both Inside and Outside the JSME

Today Japan faces population decrease and aging. To enhance the quality of Japanese people's lives as well as of Japanese society and to address environmental issues on a world scale amid these demographic trends, Japan must continually create innovations. Innovation will not be achieved by a single piece of knowledge or a single piece of technology. Innovation is the culmination of bringing together various kinds of scientific and technological knowledge and viewing it from the diverse perspectives of industry, government and academia.

At the same time, however, there is nothing more important than fostering research, the seed of future innovations. Human resources can be said to be Japan's only resource, so we face the urgent task of developing people who can spearhead innovation. The JSME can serve as a center for such development. We are being called to continue our activities as a center for the long term training of engineers and the facilitation of their active involvement in science and technology. Partnerships that transcend past frameworks with other related academic societies and associations are of increasing importance as we seek to do this. Also important are strengthening and expanding the core areas of mechanical engineering as well as making our divisions, branches and centers more flexible to promote solutions-oriented research and technological advancement. We must also improve the JSME's financial situation. In addition, I would like to see the JSME take the following measures to enhance its operations as an organization of engineers, researchers, and educators: strengthen activities to support skills development for engineers and create an open environment that fosters cooperation and collaboration with researchers at universities and other institutions in order to make the JSME an organization that is more appealing to engineers at corporations, which make up the majority of the JSME's membership.

The Japan Society of Mechanical Engineers has developed over its long history and tradition to become the nation's leading engineering society. Continuing to pursue reform on an ongoing basis—rather than being complacent with our current position—is indispensable for us to maintain the health and development of the JSME as an organization.

Recent Activities of Division of Manufacturing and Machine Tool

Yoshimi Takeuchi

Professor, Osaka University

Continued from page 1 holds an international conference, so called LEM21, which is organized and sponsored mainly by the Manufacturing and Machine Tool Division and collaboratively by the Manufacturing System Division of the Japan Society of Mechanical Engineers (JSME). The objective of the conference of LEM21 is to provide an interdisciplinary forum for the exchange of information on the latest cutting-edge developments in manufacturing. The first conference of LEM21 was held in Tokyo in 1997 with great success, and the second one in Niigata in 2003, the third one in Nagoya in 2005, and the latest one in Fukuoka in 2007.

The Organizing Committee had been worrying about the reduction in the submission of papers to LEM21-Osaka due to the global economical recession initiating Lehman Brothers one and half years ago. Nevertheless, more than 180 selected papers were submitted, as shown below, for nineteen organized sessions.

Accepted paper: 168 papers (182 applied)
Plenary speeches: 2 titles (Korea, Japan)
Participant: 237 persons (On-line registration) 16 persons (On-site registration)
Total: 253 persons from 15 countries

The papers were actively delivered in five rooms. The program of the conference included two plenary speeches from a foreign academia and a domestic industrialist in the plenary session.

Two plenary speeches in LEM21-Osaka

Let me introduce the speeches. The former speaker is Professor Chong Nam Chu, Dean of Engineering Faculty at Seoul National University. The title is 'Overview of Korean Manufacturing Industry'.

After the Korean War, South Korea suffered from political turmoil and had to rely on foreign aid. In 1962, former general Park carried out a coup and made a foundation for industrialization. The first stage of industrialization was the production of electricity and coal. Light industry including textile and shoes played a major role in Korean economy. Low wage was the major competitiveness. Income from the construction and service companies during the Vietnamese war, and oil money from the Middle East after the oil shock were the basis of the next industrialization plan. Korea started investing in heavy and chemical industries. While these industries were government driven, electronics industry progressed in the private sector. Korean manufacturing industry enjoyed the economic boom during and after the Seoul Olympic game in 1988 and suffered from the financial shock in 1997. Ironically, the financial shock in 1997 urged Korean companies to restructure and globalize. Currently, Korean manufacturing industry is fairly competitive while many other countries have difficulties from the worldwide financial crisis.

In 2008, ten major export items were ships and off-shore structure, petrochemical product, wireless communication equipment, automobile, semiconductor, flat panel display, steel, synthetic resin, automobile parts, and computer. The strengths of Korean ship building industry are the innovation of ship building technologies such as floating dock and dockless ship-building, and young design engineers. Automobile industry is steadily growing thanks to the improvement of initial quality, design, and durability. Restructuring of the automobile industry during the economic shock in 1997 and change of the ownership were the driving force of the quality improvement. Memory chip and LCD panel production leads the world market thanks to the daring investment decision by the owners of the companies. Cellular phones are competitive because of the early adoption of the CDMA technology. World market share of Korean cellular phone is rapidly increasing.

Machinery industry is relatively weak in Korea. High end machine tools are imported from Japan and Germany, and general purpose machine tools are exported to China. Only 20 % of semiconductor manufacturing equipments are domestically provided. Construction equipments are relatively competitive in the world market. Textile and shoe making machineries are well exported while domestic demands are rapidly declining. Overall, Korean manufacturing industry is steadily growing. However, production is heavily concentrated to a few big companies. Small manufacturing companies are tied to a big company and cannot properly invest in R&D. In order for the Korean manufacturing industry to move to the next step, parts and material quality need to be improved.

The latter speaker is Mr. Hidetoshi Imazu, Executive Vice President, Nissan Motor Co., Ltd. The title of his speech is 'The Role of Production Engineering in Realizing a Future of "Sustainable Mobility'.

Since 2006, Nissan has been working on its mid-term environmental action plan, titled "Nissan Green Program 2010" abbreviated as NGP2010. The plan has three key objectives:

1. "Reducing CO2 emissions",
2. "Reducing other emissions (to protect the air, water and soil)" and
3. "Recycling resources".

Proactive actions have been taken in designing Nissan's production process to achieve these objectives and so contribute to realizing Nissan's image of a future of "sustainable mobility"

Consider the first two objectives of reducing CO_2 and other emissions and take for example the vehicle painting process. This is an energy intensive process involving complex chemical processes so Nissan has taken extensive measures to reduce energy use and so reduce our CO_2 emissions and also our operational costs. Additional process design countermeasures involving the use of leading edge technologies and materials are applied throughout the paint process to reduce emissions of volatile organic components whilst improving paint finish and durability. In this way, it is clear that "Nissan's Green Program 2010" is not only good for the environment it is also good for Nissan' s business performance.

For "Resource recycling", the automobile industry is expected to shift from not only producing products but to build our products in such a way as to encourage high levels of material recycling and reuse. Nissan's strategy to support this is to reduce their reliance on nonrenewable resources by ensuring that the materials used in their vehicles are highly recyclable both during the production process and at end of life. Recycling during the production process ensures that waste material is continuously recycled into useable material for actual production use for example Nissan recycles off cut materials from our plastic molding and metal casting processes back into the original processes thus reducing waste and improving our cost efficiency. Again this shows that being Green is not just about being a responsible corporate citizen, which Nissan is, but it is also good for Nissans business performance.

Speech by Professor Chu

Nissan's Manufacturing and Engineering Divisions have implemented various improvements to fulfill these expectations. The improvements involved the utilization of high technology skills acquired from automobile production, the merging of technologies with industries, and the development of recovery/recycling engineering skills to ensure they minimized their reliance on non renewable resources.

All of Nissans production and environmental engineering abilities and improvements have been harnessed to realize what is Nissan's key contribution to a future of "sustainable mobility" ,namely the ZERO emission car. In 2010, only a few short months away, Nissan will launch the worlds first Mass Market zero emission electric vehicle or EV. The car, called the LEAF, will be a family sized car employing a Lithium Ion battery with world beating efficiency. This battery is critical to the EV's performance in terms of reliability, driving range and driving performance. Therefore, for Nissan the in-house production of this battery is viewed as being equally as important as the production of the EV vehicle itself.

To reduce their carbon footprint Nissan plans to produce EV's and associated batteries globally with production sites already announced in the US and Europe and further sites under consideration. To supply high quality batteries globally at a low cost, Nissan's know-how, such as development of compact and modular automatic assembly lines is absolutely critical. But so is their skill in automotive recycling. Nissan has refined their concept of

Speech by Mr. Imazu

Conference banquet

battery recycling to even greater heights in order that they realize a vision for EV as a key contributor to a future of “sustainable mobility” .

This paper will show you that production engineering plays a very important role in these broad areas. Through the explanation of actual cases based on such ideas the author will present some novel thinking methods that engineers should use when developing technologies.

Importance of manufacturing technology

In recent years, the manufacture of consumer goods such as automobiles, electronics, etc is not necessarily active due to the economical recession, however, it is true that the manufacturing technology still plays an important role for the sustainable growth, and significantly contributes to the human society. Those who belong to Division of Manufacturing and Machine Tool well recognize the significance and importance of manufacturing technology in order to enhance our lives and care the environment. It is clear that the activities of Division of Manufacturing and Machine Tool range from manufacturing and production system to environmental technology.

A Key Challenge in Realizing Ideal Ultraprecision Machine Tool Structure

Hidenori Shinno
Professor
Precision and Intelligence Laboratory
Tokyo Institute of Technology

Continued from page 1 developed ultraprecision machine tool based on a new design concept. The machine tool developed here has a wide range machining function with nanometer resolution.

2. Anticipating Future Evolution Trends of Ultraprecision Machine Tool

Figure 1 shows future trends of ultraprecision machining and desirable machine tool structure. In order to respond such trends, it is necessary and indispensable to realize an innovative ultraprecision machine tool. In consequence, future ultraprecision machine tools can successfully machine micro-structures on hard and brittle materials such as glass or ceramics.

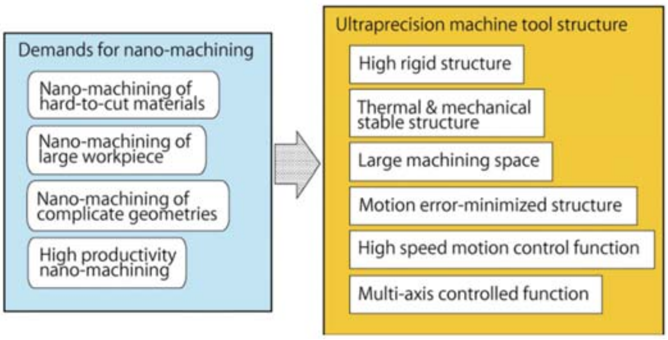

Fig.1 Future trends of ultraprecision machining

3. A Proposed Design Concept of Ultraprecision Machine Tool

Figure 2 shows a basic design concept of thermally and dynamically stable machine tool structure. Based on the proposed design concept, an innovative ultraprecision machine tool can be realized, as shown in Fig.3.

The overall machine structure is symmetrically designed with the respect to the vertical center axis. All the moving structural modules are levitated by aerostatic bearings and driven by voice coil motors in a perfect noncontact condition.

In consequence, various nonlinear phenomena can be removed from the machine structure and then the

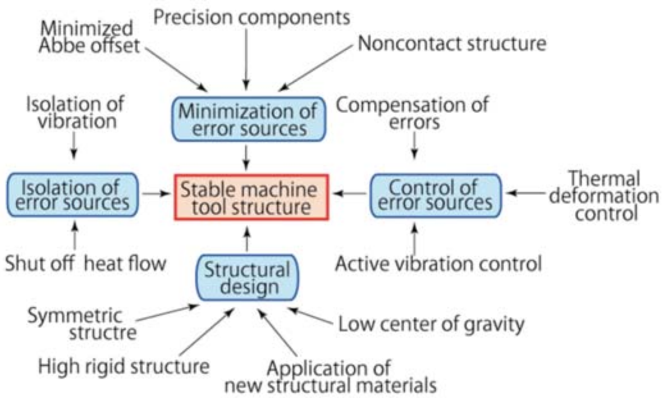

Fig.2 Stable machine tool structure

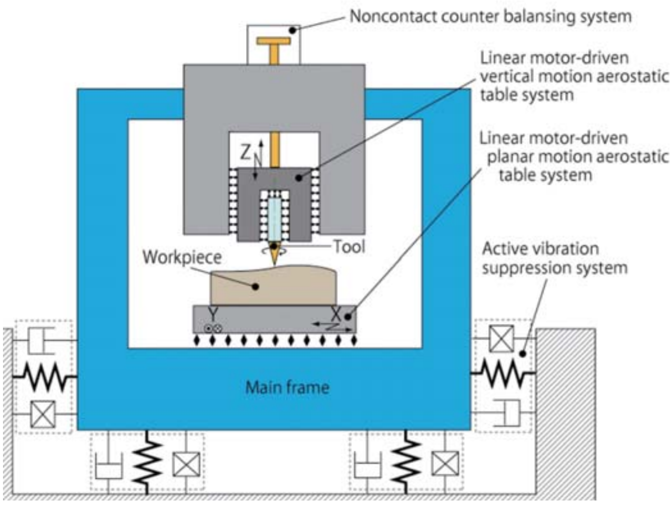

Fig.3 Concept of ultraprecision machine tool

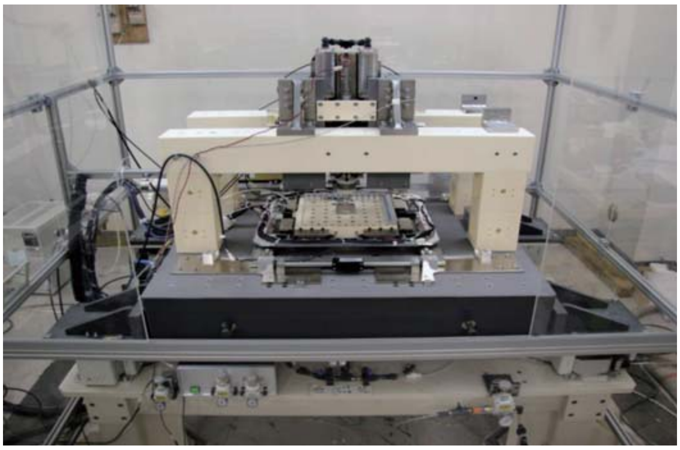

Fig.4 Advanced nano-pattern generator (ANGEL)

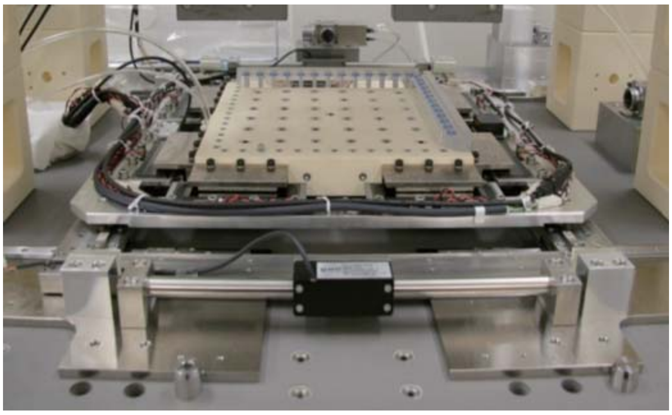

Fig.5 X-Y planar nano-motion table system

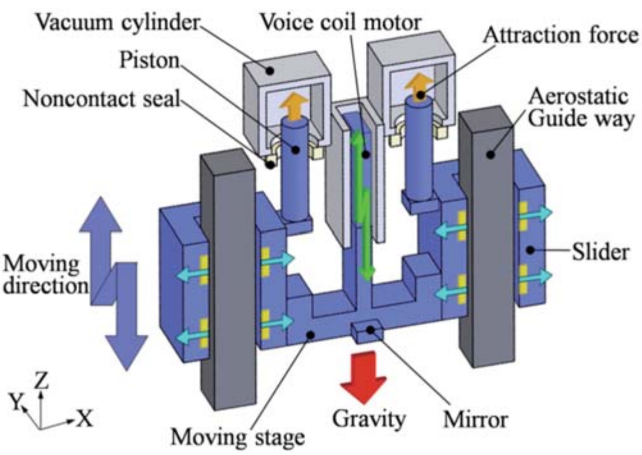

Fig.6 Vertical nano-motion platform

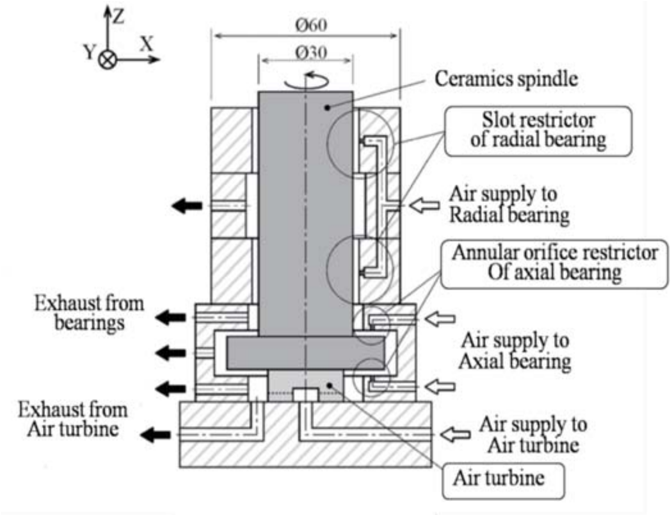

Fig.7 Air turbine-driven aerostatic spindle system

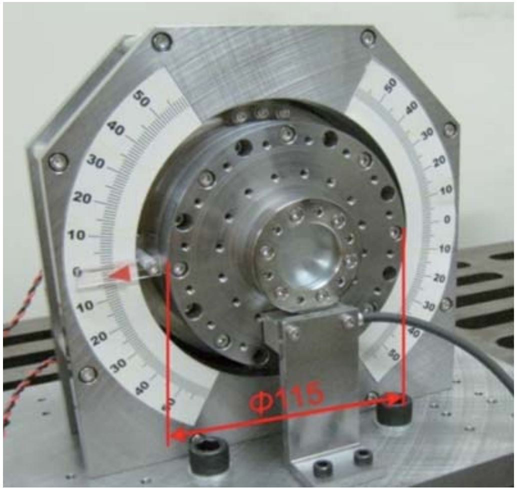

Fig.8 Tilting motion platform

error factors in the overall machine structure can be successfully minimized. The ultraprecision machine tool proposed can be characterized by the following attributes:

(1)Symmetric structure,
(2)Abbe offset-minimized structure,
(3)Motion error-minimized structure,
(4)Thermal deformation-minimized structure,
(5)Long stroke nano-motion driven by hybrid actuator[1],
(6)An X-Y planar nano-motion table system,
(7)Vertical axis nano-motion platform with a gravity compensator.

4. A Newly Developed Ultraprecision Machine Tool

Figure 4 shows the structural configuration of the advanced nano-pattern generator with large work area named ANGEL.

The machine structure is composed of the X-Y planar nano-motion table system [2,3] in Fig.5, the Z-axis nano-motion platform equipped with a noncontact gravity compensator [4] in Fig.6, an air turbine-driven aerostatic spindle system [5] in Fig.7, a flat rectangular bed, columns and top beams. These structural modules were made of ceramics. In addition, a tilting motion platform with high performance hybrid actuator in Fig.8 was developed for realizing a trunnion type rotary table system [6].

5. Conclusions

The article introduced a newly developed ultraprecision machine tool and the fundamental structural modules. The function and structure of the ultraprecision machine tool developed are of the utmost importance in realizing future ultraprecision machine tools. The structural design and nano-motion control technologies developed will be widely applied in industry.

References

[1]Shinno,H., Hashizume,H., 2001, High Speed Nanometer Positioning Using a Hybrid Linear Motor, Annals of the CIRP, Vol.50, No.1, 243-246.

[2] Shinno, H. , Hashizume,H., Yoshioka,H., Komatsu,K., Shinshi,T., Sato,K., 2004, X-Y- Nano-Positioning Table System for a Mother Machine, Annals of the CIRP, Vol.53, No.1, pp.337-340.

[3] Shinno,H., Yoshioka,H., Taniguchi,K., 2007, A Newly Developed Linear Motor-Driven Aerostatic X-Y Planar Table System for Nano-Machining, Annals of the CIRP, Vol.56, No.1, pp.369-372.

[4]Takahashi,M, Yoshioka,H., Shinno,H., 2008, A Newly Developed Long-Stroke Vertical Nano-Motion Platform with Gravity Compensator, Journal of Advanced Mechanical Design, Systems, and Manufacturing, Vol.2, No.3, pp.356-365.

[5] Yoshioka,H., Okubo,M., Hashizume,H., Shinno,H., 2005, A Developed Ultraprecisin Air Spindle System for Nano-Machining, Proc. of the ASPE 2005 Annual Meeting, Vol.37, pp.126-129.

[6]Shinno,H., Yoshioka,H., Hayashi,M, 2009, A High Performance Tilting Platform Driven by Hybrid Actuator, CIRP Annals-Manufacturing Technology, Vol.58, No.1, pp.363-366.

Advanced Manufacturing Software and System

Keiichi Nakamoto Assistant Professor,

Dept. of Mechanical Engineering, Osaka University

Continued from page 1 However, it is true that the manufacturing technology still plays an important role for the sustainable growth, and significantly contributes to the human society.

The 5th International Conference on Leading Edge Manufacturing in the 21st Century, entitled LEM21-Osaka, was held in Osaka in 2009 to provide an interdisciplinary forum for the exchange of information on the latest developments in manufacturing. Through the distinguished presentations at LEM21-Osaka, advanced manufacturing system and software for the next generation are introduced here.

Collision avoidance for multi-axis machine tool

In the area of machining, automation of operations is comparatively realized by the contribution of NC machine tools so far. Recently, the usage of 5-axis machine tools, which has 3 translational axes and 2 rotational axes, has dramatically expanded to manufacture various products with complicated shapes. However, the flexibility of 5-axis machine tools causes problems such as collision avoidance, NC program generation, and so on.

Geometric simulation before machining has prevailed to prevent the collision. However, many collision accidents still occur when used manually, and both user and machine tool builder are highly focusing in collision free machining. Thus, an on-line collision check system shown in Figure 1, that is used by Geometric simulator and CNC openness is developed [1]. Also, conventional collision prevention systems for machine tools are based on simulations using 3D models of workpieces that are made in advance. If the setting up of workpieces differs from the models, then collision accidents are unavoidable. Therefore, as shown in Figure 2, a collision prevention system is proposed with enhanced functions for detecting workpiece setting defects of machine tools by simulation based on actual conditions from NC controllers and measurement data of workpieces using 3D laser scanning [2].

To realize both high productivity and fine surface, a planning method to keep dynamic synchronous accuracy

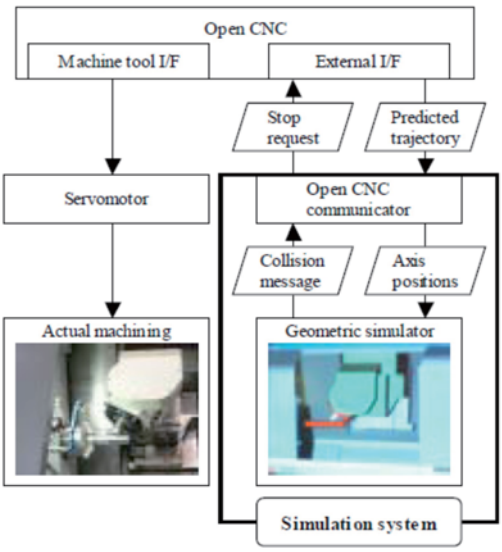

Figure 1: On-line collision check system [1]

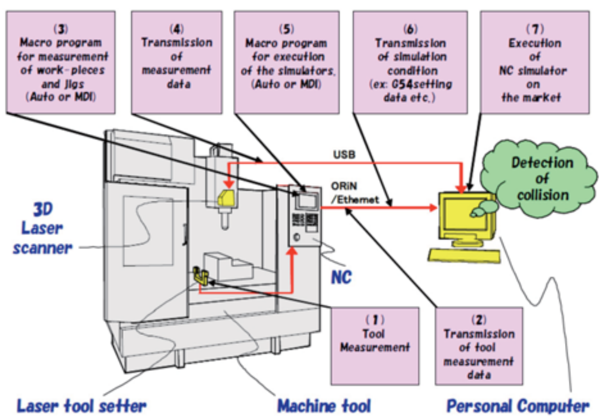

Figure 2: Concept of collision prevention system [2]

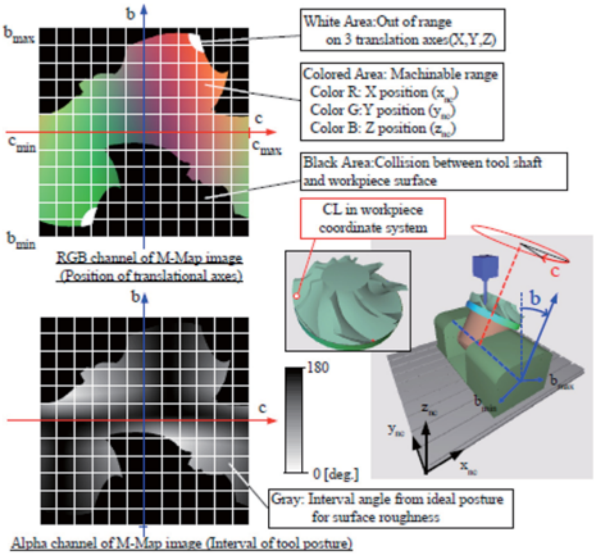

Figure 3: Movable range illustrated as image [3]

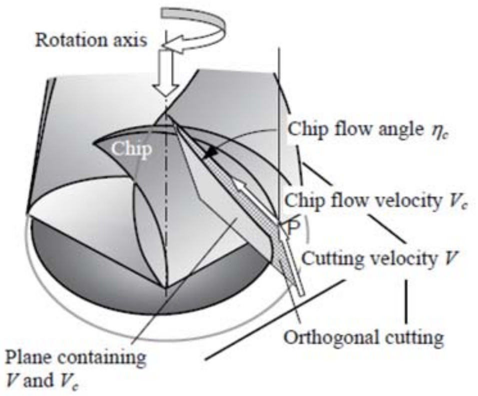

Figure 4: Chip flow model in drilling process [6]

among tool axes and tool posture against surface of workpiece is required. Therefore, a new planning method based on integrated main/post processing system for tool posture is proposed [3]. In the proposed method, as shown in Figure 3, movable range of rotational axes without collision and tool posture against surface is illustrated as image for each cutting point with GPU. Then, by referring these images, continuous change in rotational axes can be planned, while keeping the tool posture.

Cutting simulation for various machining methods

A NC milling simulation kernel that uses voxel models as an underlying representation of workpiece shapes is developed to achieve simplicity and efficiency in the boolean operations [4]. This enabled better simulation performances compared with conventional B-Rep based simulators. The adaptiveness also achieved the desired balance between model precision and data size. The chip area and cutting performance in oval end milling of an inclined surface is analyzed [5]. The chip area is calculated by the interference of the rake surface and the chip volume. The influence of cutting conditions on the behavior of the chip area is shown and the evaluation value for cutting performance is proposed. The theoretical

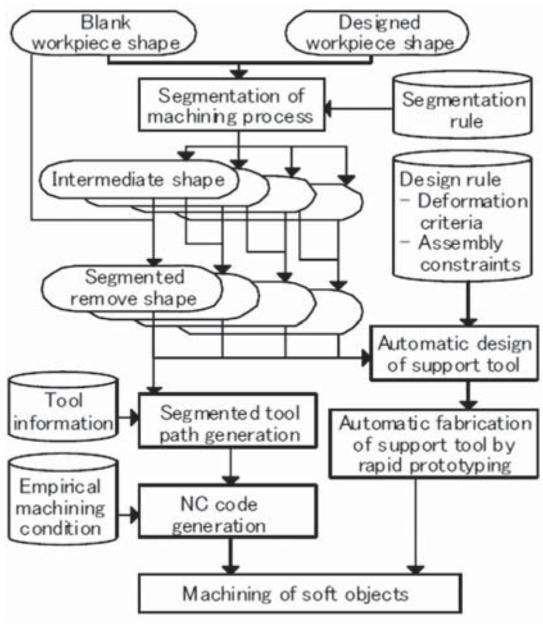

Figure 5: Framework for machining of soft object [8]

Figure 6: Prototype autonomous NC machine tool [9]

surface roughness in oval end mill is also compared with those of a machined surface. The cutting force and the chip flow direction are simulated to reduce burr formation at the backside of the machined plate in an analytical model based on the minimum cutting energy [6]. Figure 4 shows chip flow model in drilling process. The curved lips drill is discussed to reduce the thrust and increase the chip flow angle with the orientation and the curvature. The counterclockwise orientation is effective to reduce the thrust and control the chip flow with the small curvature. A curved lip drill is designed with a large radial rake angle at the end of the lips based on the cutting simulation.

Process planning for high performance machining

Multi-tasking machine tools, which have the milling function in addition to the turning function, are very useful to manufacture complicated workpiece efficiently. However, it is very difficult to generate NC programs. Therefore, CAM system is developed which can recognize part configurations, calculate tool paths automatically for turning and milling operations, and sort them in machining order [7].

To realize a high-precision soft object machining in small lot production, end milling with adaptive workpiece support is proposed [8]. Figure 5 shows the proposed framework for machining of soft object. A rapid prototyping technology enables to realize the automatic fabrication of adaptive support tools. Effects of the adaptive workpiece support for thin-walled soft objects are investigated by measuring the machining error of machined workpiece. The results show the accuracy for soft objects machining can be improved by appropriate insertion of dedicated support tools.

Challenging approach for future machining

Most machining tools are controlled by NC programs in order to achieve unmanned machining operations with high precision and improved productivity. However, all the movements of the machining tool are predetermined, and all instructions coded in the NC program are performed sequentially. Therefore, since the cutting process is not adaptable during unmanned machining, the cutting conditions should be set conservatively to avoid cutting difficulties. In order to adapt the cutting process, machining strategies have been integrated into an autonomous NC machining tool developed under digital copy milling concept as shown in Figure 6 [9]. By using copy milling principle, the machine tool can generate a tool path in real time to avoid tool breakage and to stabilize cutting load during a milling operation. In machining strategies, feed speed, radial and axial depths of cut are adapted according to cutting load detected from load cells in the machining table. Successful end milling experiments verified the effectiveness of the developed machining strategy.

An improvement of design efficiency of machine tool structure is discussed in the stage of conceptual and basic design [10]. An interactive system has been developed for designing machine tool structure. The distinguishing point in this system is that several conceptual beams are used to compose the total structure of machine tool because it is easy to analyze the static, dynamic and thermal properties. By converting the beam structure into an actual structure, the conceptual and basic design is completely finished. Consequently, the use of the interactive system allows the designer to complete structural design of a machine tool in a shorter time with higher efficiency.

Summary

The article describes advanced manufacturing system and software presented at LEM21-Osaka. Future manufacturing will be deeply supported by using these manufacturing system and software introduced here.

It is no exaggeration to say that the human society has progressed with manufacturing. The manufacturing technology is the driving forces behind the sustainable growth. In order to realize more effective and productive manufacturing and to create an affluent society, it is increasingly important to develop more highly advanced manufacturing system and software.

References

[1]Asano, T., Hida, T. and Goto, A., 2009, Study on Collision Free Machining Using Simulation and CNC Openness, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 45-48.

[2]Kimura, T., Izaki, T., Terada, H., Shitaya, Y., Sayama, K. and Kanda, Y., 2009, A Collision Prevention System with Enhanced Functions for Detecting Work-piece Seting Defects of Machine Tools, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 79-82.

[3]Kaneko, J. and Horio, K., 2009, Tool Posture Planning Method for 5-axis Control Machining with an Idea of Spatial Temporal Representation Based on Machine Tool Coordinate System, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 149-154.

[4]Miyata, A. and Azuma, T., 2009, NC Milling Simulation Using Adaptively-sampled Distance Fields, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 271-274.

[5]Iwabe, H., Kumaki, T. and Hori, I., 2009, Study on Cutting Mechanism and Cutting Performance for Inclined Surface by Oval End Mill using 3D-CAD, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 495-500.

[6]Matsumura, T. and Leopold, J., 2009, Simulation of Drilling Process for Control of Burr Formation, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 489-494.

[7]Kubota, K., Kotani, T., Nakamoto, K., Ishida, T. and Takeuchi, Y., 2009, Development of CAM System for Multi-tasking Machine Tools, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 49-54.

[8]Teramoto, K., Kuroishi, Y. and Yamashita, M., 2009, A framework for machining of soft objects, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 365-368.

[9]Shimada, T., Nakamoto, K. and Shirase, K., 2009, Machining Strategy to Adapt Cutting Conditions under Digital Copy Milling Concept, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 101-106.

[10] Yu, Z. Y., Nakamoto, K., Ishida, T. and Takeuchi, Y., 2009, Study on an Interactive System for Conceptual and Basic Design of Machine Tool Structure, The 5th International Conference on Leading Edge Manufacturing in the 21st Century, pp. 33-38.

JSME News Vol. 21 No. 1

Editors:Hiroyuki Kawada,Naoto Ohtake,Yoshio Saito

International Liaison Committee
Published by The Japan Society of Mechanical Engineers
Shinanomachi-Rengakan Bldg,Shinanomachi 35,
Shinjuku-ku,Tokyo 160-0016,Japan

Fax:81-3-5360-3508