# Development of fundamental technologies for manufacturing software; development of intelligent machine tools and industrial robots

## Koichi MORISHIGE Laboratory

Koichi MORISHIGE

### Summary of Research

#### Research and Development on Technologies for *Monozukuri* Manufacturing Software and Machines

Japan offers world-leading technologies not just in the automobile industry, but in industrial machinery production, including machine tools and industrial robots. However, many issues in the area of utilization technologies remain to be resolved.

Given the traditional emphasis among Japanese engineers on hardware development at the expense of software technologies, efforts related to studying and finding practical applications for software to assist industrial production has indisputably lagged behind the Western world.

Increasingly encountered in industry settings, machining processes incorporating multi-axis control machine tools have gained visibility for their high degree of freedom. They represent part of the industry strategy for achieving increased production efficiency.

Nevertheless, effective technologies have yet to be developed for the software needed to process information and to optimize the operating conditions of these complex machines. Associate Professor Morishige hopes to address this issue and to improve the machining process.

#### Developing Software for Multi-axis Control Machine Tools

With tool/workpiece interference prevention and path optimization, we are currently developing practical software for multi-axis control machine tools. These efforts include efforts underway to identify practical applications of ideas already proposed.

#### Developing a Production System for Comprehensive and Integrated Use of CNC Machine Tools

Our laboratory is also striving to develop a production system that will permit comprehensive and integrated control of multiple information/intelligent CNC machine tools. Based on its own internal data associated with a machining operation it is tasked to perform, each machine tool participates in the decision-making process to optimize the selected machining method and conditions.

The machining results are retained as “experience” in the machine tool’s own database and applied to future decision-making processes. Our study creates more efficient production systems by linking information/intelligent machine tools responsible for various machining operations. Additionally, we have also developed a new machining interface. When a user applies a stylus and touches a 3D model on a computer screen, the motion of the stylus is transmitted to the machine tool, which then carves the material based on the movements of the stylus. This system would free workers from the complexity of machine tools that have progressed remarkably little through the past decades and increase the degree of freedom in machining.

Current evaluations of machined surfaces are generally based on surface roughness measurements. Our laboratory is investigating a minute-scale property called *surface integrity* that cannot be evaluated with surface roughness meters as we explore ways to apply image processing technologies to perform surface integrity evaluations.

### Advantages

#### High Praise for World-Class Research Achievements

“The significance of any engineering study lies in its potential for practical application.” This is our laboratory motto, one that has guided vigorous R&D efforts in manufacturing software. Centered around this R&D is the development of an intelligent

### Keywords

**Manufacturing software, intelligent production system, CAD/CAM, information/intelligent machine tool, intelligent industrial robot, multi-axis control machining, *monozukuri* manufacturing**

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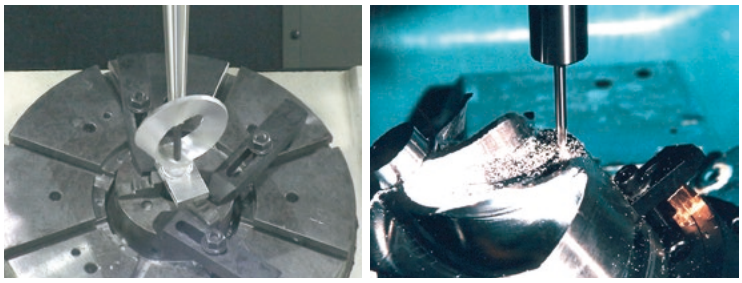
| Affiliations | Japan Society for Precision Engineering; Japan Society of Mechanical Engineers; Japanese Society of Die and Mold Technology |
| Member | Koichi Morishige, Associate professor |

computer-based production system.

We participate in joint research projects with domestic machining manufacturers and CAM vendors to develop real-world applications for our technologies. These efforts have led to world-class results in R&D based on a 3D solid modeling kernel, which has won high praise from industry. We are one of Japan's leading laboratories in this field, something in which we take great pride.

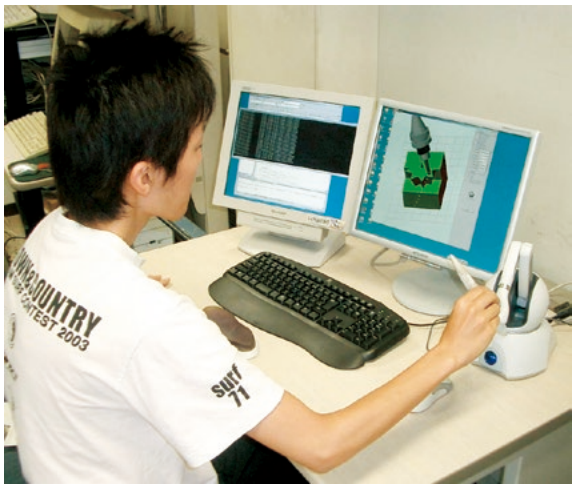


5-axis control machining

### Access to World Standard Systems and a Broad Range of Machine Tools

In addition to multiple world-class 3D CAD/CAM systems, we own and operate numerous machine tools essential for machining studies.

Our laboratory has taken multiple approaches in our study of intelligent industrial robots, including motion planning for six-axis multi-joint robots based on their structure and work characteristics, automatic evaluations of machined surfaces using image processing technologies, and the development of new devices for special machining processes. Japan is the world's leading industrial robot manufacturer; we aspire to help Japan achieve the same heights in the sphere of utilization technologies.



Machining interface using haptic device

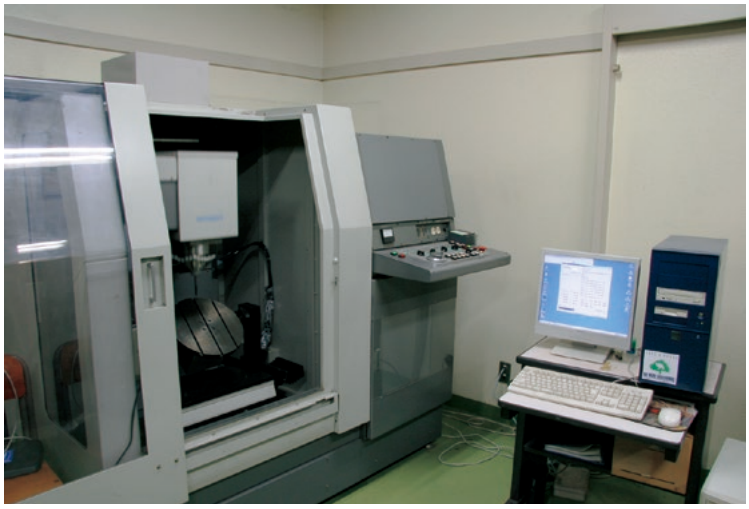
## Future Prospects

### Realizing High Added Value Production Systems

Not so far into the future, it is our hope that Japanese workers will become accustomed to the idea of using computers extensively at production sites. In addition to our current efforts to develop technologies for machine tools, we plan to expand the domain of applications for past research results and to develop utilization technologies for industrial robots. In light of prospects for Japan's future—an aging society, a diminishing pool of skilled workers and technicians, and ever-increasing demands to achieve global cost-competitiveness—we are clearly approaching the limits to production overly reliant on human power and resources.

Japan must steer towards more creative and advanced technologies, breaking free of constraints imposed by tradition and allowing machines do the work they can. This will free industry to produce products offering added value offered by the industry of no other country and to develop ideas and technologies only Japan can conceive. In the hopes of proposing real-world solutions, our laboratory offers support in aiming for this goal.

Automating polishing tasks with robots



Information/intelligent machine tool

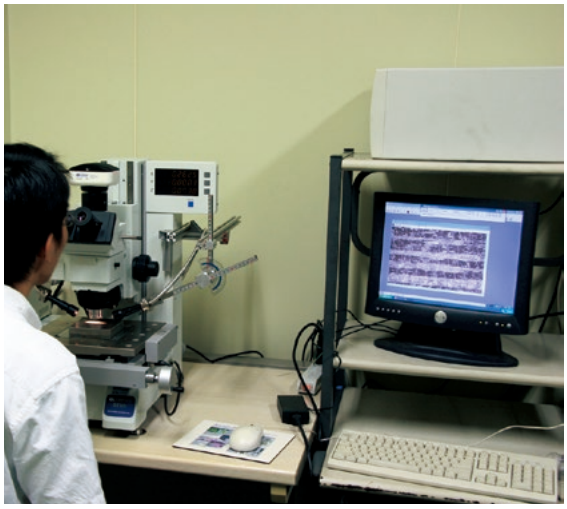


Image processing to evaluate cutting surfaces