



Keynote Speaker

Professor Michael Zäh
Institute for Machine Tools and Industrial Management (iwb)
Germany

“Towards the Cognitive Factory”

M.F. Zäh; C. Lau; M. Wiesbeck; M. Ostgathe; W. Vogl

Abstract:

Skilled human workers turn mechanical workshops into today's most flexible and widely applicable forms of production. However, this flexibility and generality comes at very high production costs, which restrict the use of mechanical workshops to building prototypes and limited, highly specialized and valuable parts or products. The source of flexibility in this case can be easily identified: the cognitive capabilities of the humans which operate it. Humans can perceive their environment, plan actions, learn and adapt behaviors and they can interact in multiple ways with their surroundings. And, most important, humans can do this robustly despite changing contexts and situations.

The realization of comparable cognitive capabilities in technical systems therefore bears an immense potential for the creation of industrial automation systems that are able to overcome today's boundaries. The first part of this paper outlines the paradigm cognitive factory, in which the machines and processes are equipped with cognitive capabilities in order to allow them to assess and increase their scope of operation self-reliantly. This will also allow getting closer to human operators in terms of more natural and effective ways for interaction and cooperation.

To underline this vision, the second part of this paper describes selected research projects of the German cluster of excellence “Cognition in technical Systems” (CoTeSys). These projects aim to use cognitive capabilities to achieve a balance between flexibility, performance and cost effectiveness by transforming machines and processes that currently require human expertise into cognitive ones. Specifically, one project addresses cognitive machines, production processes and work pieces that can find new ways of conducting production tasks, can improve production processes based on their experience, can learn to recover from failures, are self-maintaining and can exploit advice from experienced machinists. Another project will analyze possibilities to introduce cognitive capabilities into the planning process and will point out ways to transfer tasks that are performed typically by humans today (e.g. selection of production technologies) to a cognitive machine shop floor. Therefore, the cognitive factory will be able to manufacture previously unknown products with only a minimum of human advance planning and will thus go beyond existing concepts of flexibility. In addition, the integration of cognitive machines in currently humanly dominated production environments to support human workers will be targeted. Mechanisms and methods for a dynamic allocation of work content among human workers and machines as well as user and situation adaptive assistance for ergonomic worker integration will be investigated.

The results of these projects will be integrated in a large scale research platform for cognitive automation systems, which is finally described concerning the current planning status and intended realization phases.

Brief Biography:

Prof. Dr. Michael Friedrich Zaeh studied mechanical engineering at the Technical University of Munich. He received his doctorate in 1993 with a thesis about a dynamic process model for circular sawing. From 1994 until 1995 he was head of a department of the *iwb*.

In 1996, he joined Gleason-Pfauter Maschinenfabrik GmbH, a builder of machine tools for manufacturing of gears, where he worked in the research laboratory and in the design department and then promoted to head of the order management department. He also worked on an ERP-system-implementation project.

In the year 2002, he accepted the position of full professor for machine tools and manufacturing technology. Since then he has been director of the *iwb* and in charge of the chair for assembly system technology and manufacturing management.

Prof. Dr. Michael Zaeh is a member of acatech, the convent for technical sciences of the union of the German academies of science, of the WGP (German Scientific Society for Production Technology), of the WLT (Scientific Society of Laser Technology) as well as of several other institutions.



Keynote Speaker

Professor Tullio Tolio
Politecnico di Milano-Dipartimento di Meccanica
Italy

“Focused Flexibility and Production System Evolution”

T. Tolio

Abstract:

In the last decade, the production of mechanical components to be assembled into final products produced in high volumes has undergone deep changes due to the overall modifications in the way companies compete. In particular, companies have adopted the following directions:

- Strategic components tend to be manufactured by the companies that produce the final products. For these strategic components firms define long term plans. As a consequence, the technological characteristics, even if in continuous evolution, can be predicted with high reliability.
- Less critical components tend to be externalized. In a context of continuous cost reduction, the producers of components try to obtain economies of scale by enlarging their size while specializing on specific types of components.

In both the cases, we observe that single companies work on quite stable product categories produced in high volumes but, at the same time, they must cope with frequent product modifications and short product lifecycles. These frequent changes, even if restricted to a defined domain, have an impact on production processes.

In this situation the acquisition of production capacity is particularly difficult. On the one hand, dedicated manufacturing systems, even if very competitive from the point of view of costs, are not adequate to accommodate continuous product changes. On the other hand, flexible manufacturing systems have excessive flexibility, which remains almost unused and has a negative impact on costs. Therefore, to address this trade-off, there is a need of creating new manufacturing systems with *focused flexibility* i.e. with the minimum level of flexibility required by the production problem. The focalization of flexibility on the one hand calls for a deeper understanding of the interaction among products processes and production systems and on the other hand requires to cope with the uncertainties related with the evolution of the products which must be synchronized with the evolution of the production system (co-evolution).

The paper presents the different facets of this problems referring both to the previous literature and to some examples taken from real cases. Ideas for future development in the field and possible research directions are also provided.

Brief Biography:

A Full Professor of “Manufacturing and Production Systems”, Professor Tolio teaches Manufacturing, Integrated Production Systems and Reconfigurable Manufacturing Systems and heads the Ph.D. level course: “Management of Research” at Politecnico di Milano, Faculty of Systems Engineering.

His research interests are in the areas of design and management of integrated production systems. The research activities encompass innovative and traditional system architectures in different sectors (machine tools production, production of mechanical components, services).

He is a Member of the Evaluation Board, Delegate of the Rector on "Quality Assurance in Didactics" and is Head of the Manufacturing Division in the Department of Mechanical Engineering.

He has been scientifically responsible for many research projects, including projects funded by the European Community and by MURST (former Italian Ministry of University and Research). He is the National Coordinator of the project "Methodologies and Tools to Design Production Systems with Focused Flexibility" funded by MIUR. He has carried out research activities at the Laboratory for Manufacturing and Productivity (LMP) of the Massachusetts Institute of Technology (MIT), USA.

Professor Tolio has published more than 90 papers in International Journals and Conferences. He is a member of AITEM (Italian Association for Manufacturing) and is a Member of the prestigious CIRP (International Academy for Production Engineering).



Keynote Speaker

Dr. Makoto Fujishima
Mori Seiki
Japan

“Research & Development Activities of Machine Tools”

M. Fujishima, M. Mori

Abstract:

The latest technological development in machine tools is introduced in this paper. High speed and high precision multi axis machine tools, reconfigurable machine tools and new service method with network system has been developed.

The key technologies of high speed and high precision machine tools are high speed and high precision motion equipment and easy operation system. To achieve highly stable and accurate machine tool operation over the long operating hours, the complicated motion mechanism of such a versatile machine tool system should be simplified avoiding indirect driving scheme as much as possible. Direct Drive motor has been developed to realize high speed and high precision rotary axis. To realize avoiding a collision in this kind of multi axis machine, real time collision checking function has been developed.

Special purpose machine tools have been mainly used for mass production such an automotive parts production line. As the lifetime of product becomes shorter, the demands for reconfigurable system increase. To realize these demands, horizontal machining center, vertical machining center and vertical have been developed. These machines all have the same footprint. The reason for this is production line re-configurability. For example, due to a part design change, machine changed from a horizontal machining center to a vertical one easily. Moreover to minimize the downtime, new maintenance system with network technology has been developed.

Brief Biography:

Dr. Makoto Fujishima received his Doctorate of Engineering from Kyoto University, Japan in 2002. He has researched spindle synchronized control and workpiece transfer on multi-spindle NC lathes, error control during quadrant conversion of machining centers, open CNCs and on drilling by intelligent machine tools.

Presently, he is Managing Director, Information Technology Head Quarters Executive Officer of Mori Seiki Company, Limited, in Nara, Japan. The company has 150,000 machines currently around the world. Networking these machines in the world will be realised by expanding the maintenance system; as a standard in Japan. At present, more than 5,500 machines have been networked.

His work with Mori Seiki is extensive. Previous positions he held have been:

- ∞ Section Leader and Assistant Manager of the Engineering Department, Design Section
- ∞ Manager of the Electrical Design Section
- ∞ Deputy General Manager and General Manager of the Control Technology Department
- ∞ General Manager of the Digital Technology Laboratory
- ∞ General Manager and Director of the Control Technology Laboratory
- ∞ General Manager and Director of the Information System Department and Control Technology Laboratory
- ∞ General Manager and Managing Director of the Development & Manufacturing HQ
- ∞ Executive Officer, Information System Department and Control Technology Laboratory
- ∞ General Manager and Managing Director of the Development & Manufacturing HQ
- ∞ Executive Officer, Information System Department, Control Technology Laboratory and Dura



Keynote Speaker

Professor Alain Bernard
IRCCyN - Ecole Centrale de Nantes
France

“Knowledge-based Approach for Changeability Management”

A. Bernard, N. Perry, A. Candlot, S. Ammar-Khodja

Abstract:

Trade expertise changeability management is a major issue of new generations of product-lifecycle global-management systems. Project control of such changeability has been hardened by knowledge management complexity increasing with the product complexity, the diversity of stakeholders and the lack of feedbacks during or at the end of such projects, past or present. An example of such changeability management has been lead as a case study on the USIQUICK project, which seeks an automation of process planning generation. This experience has also been compared to projects taking place in other service or industry fields.

The contribution of this paper proposes a conceptual tool set, usable to prepare or control expertise changeability projects. In early phases this tool set can be used to consolidate previous experiences and constitute analysis grids to take decision on methodologies to deploy. During the project, this methodological tool base underlines for project control some analysis criteria to evaluate the project dynamic. It allows the identification of modelling problems, the development preparation. In these two cases, it indicates possible representation locations from which could be constructed some performance indicators related to the project specificity.

The methodological output for project control is constituted of the proposition and the analysis of four “pillars” or resources sustaining expertise changeability modelling and integration (concept networks, specification lists, document corpus, management tools). These pillars are justifying a list of phases, describing modelling stakes (identification, extraction, structuring and formalisation phases) and integration issues (refinement, specification development, diffusion and maintenance phases). Combined with the analyses of initial and expected management maturity of expertise, these “pillars” and phases allow constituting a framework for feedback consolidation and project deployment. In parallel, three couples of concepts, syntax / semantic, infrastructure / architecture, domain / project, allow questioning and identifying potential problem zones in representation and considering resolutions axes of changeability management. This contributes to bringing closer “epistemological systematisation” of knowledge management with empirical and pragmatic practice of learning. The consolidation of binds between these two aspects of expertise allows driving projects with real elements of knowledge and expertise.

Brief Biography:

Prof. A. Bernard, graduated in 1982, obtained his PhD in 1989. As an assistant-Professor, he worked from 1990 to 1996, in Ecole Centrale de Paris, on product, technology and process modeling. From Sept. 1996 to Oct. 2001, he has been Professor in CRAN, as the head of the mechanical and production engineering team. His main research topics are related to RE, KBS, CAPP, product and process modeling, integration of economical and human aspects. His current position is Professor and Deputy Director for Research at Ecole Centrale de Nantes, and in IRCCyN (head of the “Virtual Engineering for industrial engineering” project). Prof. A. Bernard has published more than 40 papers in international journals and books. He has presented more than 120 papers in international conferences, including about 20 invited keynotes. Prof. A. Bernard is member of national scientific committees and of professional and scientific international organizations. He is also a member of the editorial board of six international journals and reviewer for twelve others.



Keynote Speaker

Professor Stephen T. Newman
University of Bath - Department of Mechanical Engineering
UK

“The Evolution of CNC Technology from Automated Manufacture to Global Interoperable Manufacturing”

S.T. Newman, L. Ali, A. Brail, P. Klemm, R. Liu, A. Nassehi, V.K. Nguyen,
F. Proctor, R.S.U. Rosso Jr., I. Stroud, S-H. Suh, L. Wang, X.W. Xu

Abstract:

Over the last 50 years there have been many developments in CNC manufacturing. These advances make today's CNC technology completely unrecognisable from their early NC ancestors. Developments in manufacturing processes with the addition of extra axes and integrating new manufacturing processes such as laser hardening and grinding on the current generation of CNC machines enable them to manufacture the most complex of designs utilising an ever increasing range of materials efficiently.

To meet the requirements of these new machines, controllers have evolved from the early memory-less controllers to modern open-architecture PC based CNCs. In combination with these advances, programming methods have progressed to take advantage of the new processes and controller capabilities. Manual programming has given way to computer-aided part programming enabling the users to rapidly and efficiently program these modern PC-CNC machines.

Most importantly the paradigms of manufacturing have evolved in the past five decades to meet the ever-changing requirements of the market relying on the support of the technological tools described above. From the days of mass production where the major requirement was the capability to produce parts with accuracy and repeatability at a standard production rate to the flexible automation trend of the '80s. The more modern paradigms of reconfigurability, human-oriented systems, interoperability and sustainability, has seen NC manufacture diversify to serve a different production scenarios for an enormous range of part designs and complexities.

This paper gathers the views of an internationally leading set of researchers on these parallel evolutionary trends to provide a global vision for interoperability in the domain of CNC manufacturing. The initial part of the paper provides the evolutionary background of the developments in NC manufacturing including technological, software and hardware. These developments are put in context of the manufacturing trends over the last 50 years to highlight the major drivers which have influenced the direction of R&D in CNC. The authors will then provide a brief view of the state-of-the-art of interoperability in each of their respective research communities with emphasis on their own area of expertise and processes. These views will then be consolidated and summarised to form a framework to specify the requirements for realising a global interoperable manufacturing network.

Brief Biography:

Stephen Newman is the Professor of Innovative Manufacturing Technology in the EPSRC Innovative Design & Manufacturing Research Centre (IdMRC) of the Department of Mechanical Engineering at the University of Bath, UK. He gained his first class honours BSc degree in Production Technology and Management in 1982 from the University of Aston, Birmingham, sponsored by Land Rover Ltd. Having worked at Land Rover for 4 years he joined Loughborough University as a Research Associate and gained his PhD in 1990. In 1989, he was appointed, as a Lecturer in Manufacturing Engineering, promoted to Senior Lecturer in 1997 and Reader in Computer-Aided Manufacturing in 2000.

In January 2006, he joined the University of Bath as a Professor responsible for CNC Manufacturing Technology, and is leading EPSRC funded National research programmes in the area of Interoperable Manufacturing and Cryogenic machining of customised products. He has 20 years of experience in European and National R & D programmes being involved in Eureka Factory, EU Framework V and Framework VI programmes together with numerous National EPSRC research programmes.

Professor Newman is Editor-in-Chief of the International journal of Computer Integrated Manufacturing and a member of 5 international Journal Editorial boards and has published over 100 refereed academic papers.