Ultra Precision Machining Of Micro Structure Arrays

In this book, the design, manufacture and control technology of precision machines are introduced to achieve the concrete requirements for precision engineering. The state-of-the-art of precision machining method and equipment including precision turning, milling, grinding and lapping/polishing are discussed. The key components of precision machines are introduced as well, such as precision spindles, control systems, tools and grinding wheels etc. In the design part, the methods for the design and simulation of the general structure of precision machines as well as the key components are described in details. In the manufacture part, the fabrication and assembly technologies for different types of precision machines are introduced. In the control part, the control system, measurement and compensation technology for precision machines are discussed. The information provided in the book will be of interest to industrial practitioners and researchers in the field of precision machines. This book is part of a handbook series that covers a comprehensive range of scientific and technological matters in ‘Precision Manufacturing’.

This paper presents techniques for fabricating microscopic, curvilinear features in a variety of workpiece materials. Micro-grooving and micro-threading tools having cutting widths as small as 13 [mu]m are made by focused ion beam sputtering and used for ultra-precision machining. Tool fabrication involves directing a 20 keV gallium beam at polished cylindrical punches made of cobalt M42 high-speed steel or C2 tungsten carbide to create a number of critically aligned facets. Sputtering produces rake facets of desired angle and cutting edges having radii of curvature equal to 0.4 [mu]m. Clearance for minimizing frictional drag of a tool results from a particular ion beam/target geometry that accounts for the sputter yield dependence on incidence angle. It is believed that geometrically specific cutting tools of this dimension have not been made previously. Numerically controlled, ultra-precision machining with micro-grooving tools results in a close match between tool width and feature size. Microtools are used to machine 13 [mu]m wide, 4 [mu]m deep, helical grooves in polymethyl methacrylate and 6061 Al cylindrical workplaces. Micro-grooving tools are also used to fabricate sinusoidal cross-section features in planar metal samples.

This book presents an in-depth study and elucidation on the mechanisms of the micro-cutting process, with particular emphasis and a novel viewpoint on materials characterization and its influences on ultra-precision machining. Ultra-precision single point diamond turning is a key technology in the manufacture of mechanical, optical and opto-electronics components with a surface roughness of a few nanometers and form accuracy in the sub-micrometric range. In the context of subtractive manufacturing, ultra-precision diamond turning is based on the pillars of materials science, machine tools, modeling and simulation technologies, etc., making the study of such machining processes intrinsically interdisciplinary. However, in contrast to the substantial advances that have been achieved in machine design, laser metrology and control systems, relatively little research has been conducted on the material behavior and its effects on surface finish, such as the material anisotropy of crystalline materials. The feature of the significantly reduced depth of cut on the order of a few micrometers or less, which is much smaller than the average grain size of work-piece materials, unavoidably means that conventional metal cutting theories can only be of limited value in the investigation of the mechanisms at work in micro-cutting processes in ultra-precision diamond turning.

Machining dynamics play an essential role in the performance of the machine tools and machining processes which directly affect the removal rate, workpiece surface quality and dimensional and form accuracy. Machining Dynamics: Fundamentals and Applications will be bought by advanced undergraduate and postgraduate students studying manufacturing engineering and machining technology in addition to manufacturing engineers, production supervisors, planning and application engineers, and designers.

The topics covered herein include: Single-point diamond turning; Ultra-precision grinding technology; High-speed and high-efficiency machining; Machine tools and systems; In-process measurement and monitoring; Metrology and evaluation; Finishing, lapping and polishing; Micro/nano machining and fabrication; Forming processes for optical and electrical components; CMP and silicon-wafer processing; Brittle-material machining; EDM, ultrasonic machining and laser machining; and Related precision machining methods. This work will provide a valuable and fruitful reference source for researchers in the field of ultra-precision machining who wish to understand, in greater depth, the underlying mechanisms and to create new and practical design technologies, systems and processes. It will also be particularly useful to practising engineers who are responsible for providing efficient, precise and effective machining.

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Precision Manufacturing provides an introduction to precision engineering for manufacturing. With an emphasis on design and performance of precision machinery for manufacturing – machine tool elements and structure, sources of error, precision machining processes and process models sensors for process monitoring and control, metrology, actuators, and machine design. This book will be of interest to design engineers, quality engineers and manufacturing engineers, academics and those who may or may not have previous experience with precision manufacturing, but want to learn more.

Micro-Cutting: Fundamentals and Applicationscomprehensively covers the state of the art research andengineering practice in micro/nano cutting: an area which isbecoming increasingly important, especially in modernmicro-manufacturing, ultraprecision manufacturing and high valuemanufacturing. This book provides basic theory, design and analysis ofmicro-toolings and machines, modelling methods and techniques, andintegrated approaches for micro-cutting. The fundamentalcharacteristics, modelling, simulation and optimization ofmicro/nano cutting processes are emphasized with particularreference to the predictabilty, producibility, repeatability andproductivity of manufacturing at micro and nano scales. The fundamentals of micro/nano cutting are applied to a varietyof machining processes including diamond turning, micromilling,micro/nano grinding/polishing, ultraprecision machining, and thedesign and implementation of micro/nano cutting process chains andmicromachining systems. Key features • Contains contributions from leading global experts • Covers the fundamental theory of micro-cutting • Presents applications in a variety of machiningprocesses • Includes examples of how to implement and applymicro-cutting for precision and micro-manufacturing Micro-Cutting: Fundamentals and Applications is an idealreference for manufacturing engineers, production supervisors,tooling engineers, planning and application engineers, as well asmachine tool designers. It is also a suitable textbook forpostgraduate students in the areas of micro-manufacturing,micro-engineering and advanced manufacturing methods.

The Latest Techniques of Ultra-Precise Manufacturing for Creating Mechanical, Electronic, and Optical Products Precision Engineering gives expert guidance on the application of manufacturing to micro and nano levels, using state-of-the-art miniaturization technology. The book fully explores these new in-demand techniques, providing clear explanations of precision engineering fundamentals, the theory and design of precision machines, and the mechanics of ultra-precise machining. Filled with over 200 skills-building illustrations, this vital engineering resource examines topics ranging from atomic bit processes for manufacturing and atomic force...to scanning and electronic and optical microscopy. You will find timely information on the tool materials for precision machining...the mechanics of materials cutting...advances in precision grinding...ultra-precision machine elements...rolling element, hydrodynamic, and hydrostatic bearings...gas lubricated bearings... microelectromechanical systems (MEMS)...and much more. Presenting practical know-how on everything required to create actual products, Precision Engineering features: A full account of tool materials for precision engineering The latest methods of precision grinding Detailed analysis of ultra-precise machine elements In-depth coverage of microelectromechanical systems (MEMS) Inside This Cutting-Edge Guide to Precision Engineering Methods • Tool Materials for Precision Machining • Mechanics of Materials Cutting • Advances in Precision Grinding • Ultra-Precision Machine Elements • Rolling Element, Hydrodynamic, and Hydrostatic Bearings • Gas Lubricated Bearings • Microelectromechanical Systems (MEMS)

The realm of ultra precision mechanisms, for example in controlling motion to small fractions of a micrometer, is encroaching into many fields of technology. This book aims to provide a bridge for those moving from either an engineering or physics background towards the challenges offered by ultraprecision mechanisms. Using case study examples, this book provides a guide to basic techniques and gives technical, analytical and practical information.

Microfabrication and precision engineering is an increasingly important area relating to metallic, polymers, ceramics, composites, biomaterials and complex materials. Micro-electro-mechanical-systems (MEMS) emphasize miniaturization in both electronic and mechanical components. Microsystem products may be classified by application, and have been applied to a variety of fields, including medical, automotive, aerospace and alternative energy. Microsystems technology refers to the products as well as the fabrication technologies used in production. With detailed information on modelling of micro and nano-scale cutting, as well as innovative machining strategies involved in microelectrochemical applications, microchannel fabrication, as well as underwater pulsed Laser beam cutting, among other techniques, Microfabrication and Precision Engineering is a valuable reference for students, researchers and professionals in the microfabrication and precision engineering fields. Contains contributions by top industry experts Includes the latest techniques and strategies Special emphasis given to state-of-the art research and development in microfabrication and precision engineering

Presents new developments on machine tool vibration control based on discontinuous dynamical systems Machining instability is a topical area, and there are a wide range of publications that cover the topic. However, many of these previous studies have started by assuming that the behavior of the system can be linearised. Meanwhile, there are many recent advances in the fields of signal processing, nonlinear dynamics, and nonlinear control, all of which are relevant to the machining stability problem. This book establishes the fundamentals of cutting mechanics and machine tool dynamics in the simultaneous time-frequency domain. The new nonlinear control theory developed by the authors that facilitates simultaneous control of vibration amplitude in the time-domain and spectral response in the frequency-domain provides the foundation for the development of a controller architecture universally viable for the control of dynamic instability including bifurcation and chaos. Once parameters underlying the coupling, interaction, and evolution of different cutting states and between the tool and workpiece are established, they can then be incorporated into the architecture to create a control methodology that mitigate machining instability and enable robust, chatter-free machine tool design applicable in particular to high speed micro- and nano-machining. Presents new developments on machine tool vibration control based on discontinuous dynamical systems Provides a clear and concise approach to the understanding and control of machine tool and workpiece vibrations from an alternative view, contributing to an in-depth understanding of cutting dynamics and robust control of machining instability Equips the reader with the knowledge to understand the dynamics of cutting and operation of machine-tool systems in different conditions as well as the concept of cutting instability control Includes data examples in MATLAB coding

Until recently B-spline curves and surfaces (NURBS) were principally of interest to the computer aided design community, where they have become the standard for curve and surface description. Today we are seeing expanded use

of NURBS in modeling objects for the visual arts, including the film and entertainment industries, art, and sculpture. NURBS are now also being used for modeling scenes for virtual reality applications. These applications are expected to increase. Consequently, it is quite appropriate for The.N'URBS Book to be part of the Monographs in Visual Communication Series. B-spline curves and surfaces have been an enduring element throughout my pro fessional life. The first edition of Mathematical Elements for Computer Graphics, published in 1972, was the first computer aided design/interactive computer graph ics textbook to contain material on B-splines. That material was obtained through the good graces of Bill Gordon and Louie Knapp while they were at Syracuse University. A paper of mine, presented during the Summer of 1977 at a Society of Naval Architects and Marine Engineers meeting on computer aided ship surface design, was arguably the first to examine the use of B-spline curves for ship design. For many, B-splines, rational B-splines, and NURBS have been a bit mysterious.

This book covers the recent developments in the production of micro and nano size products, which cater to the needs of the industry. The processes to produce the miniature sized products with unique characteristics are addressed. Moreover, their application in areas such as micro-engines, micro-heat exchangers, micro-pumps, micro-channels, printing heads and medical implants are also highlighted. The book presents such microsystem-based products as important contributors to a sustainable economy. The recent research in this book focuses on the development of new micro and nano manufacturing platforms while integrating the different technologies to manufacture the micro and nano components in a high throughput and cost effective manner. The chapters contain original theoretical and applied research in the areas of micro- and nano-manufacturing that are related to process innovation, accuracy, and precision, throughput enhancement, material utilization, compact equipment development, environmental and life-cycle analysis, and predictive modeling of manufacturing processes with feature sizes less than one hundred micrometers.

This, the corrected second printing of Jackson’s authoritative volume on the subject, provides a comprehensive treatment of established micro and nanofabrication techniques. It addresses the needs of practicing manufacturing engineers by applying established and research laboratory manufacturing techniques to a wide variety of materials. Nanofabrication and nanotechnology present a great challenge to engineers and researchers as they manipulate atoms and molecules to produce single artifacts and submicron components and systems. The book provides up-to-date information on a number of subjects of interest to engineers who are seeking more knowledge of how nano and micro devices are designed and fabricated. They will learn about manufacturing and fabrication techniques at the micro and nanoscales; using bulk and surface micromachining techniques, and LiGA, and deep x-ray lithography to manufacture semiconductors. Also covered are subjects including producing master molds with micromachining, the deposition of thin films, pulsed water drop machining, and nanomachining.

Faced with ever-increasing market demands, manufacturing industry is forced to seek innovation and technological breakthrough. This state-of-the-art text aims to integrate broad aspects of precision and production engineering to cope with rapid changes in market needs and technological developments as we enter the 21st century. It addresses basic theory, extensive research in advanced topics, industrial applications, and relevant surveys in related fields. Major subjects covered by this book include: Advanced manufacturing systems; Ultra-precision machining and micro machining; Nanotechnology for fabrication and measurement; Chemo-mechanical processes; Rapid prototyping technology; New materials and advanced processes; Computer-aided production engineering; Manufacturing process control; Planning. This volume contains the proceedings of the 10th International Conference on Precision Engineering (ICPE), which was held in July 2001, in Yokohama, Japan. ICPE is a well-established conference in the field of production and precision engineering, covering a wide range of topics for future-oriented manufacturing systems and processes; it is organized by the Japan Society for Precision Engineering (JSPE). This book can be used as a reference for graduate and undergraduate courses in precision and production engineering, and also for researchers and industrial engineers to capture current trends in this field.

The Encyclopedia of Nanotechnology provides a comprehensive and multi-disciplinary reference to the many fields relevant to the general field of nanotechnology. It aims to be a comprehensive and genuinely international reference work and will be aimed at graduate students, researchers, and practitioners. The Encyclopedia of Nanotechnology introduces a large number of terms, devices and processes which are related to the multi-disciplinary field of Nanotechnology. For each entry in this 4 volume set a 4-10 page description is provided by an expert in the field. Contributions are made by experts from the US, Europe and Asia, making this a comprehensive and truly international Reference Work. The authors are typically from academia, however one quarter of all entries were written by persons from industry. Topics covered in the Reference Work include: - Nano- Microfabrication Processes and Materials for Fabrication - Nanoscale Measurement Techniques - Nanostructures - Nanomaterials - Nanomechanics - Molecular Modeling and Its Role in Advancing Nanotechnology - MEMS/NEMS - Microfluidics and Nanofluidics - Biomedical Engineering and Biodevices - Bio/Nanotechnology and Nanomedicine - Bio/Nanotechnology for cellular engineering - Drug Delivery – Technology and Applications - Assembly - Organic Electronics - Nano-optical Devices - Micro/nano Integration - Materials, Coatings and Surface Treatments for Nanotribology - Micro/NanoReliability – thermal, mechanical etc. - Biomimetics

TRANSFER MATRIX METHOD FOR MULTIBODY SYSTEMS: THEORY AND APPLICATIONS Xiaoting Rui, Guoping Wang and Jianshu Zhang - Nanjing University of Science and Technology, China Featuring a new method of multibody system dynamics, this book introduces the transfer matrix method systematically for the first time. First developed by the lead author and his research team, this method has found numerous engineering and technological applications. Readers are first introduced to fundamental concepts like the body dynamics equation, augmented operator and augmented eigenvector before going in depth into precision analysis and computations of eigenvalue problems as well as dynamic responses. The book also covers a combination of mixed methods and practical applications in multiple rocket

launch systems, self-propelled artillery as well as launch dynamics of on-ship weaponry. • Comprehensively introduces a new method of analyzing multibody dynamics for engineers • Provides a logical development of the transfer matrix method as applied to the dynamics of multibody systems that consist of interconnected bodies • Features varied applications in weaponry, aeronautics, astronautics, vehicles and robotics Written by an internationally renowned author and research team with many years' experience in multibody systems Transfer Matrix Method of Multibody System and Its Applications is an advanced level text for researchers and engineers in mechanical system dynamics. It is a comprehensive reference for advanced students and researchers in the related fields of aerospace, vehicle, robotics and weaponry engineering.

Hybrid Machining: Theory, Methods, and Case Studies covers the scientific fundamentals, techniques, applications and real-world descriptions of emerging hybrid machining technology. This field is advancing rapidly in industrial and academic contexts, creating a great need for the fundamental and technical guidance that this book provides. The book includes discussions of basic concepts, process design principles, standard hybrid machining processes, multi-scale modeling approaches, design, on-machine metrology and work handling systems. Readers interested in manufacturing systems, product design or machining technology will find this one-stop guide to hybrid machining the ideal reference. Includes tables of recommended processing parameters for key engineering materials/products for each hybrid machining process Provides case studies covering real industrial applications Explains how to use multiscale modeling for hybrid machining

This book is a comprehensive engineering exploration of all the aspects of precision machine design—both component and system design considerations for precision machines. It addresses both theoretical analysis and practical implementation providing many real-world design case studies as well as numerous examples of existing components and their characteristics. Fast becoming a classic, this book includes examples of analysis techniques, along with the philosophy of the solution method. It explores the physics of errors in machines and how such knowledge can be used to build an error budget for a machine, how error budgets can be used to design more accurate machines.

Volume is indexed by Thomson Reuters CPCI-S (WoS). This special volume presents the very latest findings and ideas in the field of ultra-precision machining.

There has been an increase in worldwide interest in ultra precision machining research over the last decade. Drastic international competition has addressed the underlying necessities for predictability, repeatability and productivity in manufacturing with high accuracy. This book describes an approach for investigation of the generation of high precision surfaces in relation to the affecting factors from the machine tool, cutting tool, workpiece material and operation conditions in precision manufacturing. It also presents application of the cutting edge molecular dynamics simulation approach in the study of material removals mechanism in nanometer level. The book will of interest to senior undergraduate students, graduate students and researches in the field of precision, micro & nano machining.

CMP and polishing are the most precise processes used to finish the surfaces of mechanical and electronic or semiconductor components. Advances in CMP/Polishing Technologies for Manufacture of Electronic Devices presents the latest developments and technological innovations in the field - making cutting-edge R&D accessible to the wider engineering community. Most of the applications of these processes are kept as confidential as possible (proprietary information), and specific details are not seen in professional or technical journals and magazines. This book makes these processes and applications accessible to a wider industrial and academic audience. Building on the fundamentals of tribology - the science of friction, wear and lubrication - the authors explore the practical applications of CMP and polishing across various market sectors. Due to the high pace of development of the electronics and semiconductors industry, many of the presented processes and applications come from these industries. Demystifies scientific developments and technological innovations, opening them up for new applications and process improvements in the semiconductor industry and other areas of precision engineering Explores stock removal mechanisms in CMP and polishing, and the challenges involved in predicting the outcomes of abrasive processes in high-precision environments The authors bring together the latest innovations and research from the USA and Japan

Ultra-precision machining is a promising solution for achieving excellent machined surface quality and sophisticated micro/nano-structures that influence the applications of components and devices. Further, given the ultrathin layer of material removed, it is a highly coupled process between cutting tool and material. In this book, scientists in the fields of mechanical engineering and materials science from China, Ukraine, Japan, Singapore present their latest research findings regarding the simulation and experiment of material-oriented ultra-precision machining. Covering various machining methods (cutting, grinding, polishing, ion beam and laser machining) and materials (metal, semiconductor and hard-brittle ceramics), it mainly focuses on the evaluation of the fundamental mechanisms and their implementation in processing optimization for different materials. It is of significant theoretical and practical value for guiding the fabrication of ultra-smooth and functional surfaces using ultra-precision machining.

This thesis focuses on producing hybrid freeform surfaces using an advanced diamond-turning process, understanding the generation of surface accuracies (form errors) and how the choice of cutting strategies affects these, as well as simplifying the complications of generating cutting paths for such freeform surfaces. The breakthroughs behind this thesis are the development of novel, multiple-axis, diamond turning techniques to overcome the limitations of conventional diamond turning processes, an analytical model to optimize the generation of ultraprecise freeform surfaces, and an add-on tool path processor for CAD/CAM software solutions. It appeals to researchers and scholars with a strong machining background who are interested in the field of manufacturing ultraprecise freeform surfaces or in the field of optimizing ultraprecision machining processes.

The goal of this book is to familiarize professionals, researchers, and students with the basics of the Diamond Turn Machining Technology and the various issues involved. The book provides a comprehensive knowledge about various aspects of the technology including the background, components of the machine, mechanism of material removal, application areas, relevant metrology, and advances taking place in this domain. Solved and unsolved examples are provided in each of the areas which will help the readers to practice and get familiarized with that particular area of the Diamond Turn Machining process.

This book provides the fundamentals and recent advances in nano and micromachining for modern manufacturing engineering. It begins by outlining nanomachining before discussing various advances in field and machining processes. The coverage concludes with an evaluation of subsurface damages in nano and micromachining and a presentation of applications in industry. As such, this book serves both as a useful classroom text for engineering and machining courses at the undergraduate and graduate level, and as a reference for academics and engineers in these areas.

This special volume presents the very latest findings and ideas in the field of ultra-precision machining. The topics covered include: Single-point diamond turning of optical materials or moulding dies; Single-point diamond turning of other materials; Ultra-precision grinding of optical

materials or moulding dies; Ultra-precision grinding of hard materials; Ultra-precision polishing of optical materials or moulding dies; Ultra-precision polishing of single crystals or chemical-mechanical polishing; Ultra-precision polishing of metals or alloys; High-speed machining technology and applications; Ion beam figuring and polishing; Electron beam patterning and polishing; Ultra-precision laser machining; Ultra-precision electro-discharge machining; Ultra-precision coating; Glass moulding and plastic injection moulding of optical and electrical components; Fabrication of micro-electromechanical systems (MEMS); Ultra-precision machine tools; New ultra-precision machine and its machine elements; Ultra-precision positioning and control; Ultra-precision shape or surface-roughness measurement; New tools or new applications of tools; Other precision machining technology; Advanced manufacturing and design methods. This book will provide a valuable and fruitful reference source for researchers in the field of ultra-precision machining who wish to understand further the underlying mechanisms and to create new and practical design technologies, systems and processes. It will also be particularly useful for practising engineers who are responsible for providing efficient, precise and effective machining.

In the third part, a characterization method for the droplet wetting states, significantly affecting its sliding performance on hydrophobic surfaces, is proposed, based on observations of the droplet contact lines on the micro-grooved surfaces. This characterization method is capable of identifying intermediate wetting states but it is difficult to use traditional verification methods for such identification. The partial wetting state is found to be the sliding boundary of the micro-grooved surfaces, whereas droplets contacting the side walls of the grooves still form a favorable wetting state for the anisotropic sliding on the micro-grooved surfaces. In the fourth part, the anisotropic wetting of micro-micro hierarchical structured surfaces fabricated by ultra-precision machining, including regular, irregular, and multi-level hierarchical structures, have been investigated. It is found that applying irregular hierarchical structures and multi-level design can further enhance the water static contact angle to over 150?? and 161?? respectively. This is achieved by inducing more energy barriers, reducing the contact area of the solid-liquid interface, and reserving more buffers to air pocket formation. The originality and significance of this research include: (i) an optimization modeling for the surface geometries of biomimetic structures for advanced self-cleaning surfaces has been established; (ii) highly controllable one-step fabrication methods, potentially applicable for mass production in the plastic injection molding of bare micro-patterned surfaces with good sliding and optical performance, are proposed through study of the wetting characteristics; (iii) a characterization method for the droplet wetting states, that significantly affect the sliding performance on hydrophobic surfaces, is firstly proposed from observations of the droplet contact lines on micro-patterned surfaces; (iv) this characterization method is capable of identifying intermediate wetting states which show the sliding boundary and the favorable wetting state for anisotropic sliding on the micro-grooved surfaces. This provides more flexibility for the design of advanced self-cleaning surfaces.

By the second half of the twentieth century, a new branch of materials science had come into being — crystalline materials research. Its appearance is linked to the emergence of advanced technologies primarily based on single crystals (bulk crystals and films). At the turn of the last century, the impending onset of the “ceramic era” was forecasted. It was believed that ceramics would play a role comparable to that of the Stone or Bronze Ages in the history of civilization. Naturally, such an assumption was hypothetical, but it showed that ceramic materials had evoked keen interest among researchers. Although sapphire traditionally has been considered a gem, it has developed into a material typical of the “ceramic era.” Widening the field of sapphire application necessitated essential improvement of its homogeneity and working characteristics and extension of the range of sapphire products, especially those with stipulated properties including a preset structural defect distribution. In the early 1980s, successful attainment of crystals with predetermined char- teristics was attributed to proper choice of the growth method. At present, in view of the fact that the requirements for crystalline products have become more str- gent, such an approach tends to be insufficient. It is clear that one must take into account the physical–chemical processes that take place during the formation of the real crystal structure, i.e., the growth mechanisms and the nature and causes of crystal imperfections.

Volume is indexed by Thomson Reuters CPCI-S (WoS). The present volumes contain selected papers on the fields of precision engineering - including precision/ultra-precision machining, non-traditional machining, manufacturing systems and machine tools, nano and micro metrology and surface characterization, MEMS/NEMS, advanced moulding and forming, high-precision mechatronics and other technologies which are associated with micro/nano manufacturing. The work provides up-to-date and comprehensive coverage of the progress being made world wide.

by Professor Pat McKeown Cranfield Precision Engineering, UK Member of Joint Organising Committee IPES6/UME2 PROGRESS IN PRECISION ENGINEERING Metal working companies in tool making, prototype manu facture and subcontract machining often use the label "precision engineering" to indicate that they are accustomed to working to finer tolerances than is normally expected in series production. But what we are concerned with in this and our preceding international conferences is much wider and deeper than this. Precision engineering is a grouping of multidis ciplinary scientific and engineering skills and techniques, firmly based on dimensional metrology, by which a wide range of new advanced technology products is made possible. In the last 5 - 10 years we have witnessed dramatic progress in precision engineering, particularly by the rapid development of its important sub-sets, micro-engineering and nanotechnology. I t is a part icular pleasure for me and my colleagues on the Organising Committee to welcome you to Braunschweig on the occasion of this the first joint international meeting in high precision manufacturing/precision engineering to be held in Germany. Our aim is to bring together the world's leading precision engineering practitioners from areas of application as diverse as optics for astronomy, micro and nano machining process research, design and development of ul tra preclslon machine tools and metrology equipment, advanced materials, bio medical research and new sensor/transducer systems.