Kuljanic, Elso (ed.)
AMST'99. Advanced manufacturing systems and technology. Proceedings of the 5th international conference, Udine, Italy, June 3–4, 1999. (English) Zbl 0930.74003
CISM Courses and Lectures. 406. Wien: Springer. xxii, 906 p. (1999).

[The articles of this volume will not be indexed individually. The 4th conference 1996 has been reviewed (see Zbl 0866.73002).]

The 103 articles included in this large volume (903 pages of text, excluding preface, foreword and list of contents) represent lectures given at the title conference on advanced manufacturing systems and related technology. The reported technological advances are mostly experimental, computational and qualitative. While most of the lectures have almost no mathematics, or contain only simple semiempirical analysis, which would not be of interest to mathematicians, some of the engineering problems covered in this collection may be waiting for a person capable of combining known experimental facts with new analytical or probabilistic explanations of some very complex physical phenomena encountered in the modern manufacturing technology and processes.

This collection starts with an article by a leading expert in the theory of machining technology *M. E. Marchant*. He describes the three definite stages in understanding of machining. 1) Empirical, where the art of machining passed by mimicking the technique of successful predecessors. 2) Science-based, containing some models of processes, the theory of "shear plane" and application of accepted theories of materials to predict chip formation, and derivation of some geometric relations between forces involved in chip formation. This stage started with the *F. W. Taylor*'s presentation and consequent publication of almost 300 pages in 1906 Transactions of ASME, containing explanations of chip formation based on physics and on material science. 3) Computer integrated technology, with numerical control of machine operations, which now includes the MIT developed program of massive data input into the computer of the speed of tools, temperature, various stress components, optical measurements etc., generating instantaneous feedback which, in turn, corrects the parameters of the process. While at first a simple digital control, and later more detailed computer involvement have been very successful, and high speed machining has made sensational progress in the last ten years, the machining process is still too complex to generate even rough partially successful mathematical models, which would incorporate the sophisticated mathematics now used in applied mechanics.

Planning of experiments is included in some titles and is a subject discussed in many articles in this volume. For example, the article of *D. Romano*, *A. Bartagnolio* and *R. Levi*, "Dynamic analysis of production processes by planned experiments" discusses the advantages of analyzing some signals in frequency space. The authors dwell on disadvantages of eliminating time variable entirely, and on disadvantages of windowing functions subjected to the Fourier transform, exactly the faults which have been eliminated in wavelet analysis. They mention the flexibility of the wavelet transformation, but stop short of applying it, and return to the largely flawed short time Fourier transform, with which the authors are more comfortable. The need for communication between engineers and mathematicians capable of programming wavelet theoretical knowledge into specific mechanical engineering applications is clear to this reviewer. The Malat picture of the "lady with a feathered hat" and an arbitrary complex shape which is to be machined have a lot in common when eyed by a wavelet expert.

There is much that the engineers who wrote these articles know well, yet it could be viewed from a different perspective by solid state physicists, such as Coulomb friction, tribology, viscosity variations, etc., where massive experimental data has been accumulated, yet some authors admit that model parameters may have different meaning than assumed in the experiments (article of *Zelenka* and *de Bona*). Linear models have been used in situations where the response was nonlinear, but then a clever use of adaptive control produced excellent results in some manufacturing applications where the initial assumptions were flawed.

Some articles contain computations based on well-known theories; these computations nevertheless are very difficult. Such is the case of modelling and laser triangulation for a high precision mechanism, in the article of *de Bona*, *Strozzi* and *Zelenka*, which computes the (large) deflections of leaf springs. The authors derive a badly nonlinear system of 11 equations in 11 unknowns which is solved by the Newton-

Raphson algorithm. The authors report that only in the case of large rotations their results are not in good agreement with the measurements. In particular, their computations give a prediction of the "parasitic" motion of the center of the measuring block. To an applied mathematician, it serves as a warning against the routine use of Euler-Bernoulli equations for elastic beams, or even of the Mindlin-Timoshenko models of plate deflection. In situations where we estimate inaccuracies of measuring devices, where measurements may be in nanometers and tolerances are extremely small, one may have no choice but to invoke the rather frightening full nonlinear system of equilibrium and compatibility equations, as given originally in the monograph of *V. V. Novozhilov* [Thin shell theory, Groningen: P. Noordhoff Ltd. XVI, 417 p. (1965; Zbl 0135.43602)].

The proceedings are divided into the following parts: 1) Machining processes; 2) Optimization and process planning; 3) Flexible systems; 4) Non-conventional machining; 5) Robotics; 6) Measuring; 7) Materials and mechanics; 8) Quality (including optimization of control parameters). There is a great variety of subjects in these proceedings which may be of interest to applied mathematicians, control theorists, specialists in robotics, optimization, neural networks, artificial intelligence, theoretical mechanics, and applied mechanics experts. The reviewer believes that all parties would benefit if much closer cooperation existed between different schools and different departments in most academic and research institutions.

Reviewer: Vadim Komkov (Florida)

MSC:

74-06	Proceedings, conferences, collections, etc. pertaining to mechanics of deformable solids
00B25	Proceedings of conferences of miscellaneous specific interest
93-06	Proceedings, conferences, collections, etc. pertaining to systems and control theory
70-06	Proceedings, conferences, collections, etc. pertaining to mechanics of particles and systems
76-06	Proceedings, conferences, collections, etc. pertaining to fluid mechanics
49-06	Proceedings, conferences, collections, etc. pertaining to calculus of variations and optimal control

Keywords:

Udine (Italy); Proceedings; Conference; AMST '99; Manufacturing systems; Manufacturing technology; machining processes; optimization; flexible systems; non-conventional machining; robotics; measuring; quality; mechanics of materials; process planning; optimization of control parameters