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The introduction of numerical methods, particularly finite element (FE) analysis, represents a significant advance in metal forming operations. Numerical methods are used increasingly to optimize product design and deal with problems in metal forging, rolling, and extrusion processes. *Metal Forming Analysis*, first published in 2001, describes the most important numerical techniques for simulating metal forming operations. The first part of the book describes principles and procedures and includes numerous examples and worked problems. The remaining chapters focus on applications of numerical analysis to specific forming operations. Most of these results are drawn from the authors' research in the areas of metal testing, sheet metal forming, forging, extrusion, and similar operations. Sufficient information is presented so that readers can understand the nonlinear finite element method as applied to forming problems without a prior background in structural finite element analysis. Graduate students, researchers, and practising engineers will welcome this thorough reference to state-of-the-art numerical methods used in metal forming analysis.

The aim of this book is to summarize the current most effective methods for modeling, simulating, and optimizing metal forming processes, and to present the main features of new, innovative methods currently being developed which will no doubt be the industrial tools of tomorrow. It discusses damage (or defect) prediction in virtual metal forming, using advanced multiphysical and multiscale fully coupled constitutive equations. Theoretical formulation, numerical aspects as well as application to various sheet and bulk metal forming are presented in detail. Virtual metal forming is nowadays inescapable when looking to optimize numerically various metal forming processes in order to design advanced mechanical components. To do this, highly predictive constitutive equations accounting for the full coupling between various physical phenomena at various scales under large deformation including the ductile damage occurrence are required. In addition, fully 3D adaptive numerical methods related to time and space discretization are required in order to solve accurately the associated initial and boundary value problems. This book focuses on these two main and complementary aspects with application to a wide range of metal forming and machining processes. Contents 1. Elements of Continuum Mechanics and Thermodynamics. 2. Thermomechanically-Consistent Modeling of the Metals Behavior with Ductile Damage. 3. Numerical Methods for Solving Metal Forming Problems. 4. Application to Virtual Metal Forming.

*Ductile Fracture in Metal Forming: Modeling and Simulation* examines the current understanding of the mechanics and physics of ductile fracture in metal forming processes while also providing an approach to micromechanical ductile fracture prediction that can be applied to all metal forming processes. Starting with an overview of different ductile fracture scenarios, the book then goes on to explain modeling techniques that predict a range of mechanical phenomena that can lead to ductile fracture. The challenges in creating micromechanical models are addressed alongside methods of applying these models to several common metal forming processes. This book is suitable for researchers working in mechanics of materials, metal forming, mechanical metallurgy, and plasticity. Engineers in R&D industries involved in metal forming such as manufacturing, aerospace, and automation will also find the book very useful. Explains innovative micromechanical modeling techniques for a variety of material behaviors Examines how these models can be applied to metal forming processes in practice, including blanking, arrowed cracks in drawing, and surface cracks in upset forging Provides a thorough examination of both macroscopic and microscopic ductile fracture theory

*Deformation Based Processing of Materials: Behavior, Performance, Modeling and Control* focuses on deformation based process behaviors and process performance in terms of the quality of the needed shape, geometries, and the requested properties of the deformed products. In addition, modelling and simulation is covered to create an in-depth and epistemological understanding of the process. Other topics discussed include ways to efficiently reduce or avoid defects and effectively improve the quality of deformed parts. The book is ideal as a technical document, but also serves as scientific literature for engineers, scientists, academics, research students and management professionals involved in deformation based materials processing. Covers process behaviors, such as non-uniform deformation, unstable deformation, material flow phenomena, and process performance Includes modelling

and simulation of the entire deformation process Looks at control of the preferred deformation, undesirable material flow, avoidance and reduction of defects, and improving the dimensional accuracy, surface quality and microstructure construction of the produced products

*Plasticity of Metallic Materials* presents a rigorous framework for description of plasticity phenomena, classic and recent models for isotropic and anisotropic materials, new original analytical solutions to various elastic/plastic boundary value problems and new interpretations of mechanical data based on these recent models. The book covers models for metals with both cubic and hexagonal crystal structures, presents the mechanical tests required to determine the model parameters, various identification procedures, verification, and validation tests, and numerous applications to metal forming. Outlines latest research on plastic anisotropy and its role in metal forming Presents characterization and validation tests for metals with various crystal structures Compares the predictive capabilities of various models for a variety of loadings

Functioning as an introduction to modern mechanics principles and various applications that deal with the science, mathematics and technical aspects of sheet metal forming, *Mechanics Modeling of Sheet Metal Forming* details theoretically sound formulations based on principles of continuum mechanics for finite or large deformation, which can then be implemented into simulation codes. The forming processes of complex panels by computer codes, in addition to extensive practical examples, are recreated throughout the many chapters of this book in order to benefit practicing engineers by helping them better understand the output of simulation software.

The principal aim of this text is to encourage the development and application of numerical modelling techniques as an aid to achieving greater efficiency and optimization of metal-forming processes. The contents of this book have therefore been carefully planned to provide both an introduction to the fundamental theory of material deformation simulation, and also a comprehensive survey of the "state-of-the-art" of deformation modelling techniques and their application to specific and industrially relevant processes. To this end, leading international figures in the field of material deformation research have been invited to contribute chapters on subjects on which they are acknowledged experts. The information in this book has been arranged in four parts: Part I deals with plasticity theory, Part II with various numerical modelling techniques, Part III with specific process applications and material phenomena and Part IV with integrated computer systems. The objective of Part I is to establish the underlying theory of material deformation on which the following chapters can build. It begins with a chapter which reviews the basic theories of classical plasticity and describes their analytical representations. The second chapter moves on to look at the theory of deforming materials and shows how these expressions may be used in numerical techniques. The last two chapters of Part I provide a review of isotropic plasticity and anisotropic plasticity.

Material properties -- Sheet deformation processes -- Deformation of sheet in plane stress -- Simplified stamping analysis -- Load instability and tearing -- Bending of sheet -- Simplified analysis of circular shells -- Cylindrical deep drawing -- Stretching circular shells -- Combined bending and tension of sheet -- Hydroforming.

This book helps the engineer understand the principles of metal forming and analyze forming problems - both the mechanics of forming processes and how the properties of metals interact with the processes. In this fourth edition, an entire chapter has been devoted to forming limit diagrams and various aspects of stamping and another on other sheet forming operations. Sheet testing is covered in a separate chapter. Coverage of sheet metal properties has been expanded. Interesting end-of-chapter notes have been added throughout, as well as references. More than 200 end-of-chapter problems are also included.

*Modeling of Thermo-Electro-Mechanical Manufacturing Processes with Applications in Metal Forming and Resistance Welding* provides readers with a basic understanding of the fundamental ingredients in plasticity, heat transfer and electricity that are necessary to develop and proper utilize computer programs based on the finite element flow formulation. Computer implementation of a wide range of theoretical and numerical subjects related to mesh generation, contact algorithms, elasticity, anisotropic constitutive equations, solution procedures and parallelization of equation solvers is comprehensively described. Illustrated and en-

riched with selected examples obtained from industrial applications, *Modeling of Thermo-Electro-Mechanical Manufacturing Processes with Applications in Metal Forming and Resistance Welding* works to diminish the gap between the developers of finite element computer programs and the professional engineers with expertise in industrial joining technologies by metal forming and resistance welding.

Finite element analysis has been widely applied in mechanical, civil, and biomedical designs. This book aims to provide the readers comprehensive views of various material models with practical examples, which would help readers understand various materials, and build appropriate material models in the finite element analysis. This book is composed of four main parts: 1) metals, 2) polymers, 3) soils, and 4) modern materials. Each part starts with the structure and function of different materials and then follows the corresponding material models such as BISO, MISO, Chaboche model in metals, Arruda-Boyce model, Mooney-Rivlin model, Ogden model in polymers, Mohr-Coulomb model, Cam Clay model and Jointed Rock model in geomechanics, composites and shape memory alloys in modern materials. The final section presents some specific problems, such as metal forming process, combustion chamber, Mullins effect of rubber tire, breast shape after breast surgery, viscoelasticity of liver soft tissues, tunnel excavation, slope stability, orthodontic wire, and piezoelectric microaccelerometer. All modeling files are provided in the appendixes of the book. This book would be helpful for graduate students and researchers in the mechanical, civil, and biomedical fields who conduct finite element analysis. The book provides all readers with comprehensive understanding of modeling various materials. The concept of virtual manufacturing has been developed in order to increase the industrial performances, being one of the most efficient ways of reducing the manufacturing times and improving the quality of the products. Numerical simulation of metal forming processes, as a component of the virtual manufacturing process, has a very important contribution to the reduction of the lead time. The finite element method is currently the most widely used numerical procedure for simulating sheet metal forming processes. The accuracy of the simulation programs used in industry is increased by the constitutive models and the forming limit curves models incorporated in their structure. From the above discussion, we can distinguish a very strong connection between virtual manufacturing as a general concept, finite element method as a numerical analysis instrument and constitutive laws, as well as forming limit curves as a specificity of the sheet metal forming processes. Consequently, the material modeling is strategic when models of reality have to be built. The book gives a synthetic presentation of the research performed in the field of sheet metal forming simulation during more than 20 years by the members of three international teams: the Research Centre on Sheet Metal Forming—CERTETA (Technical University of Cluj-Napoca, Romania); AutoForm Company from Zürich, Switzerland and VOLVO automotive company from Sweden. The first chapter presents an overview of different Finite Element (FE) formulations used for sheet metal forming simulation, now and in the past.

This book gives a unified presentation of the research performed in the field of multiscale modelling in sheet metal forming over the course of more than thirty years by the members of six teams from internationally acclaimed universities. The first chapter is devoted to the presentation of some recent phenomenological yield criteria (BBC 2005 and BBC 2008) developed at the CERTETA center from the Technical University of Cluj-Napoca. An overview on the crystallographic texture and plastic anisotropy is presented in Chapter 2. Chapter 3 is dedicated to multiscale modelling of plastic anisotropy. The authors describe a new hierarchical multi-scale framework that allows taking into account the evolution of plastic anisotropy during sheet forming processes. Chapter 4 is focused on modelling the evolution of voids in porous metals with applications to forming limit curves and ductile fracture. The chapter details the steps needed for the development of dissipation functions and Gurson-type models for non-quadratic anisotropic plasticity criteria like BBC 2005 and those based on linear transformations. Chapter 5 describes advanced models for the prediction of forming limit curves developed by the authors. Chapter 6 is devoted to anisotropic damage in elasto-plastic materials with structural defects. Finally, Chapter 7 deals with modelling of the Portevin-Le Chatelier (PLC) effect. This volume contains contributions from leading researchers from the Technical University of Cluj-

Napoca, Romania, the Catholic University of Leuven, Belgium, Clausthal University of Technology, Germany, Amirkabir University of Technology, Iran, the University of Bucharest, Romania, and the Institute of Mathematics of the Romanian Academy, Romania. It will prove useful to postgraduate students, researchers and engineers who are interested in the mechanical modeling and numerical simulation of sheet metal forming processes.

This volume contains about 180 papers including seven keynote presentations at the 7th NUMIFORM Conference. It reflects the state-of-the-art of simulation of industrial forming processes such as rolling, forging, sheet metal forming, injection moulding and casting.

The objective of this publication is to comprehensively discuss the possibilities of producing steels with pre-determined attributes, demanded by the customer to fit exacting specifications. The information presented in the book has been designed to indicate the reasons for the expenses and to aid in the process of overcoming the difficulties and reducing the costs. In nine detailed chapters, the authors cover topics including: • steel as a major contributor to the economic wealth of a country in terms of its capabilities and production • current concerns of major steel producers • phenomena contributing to the quality of the product • information concerning the boundary conditions of the rolling process and initial conditions, put to use by mathematical models • the solid state incremental approach and flow formulation • parameters and variables - most of which make use of the exponential nature of phenomena that are activated by thermal energy • the application of three dimensional analysis to shape rolling • the evaluation of parameters by a form of inverse analysis to the flat rolling process • knowledge based modeling, using artificial intelligence, expert systems and neural networks They conclude that when either mathematical or physical modeling of the rolling process is considered and the aim is to satisfy the demands for customers, it is possible to produce what the customer wants, exactly.

State-of-the-technology tools for designing, optimizing, and manufacturing new materials Integrated computational materials engineering (ICME) uses computational materials science tools within a holistic system in order to accelerate materials development, improve design optimization, and unify design and manufacturing. Increasingly, ICME is the preferred paradigm for design, development, and manufacturing of structural products. Written by one of the world's leading ICME experts, this text delivers a comprehensive, practical introduction to the field, guiding readers through multiscale materials processing modeling and simulation with easy-to-follow explanations and examples. Following an introductory chapter exploring the core concepts and the various disciplines that have contributed to the development of ICME, the text covers the following important topics with their associated length scale bridging methodologies: Macroscale continuum internal state variable plasticity and damage theory and multistage fatigue Mesoscale analysis: continuum theory methods with discrete features and methods Discrete dislocation dynamics simulations Atomistic modeling methods Electronics structures calculations Next, the author provides three chapters dedicated to detailed case studies, including "From Atoms to Autos: A Redesign of a Cadillac Control Arm," that show how the principles and methods of ICME work in practice. The final chapter examines the future of ICME, forecasting the development of new materials and engineering structures with the help of a cyberinfrastructure that has been recently established. Integrated Computational Materials Engineering (ICME) for Metals is recommended for both students and professionals in engineering and materials science, providing them with new state-of-the-technology tools for selecting, designing, optimizing, and manufacturing new materials. Instructors who adopt this text for coursework can take advantage of PowerPoint lecture notes, a questions and solutions manual, and tutorials to guide students through the models and codes discussed in the text.

Discover the state-of-the-art in multiscale modeling and optimization in manufacturing from two leading voices in the field Modeling and Optimization in Manufacturing delivers a comprehensive approach to various manufacturing processes and shows readers how multiscale modeling and optimization processes help improve upon them. The book elaborates on the foundations and applications of computational modeling and optimization processes, as well as recent developments in the field. It offers discussions of manufacturing processes, including forming, machining, casting, joining, coating, and additive manufacturing, and how computer simulations have influenced their development. Examples for each category of manufacturing are provided in the text, and industrial applications are described for the reader. The distinguished authors also provide an insightful perspective on likely future trends and developments in manufacturing modeling and optimization, including the use of large materials databases and machine learning. Readers will also benefit from the inclusion of: A thorough introduction to the origins of manufacturing, the history of traditional and advanced manufacturing, and recent progress in manufacturing An exploration of advanced manufacturing and the environmental impact and significance of manufacturing Practical discussions of the economic importance of advanced manufacturing An examination of the sustainability of advanced manufacturing, and developing and future trends in manufacturing Perfect for mate-

rials scientists, mechanical engineers, and process engineers, Modeling and Optimization in Manufacturing will also earn a place in the libraries of engineering scientists in industries seeking a one-stop reference on multiscale modeling and optimization in manufacturing.

Mechanics of Materials in Modern Manufacturing Methods and Processing Techniques provides a detailed overview of the latest developments in the mechanics of modern metal forming manufacturing. Focused on mechanics as opposed to process, it looks at the mechanical behavior of materials exposed to loading and environmental conditions related to modern manufacturing processes, covering deformation as well as damage and fracture processes. The book progresses from forming to machining and surface-treatment processes, and concludes with a series of chapters looking at recent and emerging technologies. Other topics covered include simulations in autofrettage processes, modeling strategies related to cutting simulations, residual stress caused by high thermomechanical gradients and pultrusion, as well as the mechanics of the curing process, forging, and cold spraying, among others. Some non-metallic materials, such as ceramics and composites, are covered as well. Synthesizes the latest research in the mechanics of modern metal forming processes Suggests theoretical models and numerical codes to predict mechanical responses Covers mechanics of shot peening, pultrusion, hydroforming, magnetic pulse forming Considers applicability of different materials and processes for optimum performance

Ductile Fracture in Metal Forming provides an approach to micromechanical ductile fracture prediction which is applicable to all metal-forming processes. It also examines, in detail, our current understanding of the mechanics and physics of ductile fracture in metal-forming processes. Starting with an overview of different ductile fracture scenarios, this book goes on to explain modeling techniques that predict a range of mechanical phenomena that can lead to ductile fracture. The particular challenges in creating micromechanical models are addressed, as are methods of applying these models to several common metal-forming processes. Explains innovative micromechanical modeling techniques for a variety of material behaviors Examines how these models can be applied to metal forming processes in practice, including blanking, arrowed cracks in drawing, and surface cracks in upset forging Provides a thorough examination of both macroscopic and microscopic ductile fracture theory

This book deals with metal processing and its numerical modelling and simulation. In total, 21 papers from different distinguished authors have been compiled in this area. Various processes are addressed, including solidification, TIG welding, additive manufacturing, hot and cold rolling, deep drawing, pipe deformation, and galvanizing. Material models are developed at different length scales from atomistic simulation to finite element analysis in order to describe the evolution and behavior of materials during thermal and thermomechanical treatment. Materials under consideration are carbon, Q&T, DP, and stainless steels; ductile iron; and aluminum, nickel-based, and titanium alloys. The developed models and simulations shall help to predict structure evolution, damage, and service behavior of advanced materials.

This publication has been written to honour the contribution to science and education made by the Distinguished Professor Emeritus Professor Schey on his eightieth birthday. The contributors to his book are among the countless researchers who have read, studied and learned from Professor Schey's work, which includes books, research monographs, invited papers, keynote papers, scientific journals and conferences. The topics include manufacturing, sheet and bulk metal forming and tribology, amongst others. The topics included in this book include: John Schey and value-added manufacturing; Surface finish and friction in cold-metal rolling; Direct observation of interface for tribology in metal forming; An examination of the coefficient of friction; Studies on micro plasto hydrodynamic lubrication in metal forming; Numerical simulation of sheet metal forming; Geometric and mechanics model of sheet forming; Modelling and optimisation of metal forming processes; The mathematical modelling of hot rolling steel; Identification of rheological and tribological parameters; Oxide behaviour in hot rolling; Friction, lubrication and surface response in wire drawing; and Modelling and control of temper rolling and skin pass rolling.

This book provides a comprehensive introduction to the unique theory developed over years of research on materials and process modelling and its application in metal forming technologies. It starts with the introduction of fundamental theories on the mechanics of materials, computational mechanics and the formulation of unified constitutive equations. Particular attention is paid to elastic-plastic formulations for cold metal forming and unified elastic-viscoplastic constitutive equations for warm/hot metals processing. Damage in metal forming and numerical techniques to solve and determine the unified constitutive equations are also detailed. Examples are given for the application of the unified theories to solve practical problems encountered in metal forming processes. This is particularly useful to predict microstructure evolution in warm/hot metal forming processes. Crystal plasticity theories and modelling techniques with their applications in micro-forming are also introduced in the book. The book is self-contained and unified in presentation. The explanations are highlight-

ed to capture the interest of curious readers and complete enough to provide the necessary background material to further explore/develop new theories and applications.

Metal Forming: Formability, Simulation, and Tool Design focuses on metal formability, finite element modeling, and tool design, providing readers with an integrated overview of the theory, experimentation and practice of metal forming. The book includes formability and finite element topics, including insights on plastic instability, necking, nucleation and coalescence of voids. Chapters discuss the finite element method, including its accuracy, reliability and validity and finite element flow formulation, helping readers understand finite element formulations, iterative solution methods, friction and contact between objects, and other factors. The book's final sections discuss tool design for cold, warm and hot forming processes. Examples of tools, design guidelines, and information related to tool materials, lubricants, finishes, and tool failure are included as well. Provides fundamental, integrated knowledge on metal formability, finite element topics and tool design Outlines user perspectives on accuracy, reliability and validity of finite element modeling Discusses examples of tools, their design guidelines, tool lubricants, and tool failure Considers the role played by stress triaxiality and shear and introduces uncoupled ductile damage criteria Includes applications, worked examples and detailed techniques

This book is a printed edition of the Special Issue "Advances in Plastic Forming of Metals" that was published in Metals

This state-of-the-art book highlights recent advances and discussions in tribological technologies in sheet metal forming. The contents focus on the fundamentals to the more complex topics such as micro contact and lubricant behaviors, FEM analysis in deep drawing process, usage of tribo-simulators, friction behavior in flat sliding, tribological numerical modeling, and simulation of seizure. This book is a useful reference for academicians and researchers in the field of lubrication, sheet metal forming, and tooling.

The application of computer-aided design and manufacturing techniques is becoming essential in modern metal-forming technology. Thus process modeling for the determination of deformation mechanics has been a major concern in research. In light of these developments, the finite element method—a technique by which an object is decomposed into pieces and treated as isolated, interacting sections—has steadily assumed increased importance. This volume addresses advances in modern metal-forming technology, computer-aided design and engineering, and the finite element method.

This book contains the most relevant papers presented in the International Conference on Materials Forming, ESAFORM 2005. It gathers selected plenary and keynote papers presented in the conference, offering an up-to-date synthesis of the academic and industrial research in the fields of physical and numerical modeling of materials forming processes.

Micro Metal Forming, i. e. forming of parts and features with dimensions below 1 mm, is a young area of research in the wide field of metal forming technologies, expanding the limits for applying metal forming towards micro technology. The essential challenges arise from the reduced geometrical size and the increased lot size. In order to enable potential users to apply micro metal forming in production, information about the following topics are given: tribological behavior: friction between tool and work piece as well as tool wear mechanical behavior: strength and formability of the work piece material, durability of the work pieces size effects: basic description of effects occurring due to the fact, that the quantitative relation between different features changes with decreasing size process windows and limits for forming processes tool making methods numerical modeling of processes and process chains quality assurance and metrology All topics are discussed with respect to the questions relevant to micro metal forming. The description comprises information from actual research and the young history of this technology branch to be used by students, scientists and engineers in industry who already have a background in metal forming and like to expand their knowledge towards miniaturization. tribological behavior: friction between tool and work piece as well as tool wear mechanical behavior: strength and formability of the work piece material, durability of the work pieces size effects: basic description of effects occurring due to the fact, that the quantitative relation between different features changes with decreasing size process windows and limits for forming processes tool making methods numerical modeling of processes and process chains quality assurance and metrology All topics are discussed with respect to the questions relevant to micro metal forming. The description comprises information from actual research and the young history of this technology branch to be used by students, scientists and engineers in industry who already have a background in metal forming and like to expand their knowledge towards miniaturization.

The numerical simulation of sheet metal forming processes has become an indispensable tool for the design of components and their forming processes. This role was attained due to the huge impact in reducing time to market and the cost of developing new components in industries ranging from automotive to packing, as well as enabling an improved understanding of the deformation mechanisms and their interaction with process parameters. De-

spite being a consolidated tool, its potential for application continues to be discovered with the continuous need to simulate more complex processes, including the integration of the various processes involved in the production of a sheet metal component and the analysis of in-service behavior. The quest for more robust and sustainable processes has also changed its deterministic character into stochastic to be able to consider the scatter in mechanical properties induced by previous manufacturing processes. Faced with these challenges, this Special Issue presents scientific advances in the development of numerical tools that improve the prediction results for conventional forming process, enable the development of new forming processes, or contribute to the integration of several manufacturing processes, highlighting the growing multidisciplinary characteristic of this field.

"Modeling and planning of manufacturing processes" provides the reader with detailed information about the different kinds of numerical modeling methods for the manufacturing processes forming, cutting and grinding, integrated in technology planning and design of process chains. Basic approaches in modeling are presented. The orientation towards industrial applications for many

kinds of modeling methods was evaluated. Empirical, analytical and numerical models are introduced. Finite Element Methods (FEM) are widely applied in the design of new manufacturing tools, their application is described and numerous application examples of FEM are presented. The method is a valuable device for the process planner for the design and the analysis of the metal forming process. Even complex forming processes can be analysed by means of the FEM. The interested reader receives profound information for the modeling approaches in forming, cutting, grinding, and the integration of these tools into complex technology planning systems.

Written by authorities in the subject, this book provides a complete treatment of metal forming and machining by using the computational techniques FEM, fuzzy set theory and neural networks as modelling tools. The algorithms and solved examples included make this book of value to postgraduates, senior undergraduates, and lecturers and researchers in these fields. Research and development engineers and consultants for the manufacturing industry will also find it of use.

It is the objective of the series IIMaterials Research and Engineering to publish information on technical facts and processes to-

gether with specific scientific models and theories. Fundamental considerations assist in the recognition of the origin of properties and the roots of processes. By providing a higher level of understanding, such considerations form the basis for further improving the quality of both traditional and future engineering materials, as well as the efficiency of industrial operations. In a more general sense, theory helps to integrate facts into a framework which ties relations between physical equilibria and mechanisms on the one hand, product development and economical competition on the other. Aspects of environmental compatibility, conservation of resources and of socio-cultural interaction form the final horizon - a subject treated in the first II volume of this series, IIMaterials in World Perspective. The four authors of the present book endeavor to present a comprehensive picture of process modelling in the important field of metal forming and thermomechanical treatment. The reader will be introduced to the rapidly-growing new field of application of computer-aided numerical methods to the quantitative simulation of complex technical processes. Extensive use is made of the state of scientific knowledge related to materials behavior under mechanical stress and thermal treatment.