Metal Forming Technology And Process Modelling


“Simulation-based technology development for metal forming” is a compilation of selected conference papers presented at the metal forming conference MEFORM 2019, that has taken place from March 20th to 21st, 2019 in Freiberg / Saxony. The publication addresses to engineers as well as to representatives of R&D institutions and technical education aiming for simulation-based technology development in the metalworking industries. It provides insights and information about new simulation approaches to support the development of materials and forming technologies for light or heavy metals and material characterization. The models range from fast models for material flow and load prediction to time-consuming multi-scale approaches, including microstructure evolution and the resulting mechanical properties.

Metal Forming Sheet metal is one of the most important semi finished products used in the steel industry, and sheet metal forming technology is therefore an important engineering discipline within the area of mechanical engineering. The development of new sheet metal forming processes, tooling and so on has up till now to a large extent been based on experience, rules of thumb and trial-error experiments without or with only little use of scientifically based engineering methods. As mentioned above, experience is not enough, and trial-error experiments are very expensive with regard to both money and time. There is therefore great need for the development of both theoretical and experimental engineering methods. In this case, Taguchi method was selected to design of experiment using the statistica software.
version 7 which enables the problems to be tackled effectively; the punching process has been chosen to form the sheet metal. The objective of the project is to determine the optimize parameters. The parameters to be considered in this study are punching tonnage, the sheet thickness, the sheet length and the sheet width.

Microforming Technology

Comprehensive Materials Processing The Primary Objective Of Metal Forming Technology Is To Produce A Desired Shape Change. Two Major Concerns Of This Technology Are The Forces Required For The Operation & The Properties Of The Work Material. It Is Well Known That Material Properties Affect The Process & Processing Which Changes The Material Properties

Modelling of process chains and interfaces for sheet metal forming Briefly reviews the basic principles of metal forming but major emphasis is on the latest developments in the design of metal-forming operations and tooling. Discusses the position of metal forming in manufacturing and considers a metal-forming process as a system consisting of several interacting variables. Includes an overall review and classification of all metal-forming processes. The fundamentals of plastic deformation - metal flow, flow stress of metals and yield criteria - are discussed, as are significant practical variables of metal-forming processes such as friction, temperatures and forming machines and their characteristics. Examines approximate methods of analyzing simple forming operations, then looks at massive forming processes such as closed-die forging, hot extrusion, cold forging/ extrusion, rolling and drawing (discussion includes the prediction of stresses and load in each process and applications of computer-aided techniques). Recent developments in metal-forming technology, including CAD/CAM for die design and manufacture, are discussed, and a review of the latest trends in metal flow analysis and simulations.

Micro Metal Forming 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
Aerospace Manufacturing Processes Over the last 15 years, the application of innovative steel concepts in the automotive industry has increased steadily. Numerical simulation technology of hot forming of high-strength steel allows engineers to modify the formability of hot forming steel metals and to optimize die design schemes. Theories, Methods and Numerical Technology of Sheet Metal Cold and Hot Forming focuses on hot and cold forming theories, numerical methods, relative simulation and experiment techniques for high-strength steel forming and die design in the automobile industry. Theories, Methods and Numerical Technology of Sheet Metal Cold and Hot Forming introduces the general theories of cold forming, then expands upon advanced hot forming theories and simulation methods, including: the forming process, constitutive equations, hot boundary constraint treatment, and hot forming equipment and experiments. Various calculation methods of cold and hot forming, based on the authors’ experience in commercial CAE software for sheet metal forming, are provided, as well as a discussion of key issues, such as hot formability with quenching process, die design and cooling channel design in die, and formability experiments. Theories, Methods and Numerical Technology of Sheet Metal Cold and Hot Forming will enable readers to develop an advanced knowledge of hot forming, as well as to apply hot forming theories, calculation methods and key techniques to direct their die design. It is therefore a useful reference for students and researchers, as well as automotive engineers.

Rubber-Pad Forming Processes Incremental Sheet Forming (ISF) exempts use of dies and reduces cost for manufacturing complex parts. Sheet metal forming is used for producing high-quality components in automotive, aerospace, and medical industries. This book covers the benefits of this new technology, including the process parameters along with various techniques. Each variant of this novel process is discussed along with the requirements of machinery and hardware. In addition, appropriate guidelines are also suggested regarding the relationship between process parameters and aspects of ISF process in order to ensure the applicability of the process on the industrial scale. This book will be a useful asset for researchers, engineers in manufacturing industries, and postgraduate level courses.

Lokale Laserentfestigung von Halbleugen und Bauteilen aus hochfesten Stählen This book provides essential information on metal forming, utilizing a practical distinction between bulk and sheet metal forming. In the field of bulk forming, it examines processes of cold, warm and hot bulk forming, as well as rolling and a new addition, the process of thixoforming. As for the field of sheet metal working, on the one hand it deals with sheet metal forming processes (deep drawing, flange forming, stretch drawing, metal spinning and bending). In terms of special processes, the chapters on internal high-pressure forming and high rate forming have been revised and refined. On the other, the book elucidates and presents the state of the art in sheet metal separation processes (shearing and fineblanking). Furthermore, joining by forming has been added to the new edition as a new
chapter describing mechanical methods for joining sheet metals. The new chapter “Basic Principles” addresses both sheet metal and bulk forming, in addition to metal physics, plastomechanics and computational basics; these points are complemented by the newly added topics of metallography and analysis, materials and processes for testing, and tribology and lubrication techniques. The chapters are supplemented by an in-depth description of modern numeric methods such as the finite element method. All chapters have been updated and revised for the new edition, and many practical examples from modern manufacturing processes have been added.

Incremental Sheet Forming Technologies 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 enriched 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.

Theories, Methods and Numerical Technology of Sheet Metal Cold and Hot Forming In this collection, scientists and engineers from across industry, academia, and government present their latest improvements and innovations in all aspects of metal forming science and technology, with the intent of facilitating linkages and collaborations among these groups. Chapters cover the breadth of metal forming topics, from fundamental science to industrial application.

Modeling of Thermo-Electro-Mechanical Manufacturing Processes

Metal Forming Handbook 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.

Process Modelling of Metal Forming and Thermomechanical Treatment This comprehensive text presents the subject of metalworking by offering a clear account of the theory and applications of metal forming processes relevant to engineering practice. It is designed to serve as a textbook for undergraduate and postgraduate students of mechanical engineering, production engineering, industrial engineering, and metallurgical engineering. The first seven chapters are devoted to basic concepts to equip the students with the background material on mechanics, material sciences and to provide them with a sound foundation in the theory of plasticity. In addition, the importance of friction and lubrication in metal forming processes is adequately highlighted. In the next nine chapters the reader is exposed to a richly detailed discussion of specific forming processes.
(including the lubricated metal forming processes) and new and powerful techniques are presented (load bounding and slip line field) for solving engineering problems in metal forming. The book then moves on to forming of polymers and also covers metal powder preforms, highlighting recent developments. In the concluding portions of the book, the important factors such as force, power requirements, formability and machinability in the study of individual processes, are briefly discussed. Finally, the application of computer-aided analysis in the metalworking processes has been demonstrated, being the demand in this competitive scenario. Several chapter-end exercises are included to aid better understanding of the theory.

Forming the Future This book presents state-of-the-art research on forming processes and formed metal product development aided by the Finite Element Method (FEM). Using extensive and informative illustrations, tables and photographs, it systematically presents real-life case studies and established findings regarding various forming processes and methods aided by FEM simulation, and addresses various issues related to metal formed part design, process determination, die design and die service life analysis and prolongation, as well as product quality assurance and improvement. Metal forming has been widely used in many industries. This traditional manufacturing process, however, has long been linked to many years of apprenticeship and skilled craftsmanship, and its conventional design and development paradigm appeared to involve more know-how and trial-and-error than in-depth scientific calculation, analysis and simulation. The design paradigm for forming processes and metal formed product development thus cannot meet the current demands for short development lead-times, low production costs and high product quality. With the advent of numerical simulation technologies, the design and development of forming processes and metal formed products are carried out with the aid of FEM simulation, allowing all the potential design spaces to be identified and evaluated, and the best design to ultimately be determined and implemented. Such a design and development paradigm aims at ensuring “designing right the first time” and reducing the need for trial-and-error in the workshop. This book provides postgraduates, manufacturing engineers and professionals in this field with an in-depth understanding of the design process and sufficient knowledge to support metal formed part design, forming process determination, tooling design, and product quality assurance and control via FEM simulation. “/

Advanced Methods in Material Forming This book focuses on the new direction of magnetic pulsed metal working by attraction of sheet metals. In the first part, the authors focus on the magnetic pulsed pressure for forming of inner angles in the sheet metals. Part 2 of the book presents the magnetic pulsed attraction of thin-walled metals. In the third and last part, the authors present the practical realization of external restoring the dents on the car bodies by electromagnetic metal forming attraction.

Handbook of Metallurgical Process Design Following the long tradition of the Schuler Company, the Metal Forming Handbook presents the scientific fundamentals of metal forming technology in a way which is both compact and easily understood. Thus, this book makes the theory and practice of this field accessible to teaching and practical implementation. The first Schuler "Metal Forming Handbook" was published in 1930. The last edition of 1966, already revised four times, was translated into a number of languages, and
met with resounding approval around the globe. Over the last 30 years, the field of forming technology has been radically changed by a number of innovations. New forming techniques and extended product design possibilities have been developed and introduced. This Metal Forming Handbook has been fundamentally revised to take account of these technological changes. It is both a text book and a reference work whose initial chapters are concerned to provide a survey of the fundamental processes of forming technology and press design. The book then goes on to provide an in-depth study of the major fields of sheet metal forming, cutting, hydroforming and solid forming. A large number of relevant calculations offers state of the art solutions in the field of metal forming technology. In presenting technical explanations, particular emphasis was placed on easily understandable graphic visualization. All illustrations and diagrams were compiled using a standardized system of functionally oriented color codes with a view to aiding the reader’s understanding.

TECHNOLOGY OF METAL FORMING PROCESSES This book summarizes the advanced manufacturing technology of original innovations in hot stamping of lightweight car body. A detailed description of the technical system and basic knowledge of sheet metal forming is given, which helps readers quickly understand the relevant knowledge in the field. Emphasis has been placed on the independently developed hot stamping process and equipment, which help describe the theoretical and experimental research on key problems involving stress field, thermal field and phase transformation field in hot stamping process. Also, a description of the formability at elevated temperature and the numerical simulation algorithms for high strength steel hot stamping is given in combination with the experiments. Finally, the book presents some application cases of hot stamping technology such as the lightweight car body design using hot stamping components and gradient hardness components, and the cooling design of the stamping tool. This book is intended for researchers, engineers and graduate students in vehicle engineering, mechanical engineering, especially in the field of advanced manufacturing technology. The book also provides a useful reference for other new technology related temperature and phase transformation, such as aluminum-magnesium alloy hot stamping.

Electromagnetic Metal Forming for Advanced Processing Technologies Manufacturing processes for aircraft components include broad activities consisting of multiple materials processing technologies. This book focuses on presenting manufacturing process technologies exclusively for fabricating major aircraft components. Topics covered in a total of twenty chapters are presented with a balanced perspective on the relevant fundamentals and various examples and case studies. An individual chapter is aimed at discussing the scope and direction of research and development in producing high strength lighter aircraft materials, and cost effective manufacturing processes are also included.

Sheet Metal Forming The subject of this thesis is the further development of the local laser softening of high strength steels. In order to achieve more homogeneous softening over the board thickness at high feed rates, two approaches for process adaptation are investigated. For a simultaneous process of laser cutting and laser softening, a processing head, is developed. The implications of laser-softened parts in the joining zones for resistance spot welding on crash performance are demonstrated.
Applied Metal Forming 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.

Sheet Metal Forming This up-to-date volume takes a practical applications approach to developing manufacturing plans for both machined and metal worked parts. The book explores in detail all aspects of processing, tolerance charting and workplace holding. Organized in the sequence used to develop manufacturing plans, the book provides users with a first-hand working knowledge of the process of translating designs into products. Complete coverage of processing, tolerance charting, workplace holding, group technology and current tooling and technology processes. For individuals in mechanical, industrial and manufacturing engineering fields.

Design and Development of Metal-Forming Processes and Products Aided by Finite Element Simulation Innovation in all aspects of mechanical engineering and management Computer Aided Production Engineering is a compilation of papers presented at the 17th International CAPE Conference in 2001. Featuring the work of leading innovators from academia and industry, this book explores the forefront of mechanical engineering technology and practices to provide insight for today and direction for tomorrow. Broad in scope yet rich in detail, these papers cover topics ranging from supply chain management, nontraditional processes, and quality control, to machining processes, concurrent design and engineering, rapid prototyping, virtual reality applications, and much more.

Deformation Based Processing of Materials Microforming Technology: Theory, Simulation and Practice addresses all aspects of micromanufacturing technology, presenting detailed technical information and the latest research developments. The book covers fundamentals, theory, simulation models, equipment and tools design, practical micromanufacturing procedures, and micromanufacturing-related supporting systems, such as laser heating system, hydraulic system and quality evaluation systems. Newly developed technology, including micro wedge rolling, micro flexible rolling and micro hydromechanical deep drawing, as well as traditional methods, such as micro deep drawing, micro bending and micro ultrathin strip rolling, are discussed. This will be a highly valuable resource for those involved in the use, study and design of micro products and micromanufacturing technologies, including engineers, scientists, academics and graduate students. Provides an accessible introduction to the fundamental theories of microforming, size effects, and scaling laws. Includes explanations of the procedures, equipment, and tools for all common microforming technologies. Explains the numerical modeling procedures for 7 different types of microforming.

Optimization of Process Parameters in Sheet Metal Forming by Using Taguchi Method Reviewing an extensive array of procedures in hot and cold forming, casting, heat treatment, machining, and surface engineering of steel and aluminum, this comprehensive reference explores a vast range of processes relating to metallurgical component design—enhancing the production and the
properties of engineered components while reducing manufacturing costs. It surveys the role of computer simulation in alloy design and its impact on material structure and mechanical properties such as fatigue and wear. It also discusses alloy design for various materials, including steel, iron, aluminum, magnesium, titanium, super alloy compositions and copper.

Aerospace Manufacturing Processes A professional reference for advanced courses in two of the most common manufacturing processes: metal forming and metal cutting.

Hot Stamping Advanced Manufacturing Technology of Lightweight Car Body

Metal Forming Technology 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.

Sheet Metal Forming Technology Volume I. This book describes different types of rubber-pad forming processes currently being studied for their experimental and numerical advantages and disadvantages. Rubber forming adopts a rubber pad contained in a rigid box in which one of the tools (die or punch) is replaced by the rubber pad. Up to 60% of all sheet metal parts in aircraft industry such as frames, seat parts, ribs, windows and doors are fabricated using rubber-pad forming processes. Key process parameters such as rubber material, stamping velocity, rubber-pad hardness and thickness and friction conditions are investigated. The potential role of rubber as a flexible punch in metal working processes is to give insight to engineers about different parts that can be produced using this process. The procedure of suitable die design for each process is presented in detail. Full defect analysis is undertaken with a thorough report presented to optimize rubber-pad forming processes.

Handbuch der Umformtechnik The focus of the Congress will be leading-edge manufacturing processes. Topics include manufacturing at extreme speed, size, accuracy, methodology, use of resources, interdisciplinarity and more. Contributions from production and industrial engineering are welcome. Challenges from the areas of manufacturing, machines and production systems will be addressed. Production research constantly pushes the boundaries of what is feasible. The Congress "Production at the leading edge of technology" will highlight production processes that are advancing into areas that until recently were considered unfeasible, also in terms of methodology, use of resources and interdisciplinarity. But where does the
search for new limits lead? Which limitations do we still have to overcome, which ones do we not want to overcome? The aim of the German-speaking colloquium is to establish connections between the research locations and to intensify the overall transfer of results and experience with industrial users.

Simulation of Metal Forming Processes by the Finite Element Method (SIMOP-I)
The pressing of sheet metal into useful shapes is a technology which requires an understanding of a wide range of subjects. This text is divided into three sections: processes, materials and tests. In Part 1, sheet metal forming is examined mainly from a mechanical engineering viewpoint; firstly plasticity and anisotropy, then process variables - friction, lubrication and temperature - and finally practical aspects of forming in the press-shop. Part 2 deals with the main sheet alloys at varying lengths, depending on their industrial popularity. Certain research results, showing the fallibility of the phenomenological approach, are also highlighted. A section of testing procedures concludes the volume.

Production at the leading edge of technology The purpose of this project is to determine the inherent limitations of sheet metal forming processes, to develop the knowledge to significantly advance these, and to recommend the manner in which this can be accomplished. Principle areas of investigation are concerned with the effect that primary process variables such as velocity, temperature and pressure have on various classes of metals and alloys. This report presents the results of the experimental part of the program covering the first sixteen months. This experimental work was performed for tensile testing, free bulging of tubing and domes, and forming of parts with dies using a projectile impact tensile test fixture, low explosive-closed system, high explosive-open system, electrohydraulic open system, electromagnetic system, and conventional presses. In addition, high-pressure rubber forming was investigated, utilizing both static and impact presses in conjunction with heat.

Simulation-Based Technology Development for Material Forming Comprehensive Materials Processing provides students and professionals with a one-stop resource consolidating and enhancing the literature of the materials processing and manufacturing universe. It provides authoritative analysis of all processes, technologies, and techniques for converting industrial materials from a raw state into finished parts or products. Assisting scientists and engineers in the selection, design, and use of materials, whether in the lab or in industry, it matches the adaptive complexity of emergent materials and processing technologies. Extensive traditional article-level academic discussion of core theories and applications is supplemented by applied case studies and advanced multimedia features. Coverage encompasses the general categories of solidification, powder, deposition, and deformation processing, and includes discussion on plant and tool design, analysis and characterization of processing techniques, high-temperatures studies, and the influence of process scale on component characteristics and behavior. Authored and reviewed by world-class academic and industrial specialists in each subject field Practical tools such as integrated case studies, user-defined process schemata, and multimedia modeling and functionality Maximizes research efficiency by collating the most important and established information in one place with integrated applets linking to relevant outside sources.
Metal Forming and the Finite-Element Method

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.

Computer Aided Production Engineering

Manufacturing processes for aircraft components include broad activities consisting of multiple materials processing technologies. This book focuses on presenting manufacturing process technologies exclusively for fabricating major aircraft components. Topics covered in a total of twenty chapters are presented with a balanced perspective on the relevant fundamentals and various examples and case studies. An individual chapter is aimed at discussing the scope and direction of research and development in producing high strength lighter aircraft materials, and cost effective manufacturing processes are also included.

Applied Manufacturing Process Planning

Metal Forming and the Finite-element Method—Concise presentation of metal forming techniques for everyday practice—illustrated throughout by four-color figures and diagrams

Metal Forming Handbook

The purpose of this project is to determine the inherent limitations of sheet metal forming processes, to develop the knowledge to significantly advance these, and to recommend the manner in which this can be accomplished. Principal areas of investigation are concerned with the effect that primary process variables such as velocity, temperature and pressure have on various classes of metals and alloys. This report presents the results of the experimental part of the program covering the first sixteen months. This experimental work was performed for tensile testing, free bulging of tubing and domes, and forming of parts with dies using a projectile impact tensile test fixture, low explosive—closed system, high explosive open system, electrohydraulic open system, electromagnetic system, and conventional presses. In addition, high-pressure rubber forming was investigated, utilizing both static and impact presses in conjunction with heat. (Author).

Metal Forming

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

Volume 1. Final Report on Sheet Metal Forming Technology

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