

# Wohlers Report 2016

The proceedings brings together a selection of papers from the 7th International Workshop of Advanced Manufacturing and Automation (IWAMA 2017), held in Changshu Institute of Technology, Changshu, China on September 11–12, 2017. Most of the topics are focusing on novel techniques for manufacturing and automation in Industry 4.0. These contributions are vital for maintaining and improving economic development and quality of life. The proceeding will assist academic researchers and industrial engineers to implement the concepts and theories of Industry 4.0 in industrial practice, in order to effectively respond to the challenges posed by the 4th industrial revolution and smart factories.

This book gathers the peer-reviewed contributions presented at two parallel, closely interconnected events on advanced construction materials and processes, namely the 2nd International RILEM Conference on Rheology and Processing of Construction Materials (RheoCon2) and the 9th International RILEM Symposium on Self-Compacting Concrete (SCC9), held in Dresden, Germany on 8-11 September 2019. The papers discuss various aspects of research on the development, testing, and applications of cement-based and other building materials together with their specific rheological properties. Furthermore, the papers cover the latest findings in the fast-growing field of self-compacting concrete, addressing topics including components' properties and characterization; chemical admixtures, effect of binders (incl. geopolymers, calcined clay, etc.) and mixture design; laboratory and in-situ rheological testing; constitutive models and flow modelling; numerical simulations; mixing, processing and casting processes; and additive manufacturing / 3D-printing. Also presenting case studies, the

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book is of interest to researchers, graduate students, and industry specialists, such as material suppliers, consultants and construction experts.

This book covers in detail the various aspects of joining materials to form parts. A conceptual overview of rapid prototyping and layered manufacturing is given, beginning with the fundamentals so that readers can get up to speed quickly. Unusual and emerging applications such as micro-scale manufacturing, medical applications, aerospace, and rapid manufacturing are also discussed. This book provides a comprehensive overview of rapid prototyping technologies as well as support technologies such as software systems, vacuum casting, investment casting, plating, infiltration and other systems. This book also: Reflects recent developments and trends and adheres to the ASTM, SI, and other standards Includes chapters on automotive technology, aerospace technology and low-cost AM technologies Provides a broad range of technical questions to ensure comprehensive understanding of the concepts covered

3D Printing in Medicine examines the emerging market of 3D-printed biomaterials and its clinical applications. With a particular focus on both commercial and premarket tools, the book looks at their applications within medicine and the future outlook for the field. The book begins with a discussion of the fundamentals of 3D printing, including topics such as materials, and hardware. Chapters go on to cover applications within medicine such as computational analysis of 3D printed constructs, personalized 3D printing and 3D cell and organ printing. The concluding chapters in the book review the applications of 3D printing in diagnostics, drug development, 3D-printed disease models and 3D printers for surgical practice. With a strong focus on the translation of 3D printing technology to a clinical setting, this book is a valuable

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resource for scientists and engineers working in biomaterial, biomedical, and nanotechnology based industries and academia. Provides a comprehensive and authoritative overview of all the medical applications of 3D printing biomaterials and technologies Focuses on the emerging market of 3D printed biomaterials in clinical applications Reviews both commercial and under development materials, tools, their applications, and future evolution

Sustainable Manufacturing examines the overall sustainability of a wide range of manufacturing processes and industrial systems. With chapters addressing machining, casting, additive and gear manufacturing processes; and hot topics such as remanufacturing, life cycle engineering, and recycling, this book is the most complete guide to this topic available.

Drawing on experts in both academia and industry, coverage addresses theoretical developments and practical improvements from research and innovations. This unique book will advise readers on how to achieve sustainable manufacturing processes and systems, and further the clean and safe environment. This handbook is a part of the four volume set entitled Handbooks in Advanced Manufacturing. The other three address Advanced Machining and Finishing, Advanced Welding and Deforming, and Additive Manufacturing. Provides basic to advanced level information on various aspects of sustainable manufacturing Presents the strategies and techniques to achieve sustainability in numerous areas of manufacturing and industrial engineering such as environmentally benign machining, sustainable additive manufacturing, remanufacturing and recycling, sustainable supply chain, and life cycle engineering Combines contributions from experts in academia and industry with the latest research and case studies Explains how to attain a clean, green, and safe environment via sustainable manufacturing Presents recent developments and suggests future research

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directions

This engaging volume presents the exciting new technology of additive manufacturing (AM) of metal objects for a broad audience of academic and industry researchers, manufacturing professionals, undergraduate and graduate students, hobbyists, and artists. Innovative applications ranging from rocket nozzles to custom jewelry to medical implants illustrate a new world of freedom in design and fabrication, creating objects otherwise not possible by conventional means. The author describes the various methods and advanced metals used to create high value components, enabling readers to choose which process is best for them. Of particular interest is how harnessing the power of lasers, electron beams, and electric arcs, as directed by advanced computer models, robots, and 3D printing systems, can create otherwise unattainable objects. A timeline depicting the evolution of metalworking, accelerated by the computer and information age, ties AM metal technology to the rapid evolution of global technology trends. Charts, diagrams, and illustrations complement the text to describe the diverse set of technologies brought together in the AM processing of metal. Extensive listing of terms, definitions, and acronyms provides the reader with a quick reference guide to the language of AM metal processing. The book directs the reader to a wealth of internet sites providing further reading and resources, such as vendors and service providers, to jump start those interested in taking the first steps to establishing AM metal capability on whatever scale. The appendix provides hands-on example exercises for those ready to engage in experiential self-directed learning.

Additive Manufacturing (AM) technologies are developing impressively and are expected to bring about the next revolution. AM is gradually replacing traditional manufacturing methods in

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some applications because of its unique properties of customisability and versatility. This book provides a very comprehensive and updated text about different types of AM technologies, their respective advantages, shortcomings and potential applications. 3D Printing and Additive Manufacturing: Principles and Applications is a comprehensive textbook that takes readers inside the world of additive manufacturing. This book introduces the different types of AM technologies, categorised by liquid, solid and powder-based AM systems, the common standards, the trends in the field and many more. Easy to understand, this book is a good introduction to anyone interested in obtaining a better understanding of AM. For people working in the industry, this book will provide information on new methods and practices, as well as recent research and development in the field. For professional readers, this book provides a comprehensive guide to distinguish between the different technologies, and will help them make better decisions regarding which technology they should use. For the general public, this book sheds some light on the fast-moving AM field. In this edition, new AM standards (e.g. Standard of Terminology and Classification of AM systems) and format standards will be included. Furthermore, the listing of new machines and systems, materials, and software; as well as new case studies and applications in industries that have recently adopted AM (such as the Marine and Offshore industry) have also been incorporated. This book consists of papers presented at Automation 2018, an international conference held in Warsaw from March 21 to 23, 2018. It discusses the radical technological changes occurring due to the INDUSTRY 4.0, with a focus on offering a better understanding of the Fourth Industrial Revolution. Each chapter presents a detailed analysis of interdisciplinary knowledge, numerical modeling and simulation as well as the application of cyber-physical systems, where

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information technology and physical devices create synergic systems leading to unprecedented efficiency. The theoretical results, practical solutions and guidelines presented are valuable for both researchers working in the area of engineering sciences and practitioners looking for solutions to industrial problems.

This book is a printed edition of the Special Issue "Additive Manufacturing Technologies and Applications" that was published in *Technologies*

This book presents selected papers from the 1st International Conference on Industry 4.0 and Advanced Manufacturing held at the Indian Institute of Science, Bangalore and includes deliberations from stakeholders in manufacturing and Industry 4.0 on the nature, needs, challenges, opportunities, problems, and solutions in these transformational areas. Special emphasis is placed on exploring avenues for creating a vision of, and enablers for, sustainable, affordable, and human-centric Industry 4.0. The book showcases cutting edge practice, research, and educational innovation in this crucial and rapidly evolving area. This book will be useful to researchers in academia and industry, and will also be useful to policymakers involved in creating ecosystems for implementation of Industry 4.0.

3D printing (or, more correctly, additive manufacturing) is the general term for those software-driven technologies that create physical objects by successive layering of materials. Due to recent advances in the quality of objects produced and to lower processing costs, the increasing dispersion and availability of these technologies have major implications not only for manufacturers and distributors but also for users and consumers, raising unprecedented challenges for intellectual property protection and enforcement. This is the first and only book to discuss 3D printing technology from a multidisciplinary perspective that encompasses law,

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economics, engineering, technology, and policy. Originating in a collaborative study spearheaded by the Hanken School of Economics, the Aalto University and the University of Helsinki in Finland and engaging an international consortium of legal, design and production engineering experts, with substantial contributions from industrial partners, the book fully exposes and examines the fundamental questions related to the nexus of intellectual property law, emerging technologies, 3D printing, business innovation, and policy issues. Twenty-five legal, technical, and business experts contribute sixteen peer-reviewed chapters, each focusing on a specific area, that collectively evaluate the tensions created by 3D printing technology in the context of the global economy. The topics covered include: • current and future business models for 3D printing applications; • intellectual property rights in 3D printing; • essential patents and technical standards in additive manufacturing; • patent and bioprinting; • private use and 3D printing; • copyright licences on the user-generated content (UGC) in 3D printing; • copyright implications of 3D scanning; and • non-traditional trademark infringement in the 3D printing context. Specific industrial applications – including aeronautics, automotive industries, construction equipment, toy and jewellery making, medical devices, tissue engineering, and regenerative medicine – are all touched upon in the course of analyses. In a legal context, the central focus is on the technology's implications for US and European intellectual property law, anchored in a comparison of relevant laws and cases in several legal systems. This work is a matchless resource for patent, copyright, and trademark attorneys and other corporate counsel, innovation economists, industrial designers and engineers, and academics and policymakers concerned with this complex topic.

Additive Manufacturing for the Aerospace Industry explores the design, processing, metallurgy

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and applications of additive manufacturing (AM) within the aerospace industry. The book's editors have assembled an international team of experts who discuss recent developments and the future prospects of additive manufacturing. The work includes a review of the advantages of AM over conventionally subtractive fabrication, including cost considerations. Microstructures and mechanical properties are also presented, along with examples of components fabricated by AM. Readers will find information on a broad range of materials and processes used in additive manufacturing. It is ideal reading for those in academia, government labs, component fabricators, and research institutes, but will also appeal to all sectors of the aerospace industry. Provides information on a broad range of materials and processes used in additive manufacturing Presents recent developments in the design and applications of additive manufacturing specific to the aerospace industry Covers a wide array of materials for use in the additive manufacturing of aerospace parts Discusses current standards in the area of aerospace AM parts

Laser Additive Manufacturing: Materials, Design, Technologies, and Applications provides the latest information on this highly efficient method of layer-based manufacturing using metals, plastics, or composite materials. The technology is particularly suitable for the production of complex components with high precision for a range of industries, including aerospace, automotive, and medical engineering. This book provides a comprehensive review of the technology and its range of applications. Part One looks at materials suitable for laser AM processes, with Part Two discussing design strategies for AM. Parts Three and Four review the most widely-used AM technique, powder bed fusion (PBF) and discuss other AM techniques, such as directed energy deposition, sheet lamination, jetting techniques, extrusion

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techniques, and vat photopolymerization. The final section explores the range of applications of laser AM. Provides a comprehensive one-volume overview of advances in laser additive manufacturing Presents detailed coverage of the latest techniques used for laser additive manufacturing Reviews both established and emerging areas of application

This book derives from the Special Issue of the Manufacturing Engineering Society 2019 (SIMES-2019) that has been launched as a joint issue of the journals Materials and Applied Sciences. The 29 contributions published in this Special Issue of Materials present cutting-edge advances in the field of manufacturing engineering focusing on additive manufacturing and 3D printing; advances and innovations in manufacturing processes; sustainable and green manufacturing; manufacturing of new materials; metrology and quality in manufacturing; industry 4.0; design, modeling, and simulation in manufacturing engineering; and manufacturing engineering and society. Among them, the topic "Additive Manufacturing and 3D Printing" has attracted a large number of contributions in this journal due to its widespread popularity and potential.

Manufacturing Techniques for Materials: Engineering and Engineered provides a cohesive and comprehensive overview of the following: (i) prevailing and emerging trends, (ii) emerging developments and related technology, and (iii) potential for the commercialization of techniques specific to manufacturing of materials. The first half of the book provides the interested reader with detailed chapters specific to the manufacturing of emerging materials, such as additive manufacturing, with a valued emphasis on the science, technology, and potentially viable practices specific to the

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manufacturing technique used. This section also attempts to discuss in a lucid and easily understandable manner the specific advantages and limitations of each technique and goes on to highlight all of the potentially viable and emerging technological applications. The second half of this archival volume focuses on a wide spectrum of conventional techniques currently available and being used in the manufacturing of both materials and resultant products. *Manufacturing Techniques for Materials* is an invaluable tool for a cross-section of readers including engineers, researchers, technologists, students at both the graduate level and undergraduate level, and even entrepreneurs.

These proceedings exchange ideas and knowledge among engineers, designers and managers on how to support real-world value chains by developing additive manufactured series products. The papers from the conference show a holistic, multidisciplinary view.

*Metallic Biomaterials Processing and Medical Device Manufacturing* details the principles and practices of the technologies used in biomaterials processing and medical device manufacturing. The book reviews the main categories of metallic biomaterials and the essential considerations in design and manufacturing of medical devices. It bridges the gap between the designing of biomaterials and manufacturing of medical devices including requirements and standards. Main themes of the book include, manufacturing, coatings and surface modifications of medical devices, metallic

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biomaterials and their mechanical behaviour, degradation, testing and characterization, and quality controls, standards and FDA regulations of medical devices. The leading experts in the field discuss the requirements, challenges, recent progresses and future research directions in the processing of materials and manufacturing of medical devices. *Metallic Biomaterials Processing and Medical Device Manufacturing* is ideal for those working in the disciplines of materials science, manufacturing, biomedical engineering, and mechanical engineering. Reviews key topics of biomaterials processing for medical device applications including metallic biomaterials and their mechanical behavior, degradation, testing and characterization *Bridges the gap between biomaterials design and medical device manufacturing* Discusses the quality controls, standards, and FDA requirements for biomaterials and medical devices *World Economic Forum Founder and Executive Chairman Klaus Schwab offers a practical companion and field guide to his previous book, The Fourth Industrial Revolution. Today, technology is changing everything--how we relate to one another, the way we work, how our economies and governments function, and even what it means to be human. One need not look hard to see how the incredible advances in artificial intelligence, cryptocurrencies, biotechnologies, and the internet of things are transforming society in unprecedented ways. But the Fourth Industrial Revolution is just beginning, says Schwab. And at a time of such tremendous uncertainty and such rapid change, he argues it's our actions as individuals and leaders that will determine the*

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trajectory our future will take. We all have a responsibility - as citizens, businesses, and institutions - to work with the current of progress, not against it, to build a future that is ethical, inclusive, sustainable and prosperous. Drawing on contributions from 200 top experts in fields ranging from machine learning to geoenvironment to nanotechnology, to data ethics, Schwab equips readers with the practical tools to leverage the technologies of the future to leave the world better, safer, and more resilient than we found it.

Volume 10 in the Handbook of Green Chemistry series provides useful and practical tools, databases, and laboratory approaches to support chemists working in both academia and industry in achieving their green chemistry goals. Among many other helpful techniques covered, the authors offer prediction software, life cycle assessment methodology, and screening tools.

Standards, Quality Control and Measurement Sciences in 3D Printing and Additive Manufacturing addresses the critical elements of the standards and measurement sciences in 3D printing to help readers design and create safe, reliable products of high quality. With 3D printing revolutionizing the process of manufacturing in a wide range of products, the book takes key features into account, such as design and fabrication and the current state and future potentials and opportunities in the field. In addition, the book provides an in-depth analysis on the importance of standards and measurement sciences. With self-test exercises at the end of each chapter, readers can improve their

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ability to take up challenges and become proficient in a number of topics related to 3D printing, including software usage, materials specification and benchmarking. Helps the reader understand the quality framework tailored for 3D printing processes Explains data format and process control in 3D printing Provides an overview of different materials and characterization methods Covers benchmarking and metrology for 3D printing

Due to legal and consumer demands, eco-friendly resources that comply with environmental concerns while maintaining or improving performance are highly sought amongst manufacturers. Green materials are a specific material that are widely found in many product markets and are popular choices as alternative materials due to their recyclable, reusable, highly available, and corrosion-resistant features. These materials positively impact the environment through fewer emissions during the production process, positive carbon credits and energy recovery from incineration, and lower global warming effect. Extensive research is required to understand the full potential of these eco-friendly substances. Implementation and Evaluation of Green Materials in Technology Development: Emerging Research and Opportunities provides emerging research exploring the theoretical and practical aspects of environmentally friendly resources and applications within technology. Featuring coverage on a broad range of topics such as life cycle analysis, nanomaterials, and environment management, this book is ideally designed for manufacturers, engineers, product developers, industrial

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practitioners, policymakers, researchers, academicians, students, and business and marketing associates seeking current research on the advancements and applications of green materials in future technology.

**Additive Manufacturing: Materials, Processes, Quantifications and Applications** is designed to explain the engineering aspects and physical principles of available AM technologies and their most relevant applications. It begins with a review of the recent developments in this technology and then progresses to a discussion of the criteria needed to successfully select an AM technology for the embodiment of a particular design, discussing material compatibility, interfaces issues and strength requirements. The book concludes with a review of the applications in various industries, including bio, energy, aerospace and electronics. This book will be a must read for those interested in a practical, comprehensive introduction to additive manufacturing, an area with tremendous potential for producing high-value, complex, individually customized parts. As 3D printing technology advances, both in hardware and software, together with reduced materials cost and complexity of creating 3D printed items, these applications are quickly expanding into the mass market. Includes a discussion of the historical development and physical principles of current AM technologies. Exposes readers to the engineering principles for evaluating and quantifying AM

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technologies Explores the uses of Additive Manufacturing in various industries, most notably aerospace, medical, energy and electronics

This book describes recent research findings on response and integrity of thick section composite and sandwich structures. In particular, it deals with these structures for marine applications under static and dynamic loads such as shock and slamming loads in severe sea environment including sea water, temperature extremes, hydrostatic pressure and Arctic conditions. Three-dimensional constitutive equations and failure criteria for structural response and integrity are considered. The book serves as an excellent repository of major advances in research on response and integrity of composite and sandwich structures made through research grants sponsored by the U.S. Office of Naval Research in the past decade. Collects major advances in response and integrity research; Emphasizes phenomena within severe environments; Illustrates underwater fluid-structure interactions, shock/blast loads, and slamming loads.

As the global 'data revolution' accelerates, how can the data rights and interests of indigenous peoples be secured? Premised on the United Nations Declaration on the Rights of Indigenous Peoples, this book argues that indigenous peoples have inherent and inalienable rights relating to the collection, ownership and application of data about them, and about their lifeways and territories. As the

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first book to focus on indigenous data sovereignty, it asks: what does data sovereignty mean for indigenous peoples, and how is it being used in their pursuit of self-determination? The varied group of mostly indigenous contributors theorise and conceptualise this fast-emerging field and present case studies that illustrate the challenges and opportunities involved. These range from indigenous communities grappling with issues of identity, governance and development, to national governments and NGOs seeking to formulate a response to indigenous demands for data ownership. While the book is focused on the CANZUS states of Canada, Australia, Aotearoa/New Zealand and the United States, much of the content and discussion will be of interest and practical value to a broader global audience. 'A debate-shaping book ... it speaks to a fast-emerging field; it has a lot of important things to say; and the timing is right.' — Stephen Cornell, Professor of Sociology and Faculty Chair of the Native Nations Institute, University of Arizona 'The effort ... in this book to theorise and conceptualise data sovereignty and its links to the realisation of the rights of indigenous peoples is pioneering and laudable.' — Victoria Tauli-Corpuz, UN Special Rapporteur on the Rights of Indigenous Peoples, Baguio City, Philippines

Safety of Sea Transportation is the second of two Conference Proceedings of TransNav 2017, June 21-23 in Gdynia, Poland. Safety of Sea Transportation will

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focus on the following themes: Sustainability, intermodal and multimodal transportation Safety and hydrodynamic study of hydrotechnical structures Bunkering and fuel consumption Gases emission, water pollution and environmental protection Occupational accidents Supply chain of blocks and spare parts Electrotechnical problems Ships stability and loading strength Cargo loading and port operations Maritime Education and Training (MET) Human factor, crew manning and seafarers problems Economic analysis Mathematical models, methods and algorithms Fishery Legal aspects Aviation

This book presents a selection of papers on advanced technologies for 3D printing and additive manufacturing, and demonstrates how these technologies have changed the face of direct, digital technologies for the rapid production of models, prototypes and patterns. Because of their wide range of applications, 3D printing and additive manufacturing technologies have sparked a powerful new industrial revolution in the field of manufacturing. The evolution of 3D printing and additive manufacturing technologies has changed design, engineering and manufacturing processes across such diverse industries as consumer products, aerospace, medical devices and automotive engineering. This book will help designers, R&D personnel, and practicing engineers grasp the latest developments in the field of 3D Printing and Additive Manufacturing.

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The fully revamped and re-titled OECD Science, Technology and Innovation Outlook is a biennial publication that aims to inform policy makers and analysts on recent and future changes in global science, technology and innovation (STI) patterns and their potential implications.

This book is a printed edition of the Special Issue "Novel Biocomposite Engineering and Bio-Applications" that was published in Bioengineering. This book provides an overview of training and teaching methods, as well as education strategies, for Additive Manufacturing (AM) and its application in different business sectors. It presents real-world applications and case studies to demonstrate the key practical and theoretical fundamentals of AM training, written by international experts from the field. Additive Manufacturing is a rapidly developing technology, and having a well-trained workforce is essential. Accordingly, readers are introduced to new training approaches and recent breakthroughs that can facilitate and accelerate the design, application and implementation of AM. The book's contributors discuss many topics to provide readers a fundamental grasp of AM, including: - collaboration among educational bodies, and between industry and governments; - strategies for implementing AM training; - new teaching methods; - training programs that provide alternative employment choices; - the need for certification by professional bodies; and - promoting awareness of AM in society. This book offers an excellent source of information for researchers and industrial engineers who are interested in expanding their AM expertise, and learning how to implement it. It will also be of interest to readers who want to learn about the practicalities of adopting training and teaching for AM.

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Although 3D printing technologies are still a rarity in many classrooms and other educational settings, their far-reaching applications across a wide range of subjects make them a desirable instructional aid. Effective implementation of these technologies can engage learners through project-based learning and exploration of objects. *Interdisciplinary and International Perspectives on 3D Printing in Education* is a collection of advanced research that facilitates discussions on interdisciplinary fields and international perspectives, from kindergarten to higher education, to inform the uses of 3D printing in education from diverse and broad perspectives. Covering topics such as computer-aided software, learning theories, and educational policy, this book is ideally designed for educators, practitioners, instructional designers, and researchers.

The *Information Economy Report 2017* analyzes the evolving digital economy and its implications for trade and development. While these are still early days of the digital economy, it is already clear that it will have globally transformative impacts on the way we live, work and develop our economies. As the world strives to implement the 2030 Agenda for Sustainable Development, harnessing the power of information and communications technologies (ICTs) is essential. Large parts of the developing world remain disconnected from the Internet, and many people lack access to high-speed broadband connectivity. Policymaking at the national and international levels needs to mitigate the risk that digitalization could widen existing divides and create new gaps. Since increased reliance on digital technologies, such as cloud computing, three-dimensional printing, big data and “the Internet of things”, it is essential to start assessing opportunities and pitfalls alike, and to prepare for what is coming. The analysis contained in the report contributes to this process and proposes ways in which the international

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community can reduce inequality, enable the benefits of digitalization to reach all people and ensure that no one is left behind by the evolving digital economy.

This book provides details on the innovations made to achieve sustainability in manufacturing. It highlights the trends of current progress in research and development being done to achieve overall sustainability in manufacturing technology. Green-EDM, Hybrid machining, MQL assisted machining, sustainable casting, welding, finishing and casting, energy- and resource-efficient manufacturing are some of the important topics discussed in this book.

Advances in Manufacturing and Processing of Materials and Structures cover the latest advances in materials and structures in manufacturing and processing including additive and subtractive processes. It's intended to provide a compiled resource that reviews details of the advances that have been made in recent years in manufacturing and processing of materials and structures. A key development incorporated within this book is 3D printing, which is being used to produce complex parts including composites with odd shape fibers, as well as tissue and body organs. This book has been tailored for engineers, scientists and practitioners in different fields such as aerospace, mechanical engineering, materials science and biomedicine. Biomimetic principles have also been integrated. Features Provides the latest state-of-the art on different manufacturing processes, including a biomimetics viewpoint Offers broad coverage of advances in materials and manufacturing Written by chapter authors who are world-class researchers in their respective fields Provides in-depth presentation of the latest 3D and 4D technologies related to various manufacturing disciplines Provides substantial references in each chapter to enhance further study

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