



EMERALD POINTS

AUGMENTING HUMANITY

Industry 5.0 and the Rise of
Human-Machine Collaboration

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AUGMENTING HUMANITY: INDUSTRY 5.0 AND THE RISE OF HUMAN-MACHINE COLLABORATION

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INVESTOR IN PEOPLE

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FOREWORD



Dr Yogesh K. Dwivedi, Professor,
Department of Information Systems & Operations
Management, KFUPM Business School,
King Fahd University of Petroleum & Minerals,
Dhahran, Saudi Arabia; Honorary Professor,
School of Management, Swansea University, UK

This book, *Augmenting Humanity: The Rise of Human–Machine Collaboration in Industry 5.0*, explores the transformative potential of the next stage in industrial evolution. It shifts the narrative from a vision of a cold, automated future to one of a dynamic partnership between humans and machines, where previously unimaginable possibilities become achievable.

Industry 5.0 marks a departure from traditional notions of automation by placing humans at the center of technological innovation. This new paradigm seeks not only to enhance efficiency but also to create meaningful and fulfilling work environments. Its focus extends beyond operational gains to tackling the planet’s most pressing challenges, such as respecting environmental limits and advancing technology within sustainable boundaries.

Authored by Jamshed Khalid and a team of accomplished scholars, the book thoroughly analyzes the historical trajectory of industrial revolutions that culminated in the emergence of Industry 5.0. Through an accessible yet

comprehensive examination of enabling technologies such as artificial intelligence, robotics, and the Internet of Things (IoT), it offers readers a clear understanding of the forces shaping this transformative era.

Beyond technical analysis, the book addresses the broader societal implications of Industry 5.0, including its impact on employment, privacy, and the equitable distribution of benefits. The authors propose actionable strategies to navigate these challenges, emphasizing the importance of trust, understanding, and the synergy between humans and machines.

The practical applications of Industry 5.0 are illustrated through real-world case studies from the Asia-Pacific region. These examples demonstrate how innovative industrial practices are already addressing global challenges by aligning technological advancements with human-centered values, yielding tangible benefits in the process.

Augmenting Humanity concludes not merely as a thoughtful exploration of Industry 5.0 but as an inspiring call to action. It offers answers to critical questions and provides strategic insights for harnessing the power of human-machine collaboration to create a more equitable, sustainable, and resilient future.

Sincerely,
Yogesh K. Dwivedi

PREFACE



Prof Dr Noor Hazlina Ahmad, Dean,
School of Management, Universiti Sains Malaysia,
Penang, Malaysia

We stand on the brink of an extraordinary transformation – an era when the boundaries between human ingenuity and artificial intelligence blur, forging a partnership that redefines what is possible. Industry 5.0 is not just a continuation of industrial evolution; it is a bold leap into a future where machines enhance human creativity, resilience, and purpose.

Augmenting Humanity: Industry 5.0 and the Rise of Human–Machine Collaboration invites you to explore this compelling frontier. This book is about more than technology – it’s about reimagining the role of humans in a world powered by AI, robotics, and intelligent systems. It challenges us to ask: How do we create industries that perform better and care for people and the planet? How can we ensure that technology amplifies humanity rather than replaces it?

This isn’t just a guide to Industry 5.0; it’s a roadmap for a smarter, more inclusive, and more sustainable future. Through real-world case studies, groundbreaking research, and expert insights, we delve into the promises and perils of this era. This book enlightens how AI can complement human

intuition, how robotics can enhance human capabilities, and how ethical design can build trust in a machine-driven world.

I would say this is the story of humanity and technology joining forces – not to compete but to collaborate, innovate, and thrive. Welcome to Industry 5.0.

A HEARTFELT TRIBUTE

We extend our deepest gratitude to the esteemed contributors whose collective brilliance and dedication have brought this scholarly endeavor to fruition. Each of you has enriched this work with unique insights, perspectives, and a passion for knowledge that has shaped the final product in profound ways. Your unwavering commitment, timely contributions, and insightful feedback have been instrumental in crafting a publication that we hope will inspire and inform.

We are also indebted to the dedicated team at Emerald Publishing, whose expertise and unwavering support have been invaluable throughout the development of this work. The insightful feedback and guidance the editors and reviewers provided have significantly enhanced our research's quality and clarity. A heartfelt acknowledgment goes to Aimee Wright, Charlotte Maiorana, and the many others who have generously offered their time, expertise, and assistance. Their unwavering support has been a source of inspiration and motivation throughout this project.

We would also like to express our sincere gratitude to our colleagues, friends, and family members whose encouragement, support, and unwavering belief in our endeavors have been a constant source of strength.

Jamshed Khalid extends special thanks to his beloved wife and three cherished children, Ishaal, Maaz, and Aariz. Their unwavering love, support, and inspiration have been the driving force behind his academic pursuits.

Finally, we would like to express our sincere gratitude to our readers. We hope that this work will catalyze further exploration, spark meaningful discussions, and contribute to the advancement of research management and administration.

Thank you to all who have contributed to this project. Your dedication, passion, and expertise have made this publication possible. We are honored to have worked with such a talented and committed group of individuals.

DECLARATION

“During the preparation of this work the author(s) used ChatGPT and Grammarly to improve the language and readability. After using these tools, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.”

INTRODUCTION AND STRUCTURE

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1. INTRODUCTION

1.1 Executive Summary

Industry 5.0 emerges as a beacon of transformative potential in the ever-evolving landscape of human–machine interaction. This paradigm shift, characterized by its emphasis on human-centricity, sustainability, and resilience, marks a significant departure from previous industrial revolutions (Lu et al., 2022; Rožanec et al., 2023). By understanding the core elements and guiding principles of Industry 5.0, we can gain valuable insights into the future of work, technology, and society.

This book dives deeper into the multifaceted world of Industry 5.0, exploring its historical context, defining its key characteristics, and examining its implications for various industries and stakeholders. Through a comprehensive analysis of case studies, theoretical frameworks, and expert insights, we aim to provide a nuanced understanding of the opportunities and challenges associated with this emerging era. Central to Industry 5.0 is the concept of human-centricity. This paradigm shift seeks to create a more equitable, inclusive, and fulfilling work environment by placing humans at the forefront of the industrial process. Sustainability is another core value of Industry 5.0 as it emphasizes the importance of environmental responsibility and resource conservation. Resilience, too, is a critical component, enabling organizations to adapt to change and disruptions in an increasingly volatile and uncertain world.

The book explores the technologies driving Industry 5.0, such as artificial intelligence, robotics, and the Internet of Things. It examines the ethical considerations and societal implications of this paradigm shift, including job displacement, privacy concerns, and equity. Additionally, the book offers strategies for fostering effective human–machine collaboration and navigating

the challenges associated with this emerging era. By providing a comprehensive overview of Industry 5.0, this book aims to empower readers to understand and engage with this transformative shift. It offers valuable insights for businesses, policymakers, and individuals seeking to navigate the complexities of the modern industrial landscape and shape a more sustainable and equitable future. The book finishes with reflection and concluding thoughts, and some future outlooks.

2. STRUCTURE OF THE BOOK

This scholarly treatise is meticulously structured to provide a comprehensive exploration of the transformative landscape of Industry 5.0 and the symbiotic relationship between humans and machines. The book is divided into three distinct sections, each delving into a critical facet of this emerging paradigm.

Section I, titled “Foundations of Industry 5.0 and Human-Machine Collaboration,” lays the groundwork for understanding the historical context, key principles, and technological drivers of this revolutionary era. Chapter 1 traces the evolution of Industry 5.0, contextualizing its emergence within the broader tapestry of industrial revolutions. Chapter 2 explores the technological arsenal that empowers human-machine collaboration, examining the transformative potential of artificial intelligence, robotics, augmented reality, and the Internet of Things. Finally, Chapter 3 presents a series of case studies from the Asian Pacific region, showcasing the tangible applications and benefits of human-machine collaboration across diverse industries.

Section II, “Navigating the Impacts and Challenges,” shifts the focus to the ethical, societal, and strategic considerations that accompany the advent of Industry 5.0. Chapter 4 explores the complex ethical and societal implications of human-machine collaboration, examining issues such as job displacement, privacy concerns, and equity. Chapter 5 delves into strategies for effective collaboration, offering insights into fostering trust, building shared understanding, and maximizing the benefits of human-machine partnerships.

Section III, “Reflection and Concluding Thoughts,” provides a thought-provoking synthesis of the key themes explored throughout the book. This section offers a visionary perspective on the future of Industry 5.0, emphasizing the need to embrace human-machine collaboration as a catalyst for innovation, sustainability, and human flourishing.

2.1 Practicalities of the Book

This scholarly work is not merely a theoretical exploration but a practical guide for navigating the complexities of Industry 5.0. By providing a comprehensive overview of the key principles, technologies, and challenges associated with this paradigm shift, the book equips readers with the knowledge and tools necessary to implement human–machine collaboration in their organizations. Through carefully curated case studies and expert insights, the book offers actionable strategies for fostering effective partnerships, addressing ethical concerns, and maximizing the benefits of this emerging era. Whether you are a business leader, policymaker, or technology enthusiast, this publication serves as an invaluable resource for understanding and shaping the future of work and society.

Acknowledgments

The Editors would like to thank each and every one of the authors who contributed to this project.

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Section I

FOUNDATIONS OF INDUSTRY 5.0 AND HUMAN-MACHINE COLLABORATION

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THE EVOLUTION OF INDUSTRY 5.0 AND HUMAN-MACHINE COLLABORATION

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ABSTRACT

This chapter offers a comprehensive exploration of Industry 5.0, a transformative paradigm that prioritizes human-centricity, sustainability, and resilience. By tracing the historical evolution of Industrial Revolutions (IRs), from mechanization to digitalization, this chapter establishes the contextual foundation for this new era. Industry 5.0 is characterized by a profound shift toward human-machine collaboration (HMC), leveraging technological advancements to augment human capabilities and foster innovation. The core principles and features of Industry 5.0 highlight its capacity to drive sustainable development, social equity, and economic prosperity. A detailed analysis of key players in HMC and a regional perspective on Industry 5.0 is also provided, offering valuable insights into the global landscape of this emerging IR.

Keywords: Industry 5.0; Industrial Revolution; human-machine collaboration (HMC); human-machine interaction; human-centered design

1. INTRODUCTION

What lies beyond the automation age? Is it a future where humans and machines collaborate seamlessly or a dystopian reality where technology eclipses human potential? This is an acute question in today's dynamic and automotive world. It

is no more uncertain that the future of work is no longer a solitary journey but a collaborative odyssey between humans and machines. We are currently in the age of automation, an age that is giving way to an era of augmentation, where technology empowers human potential (Guzman, 2018; Hoc, 2000). From the steam engine to Artificial Intelligence (AI), humanity has always been driven by the relentless pursuit of innovation. Industry 5.0, the next stage in this ongoing evolution, holds the potential for the most significant transformation we have witnessed (Yin et al., 2021). Industry 5.0 is not merely a technological advancement; it's a cultural and societal shift that will redefine the very essence of human existence.

The Industrial Revolution (IR), a relentless march of progress, has fundamentally altered the way we live, work, and interact with the world. IR can be regarded as a journey. A journey through time, a tale of innovation, and a testament to human ingenuity – the IR has been a relentless force, reshaping the world at every turn (Rymarczyk, 2020). The IR was a period of major industrial and technological development that took place in Great Britain, continental Europe, North America, and eventually the rest of the world. It marked a shift from traditional agrarian and handicraft economies to new manufacturing processes.

1.1 Industrial Revolution

Too often, we trace the past, trying to pinpoint the exact beginning of something we later called revolution. Revolution is not a one-time event but rather a continuous process of evolution and improvement. It is the convergence of – or divergence of – ideas, practices, and beliefs to a focal point. That focal point is often considered the ‘match that started the fire’. The IR refers to a significant period of economic transformation characterized by the adoption of new production processes (Rymarczyk, 2020; Schwab, 2024). Before moving to the historical view of the IR, it is important to comprehend the prominent factors that triggered these revolutions.

1.1.1. Forces of IRs

IRs lifted innovations that shifted the economy from agriculture to mass industries. IRs are devoted to the combination of economic, technological, political, social, and resource-related factors. The following are the prime factors that historically played a significant role in shaping IRs.

- *Colonization*: The expansion of European powers such as the British Empire allowed access to vast natural resources in colonies. These resources were