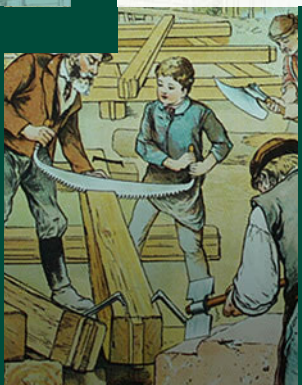
Bianca Christina Weber-Lewerenz

Accents of Added Value in Construction 4.0

Ethical Observations in Dealing with Digitization and AI



Springer

Accents of Added Value in Construction 4.0

Bianca Christina Weber-Lewerenz

Accents of Added Value in Construction 4.0

Ethical Observations in Dealing with Digitization and AI

Springer

Bianca Christina Weber-Lewerenz
Aichtal, Germany

ISBN 978-3-658-39406-6 ISBN 978-3-658-39407-3 (eBook)
https://doi.org/10.1007/978-3-658-39407-3

Translation from the German language edition: "Wertakzente im Bauwesen 4.0" by Bianca Christina Weber-Lewerenz, © Springer Fachmedien Wiesbaden 2022. Published by Springer Fachmedien Wiesbaden. All Rights Reserved.
© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Fachmedien Wiesbaden GmbH, part of Springer Nature 2022
This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Language edits by Amanda Allen

Responsible Editor: Kumm Frieder
This Springer imprint is published by the registered company Springer Fachmedien Wiesbaden GmbH, part of Springer Nature.
The registered company address is: Abraham-Lincoln-Str. 46, 65189 Wiesbaden, Germany

"Only those who think differently
change the world."

John Suttleworth

The digital world is only for the common good of all of us if we are aware of our original roots and shape the future with values.

This is why I dedicate this book to
• my four grandparents, who, despite and precisely because of their experience of war, always drove my mind to new things during their lifetime
and
• my niece Namika Hannah & my nephew Nino Ben, who continuously inspire me and are part of the generation whose environment we are shaping for them NOW.

Technology, Ethics and the Construction Industry: A Foreword

Armin Grunwald[1]

Today Technology and Ethics are often mentioned in the same breath. Hardly anyone still doubts the relevance of Ethics for Technology, nor vice versa the relevance of Technology for Ethics. Too many ethical questions have become all too obvious, whether in Biotechnology and Gene Technology, in the development and possible use of care robots, in discrimination through algorithmic decision-making systems, in Medical Technology, in the use of Artificial Intelligence, in ensuring the most sustainable possible development or in the disposal of high-level radioactive waste. So far, so good and clear. But the Construction Industry? Doesn't it mainly have to do with craftsmanship, fulfilling the client's wishes, ensuring functionality and the most auspicious cost structure? Isn't it perhaps a bit exaggerated to come up with Ethics and value references here as well? Well, it's not, on the contrary. This is exactly the reason for this book and this little foreword. The next few pages try to show why.

---

[1] *Prof. Dr. rer. nat. Armin Grunwald, Studied physics, mathematics and philosophy. Since 1999 Head of the Institute for Technology Assessment and Systems Analysis (ITAS) at the Karlsruhe Institute of Technology (KIT). Since 2002 Head of the Office for Technology Assessment at the German Bundestag (TAB). Since 2007 Professor for Technology Ethics and Technology Philosophy at the KIT. Co-Chairman of the National Monitoring Committee for Repository Search since 2020. Member of the German Ethics Council since 2021.*

The combination of Technology and Ethics is by no means self-evident. It was only a few decades ago that the thesis of the value neutrality of Technology was still being advocated —all Technology is just a tool, and therefore, irrelevant to Ethics. This only comes into play when people do something with it. Or, as the much-cited bread knife example says: neither the inventor nor the manufacturer of a bread knife is responsible for whether people use this knife to cut bread or for an assassination attempt. As understandable as this argument is, it does not fit modern Technology such as autonomously driving cars, nuclear reactors, or digitally upgraded buildings. These are not simple instruments that can be used for this or another purpose in such a way that all responsibility lies with the respective user. Inventors and manufacturers, companies and programmers, scientists and managers, regulatory authorities, and perhaps even Ethics Committees; in modern times, ethical responsibility is distributed among various actors, so that it often takes lawyers to assume responsibility and, thus, often also those involved in the event of damage to clarify associated questions of guilt or liability.

However, Technology and Ethics are by no means only connected in the event of damage. According to the observation of the German–American philosopher Hans Jonas, the great ethical challenges of modern Technology usually arise from smoothly functioning Technology. That may sound paradoxical, because Technology should function as smoothly as possible and do what is expected of it. The point is, however, that so-called unintended consequences often occur in the use of this technique. Consequences that are not desired, often not foreseen, but which are unavoidable if the Technology is used for its purpose. Climate change is a case in point. It is not the result of poorly functioning or non-functioning coal and gas-fired power plants or of failing diesel or petrol engines. On the contrary, when they work properly, carbon dioxide from fossil sources is released and contributes to the greenhouse effect. No car driver wants to influence the climate, but it still happens, mainly through the accumulation of many processes on the global level that are insignificant on their own, caused by billions of people. This thought by Hans Jonas, which can be found in his best-known book “Principle of Responsibility”, can be transferred to many

other areas. There's something tragic about him. After all, Technology is developed and implemented in order to contribute to desired goals and purposes. If it does so successfully, such unintended, often gradual and difficult-to-recognize side effects are unfortunately unavoidable in many cases. The positive cannot be harvested without accepting the negative aspects. It then only remains to develop alternative, repair, or compensation strategies for dealing with these side effects responsibly, as is the task of Technology Assessment.

While the keywords "damage" and "unintended side effects" don't sound very positive and Ethics tend to move into dealing with the negative sides of technical progress, this looks much better with the third connection between Ethics and Technology—in the design of Technology. Design needs ideas and desires, purposes, and goals. Design is fundamentally related to values. Technology design influences individual quality of life and the quality of the environment, business models and added value are created, and politics and society are enriched with new options for communal life. In short, designing Technology is shaping the future. Depending on the relevant values on which the design processes are based, the Technology and, thus, the future will develop in a different direction. This small but fundamental consideration makes the great importance of values in Technology clear—they guide the way into the future as orientation marks.

Design is probably the central task in the Construction Industry. In particular, the design of buildings for a wide variety of purposes as well as the conception and construction of infrastructures strongly predetermine future social development. Sometimes one speaks of path dependencies, because existing infrastructures can only be changed with great effort. Mobility infrastructures such as motorways or railway lines have existed for decades, maybe centuries. Their design is, therefore, faced with special challenges, not only in functional and economic terms, but also in relation to the values materialized in them. After all, they will also be used to confront future generations with their values and expectations. With regard to buildings, the Construction Industry has a great influence on people's lives, on their quality of life, but also on sustainability in building and living. Both quality of life and sustainability have a high content of value.

This way of thinking is anchored in the Construction Industry. Characteristics of building as a medium of social life, as a motor as well as a prerequisite for many social processes and changes and as an essential condition for high quality of life and work are present there, despite the diverse dominance of functionality and cost arguments. From this point of view, talking about values in the Construction Industry does not mean bringing something new into the Construction Industry from outside, convincing it or even proselytizing it, but making people aware of and strengthening what it has always done.

However, a new dimension is opening up in the face of digitization. Civil engineers and architects have been dealing with what is now called digital twins for decades, which was called *CAD (computer-aided design*). The humble beginnings in the 1980s have given way to complex software applications, which are now increasingly based on *Big Data* and *Artificial Intelligence*. While this is happening at the level of design tools, their items have also fundamentally changed. Digital building Technology, in particular for monitoring and control purposes of various functions from the optimization of the building climate to security issues, from comfort and luxury to digitally controlled material flows of building management, has become indispensable in the Construction Industry. The *Smart Home* buzzword is now out of date, and smart cities have been talked about for at least 15 years. Even if progress is slower than many visionaries expected, development continues steadily. The typical ethical questions of digitization have thus also reached the construction industry: collection and handling of data, monitoring and control, human-centred design of the interfaces between people and buildings, security and hacking, dependence on smoothly functioning IT infrastructure, broader distribution and poorer localization of responsibility, etc. This expands the value reference of the Construction Industry by a large field. It is certainly no coincidence that the currently much-discussed approach of *value-sensitive design*, with which Technology design in cooperation between engineers and Ethics should be carried out in a value-sensitive manner, was developed for the field of digital technologies.

There is a simple reasoning behind this. Technology—and digital Technology is Technology—is ultimately a means to an end, not the

end itself. The still fresh experiences from the Covid lockdowns clearly show this. Video conferences are a means to different kinds of purposes. Some fulfill them quite well, such as facilitating organizational arrangements, while others only do so poorly, such as replacing a happy and community-building holiday party. Instead of seeing digitization as the key to a heavenly future or as the gateway to the downfall of mankind, this simple consideration leads to plain thinking: it is necessary to ask what digital technologies and formats in the Construction Industry and in their products are good tools, and which ones are not, or maybe not yet. It is also necessary to ask which combinations of fundamentally analogue construction with digital Technology are promising in order to fulfill certain purposes, wishes, and requirements.

It is by no means simply a matter of Technology, but always of its relationship to people. Technology is not good or bad, rather human/technology relationships allow a good life and an appealing quality of life more or less well. Human Centering is, therefore, central to design in the Construction Industry. Humans are analogue beings and live in an analogue world, and digitization will not change that. Purposes for digital technologies should, therefore, be set in such a way that analogue life is supported and, if possible, made better. When it comes to the question of what a good life can look like in the conditions of modernity, what priorities should be set and what living environments should this be oriented towards in the future so that the corresponding quality of life can be realized for as many people as possible, the reference to values is unmistakable. The values that the Construction Industry today uses in the design of increasingly digital building worlds and infrastructures largely determine what the world of tomorrow will look like and how people will then live in it and with it. The necessary human-centredness of the Construction Industry also gets the special touch of future responsibility.

Now the Construction Industry would be overwhelmed to determine these values themselves and set appropriate purposes for the design projects. This is exactly what established formats for negotiating with clients and project developers, with authorities and municipalities are used for. The reference to values in the construction and increasingly digital worlds should also make it necessary to secure the references to values

more broadly, through participatory and inclusive processes. The Ethics of Technology may also be helpful, for example, as advice on the value references involved and their ethical background, but certainly also on the not uncommon value conflicts, such as between cost minimization and environmental compatibility or between the need for security and freedom, to name just two classic examples. It would be a service provider for information, orientation, and clarification of the relevant debates in normative terms. In no case is Technology Ethics suitable as a kind of approval authority that can issue something like ethical declarations of no objection, but it can contribute orientation and support for the actors involved to think for themselves.

Against this background, it is very meritorious that this book now exists. This book deserves an open-minded readership that will enjoy thinking further about the ideas developed here and, where possible, putting them into practice. Then the written word becomes a living design.

Karlsruhe Armin Grunwald
29th of September 2021

Foreword

The development of digital technologies and artificial intelligence (AI) raises the question of what expectations we have of them, how we humans want to design these emerging technologies, what they must be able to do, in which areas they should support us, what kind of work we do not want to transfer to machines, what kind of problems we allocate, and how we tackle them.

When science and technology such as AI meet human applications, ethical and moral questions arise. There is a tension between technical feasibility and ethical responsibility. This debate is not new. For years, experts from Medicine, Biomedicine, Healthcare and Nursing, Automotive, Ethics, Theology, and Philosophy have been analysing and evaluating the ethical aspects of the effects that technology has on people and society. The inclusion of multidisciplinary aspects and the identification of key factors enabling a sustainable implementation are essential for the success of the responsible application of these technologies. Indeed illuminating such an approach in Construction is new. Digital change requires human change. Never before has technology had such an impact on people, our society and our environment. At the same time, it represents one of the driving forces behind

the achievement of the sustainability goals of the United Nations (UN Sustainability Development Goals, SDGs). The debate in the Construction Industry helps to develop trustworthy AI, identify and enlighten potential, exchange knowledge, and to use AI responsibly and safely.

The results are conducive to the extended conduct of ethical AI debates in Construction, in particular to possible, but also necessary, ethical frameworks as we already know from other sciences. This research and book aims to shape both digital and associated human change. This contribution is in line with the implementation of the European Green Deal—following the EU initiative "The new European Bauhaus". This research follows the understanding that science, politics, and society complement each other. Expectations should not be directed at just one group, but everyone must define what they can contribute to the common good. Knowledge must be mutually shared so that values and goals, and thus, a common strategy, can be met. Because only by actively and responsibly shaping together the transformation can we ensure that the result for Construction 4.0 will be successful and sustainable.

The ethics of technology as the basis for ethical reflections in the technical sciences has a high value of practical application. Technical decision-making processes are about weighing advantages and disadvantages against each other, as well as opportunities, damage, and other influences on the common good. In order to shape a successful, sustainable digital transformation in the Construction Industry, one concrete step consists of a more efficient, economical project life cycle through the safe use of innovative digital technologies. My research critically illuminates where the sticking points are, which key factors support sustainable action with the help of digital methods and AI (see Chap. 5), and how responsible digital innovation can only be achieved with the help of a new learning and thinking culture guided by ethical principles.

Allow yourself, dear reader, to be set in motion, get inspired to change perspectives, and discover new potentials. Your courage and your will can move mountains—but most of all, let's move forward together toward digital transformation in Construction.

Digital transformation, digitization, and AI are based on data that humans select and feed—the more data, the better. AI makes software intelligent. And in Construction we have enormous amounts of data. Algorithms evaluate this data and recognize patterns and characteristics. AI is the so-called umbrella term for applications in which machines provide human-like intelligence such as learning, judgement, and problem solving. The development, application, and maintenance of such data-driven technologies—as described in the Chapter on Use Cases —require orientation to be able to take on the associated digital tasks responsibly and to weigh up decisions carefully.

Our human values and moral concepts offer the most important prerequisite and tool kit for tackling these challenges. They help answer questions e.g., if and how these technologies and methods can be reconciled with our moral ideas, what concerns do exist, and what chances and advantages of the technology should be used from an ethical point of view in the sense of social well-being. Therefore, I introduced the term "iEthics". It unifies ethical principles of CDR in the Construction Industry to achieve a meaningful and safe application of AI methods for humans.

Particularly, the Construction Industry, a branch with severe impacts on climate and on significant natural resources, needs new approaches—an industry that has lacked such consideration. It not only forms a new field of research, but closes a gap of scientific research by interdisciplinary processing and holistic analysis. The Construction Industry is considered a traditionally conservative, small-scale industry with many reservations about technical terms like digital transformation, ethics, and values. These terms are central in the ongoing scientific and professional discussions about technical innovations. Despite the fact that generally there are high ethics and values in the branch, terms such as BIM, AI, and digitization are still being interpreted very differently, sometimes misinterpreted or not understood at all. There is an urgent need for scientific communication without language barriers between sciences and society and for raising awareness.

My encounters with experts and steering groups for R&D, sustainability, and digitization, companies that play a pioneering role in the implementation of digital technologies, philosophers, theologians,

historians, and ethicists continuously proved that the main task of digital transformation consists in bringing together Construction, emerging technologies and society/people. Having collected broad practical knowledge in the national and international construction industry, people turned to me more as a bridge builder between construction, crafts, training, economy, and politics than to the now broad network of doers and visionaries for the general debate "Ethics in AI". Conversation partners focused on philosophical and ethical subjects, and I was seen as the woman who—for the first time on behalf of the Construction Industry (technology)—requested an interdisciplinary dialogue on ethics and AI to the human sciences (human beings). So far it has been the opposite, and the tendency has been, that human sciences addressed questions about people and technology was relegated to the technical discipline. AI and digitization must be explained in order to use them effectively, to recognize and use their potential, to assess the effects and interactions between humans, technology, and society, and to build trust. The will to implement constructive innovative approaches must not be hindered by a pile of voluntary commitments and guidelines but guided by ethics, accompanied especially with passionate criticism. Something new only emerges through discussion.

The rapid technological development of AI causes deep cuts. People, society, and the environment are directly affected. As THE industry with the highest economic driving force and at the same time a 40% share of global CO_2 emissions (as of 2022), the Construction Industry has to find new ways to achieve the sustainability goals. According to national accounts, construction investments amounted to around 373 billion EUR in 2019, but the gross value added in the Construction Industry only came to 171 billion EUR. Machine Learning (ML) is said to have an estimated value creation potential of 5.8 trillion US$. This means that AI has greater potential than the steam engine. According to forecasts, the market for AI in Construction will have a share of around 3.7 billion EUR by 2026. The time is overdue for the Construction Industry to discover opportunities, use opportunities to shape digital transformation, and set up innovative business models in order to benefit as a highly competitive partner. Success depends solely on the fact that potential is recognized and used, risks

are defined, consequences are assessed, and technologies are developed and applied responsibly—not exclusively with a view to maximizing profits. Digital technologies and AI support people with consistently structured, safe and efficient working environments. Only if people realize the advantages and opportunities and are also able to assess the fields of application and its effects, will they gain confidence in these technologies. Morals and values serve as a guide.

It is important to keep in mind that the human being has to be in the center of all technical and technological developments (such as AI), as humans set the direction of technological development and its practical application. The interdisciplinary cooperation is essential for the holistic assessment of human–technic interaction. It is the lively dialogue that enriches the industry.

Therefore: Enlightenment on all channels! Dedication to the topic with heart and passion, linguistic understanding and making things stronger together with fellow campaigners and doers.

I have been involved with ethics in Construction since my training as the first female bricklayer in Baden-Württemberg. Studies and years abroad reinforced the process towards a deeper research. Because emerging technologies with all its challenges increased rapidly, I have been researching CDR in Construction since 2019. The research question *"Where is Corporate Digital Responsibility (CDR) to be assigned and how shall an adequate ethical framework be designed to support digital innovations in order to fully exploit the potential of digitization and AI?"* embedded the field of digital transformation in construction into the concrete context of research. The findings not only contribute to the scientific discourse but aim to set new signals; this area of research does not sit in the ivory tower of the ethical discipline, but is much more practical and geared to the pulse of the times. Inspired by the advocates of this new scientific field of research, I founded the *Excellence Initiative for sustainable, human-led AI in Construction* in 2020.

Though new research findings enlarge the state of knowledge, a number of questions remain unanswered or they remain as conjectures with a high degree of probability, since they could only be resolved by continuing more in-depth investigations.

So far there is no comparable literature in the Construction Industry. Hence, this specific scientific research applied primary studies, as well as literature and expertise referring to AI in Construction in generally and from other disciplines. Personal interviews with experts provided deep insights into the first stage of development. When I first approached digital methods and AI, first-hand insights opened up through the experiences shared by developers, researchers, users, and designers working in various domains of digital transformation. The evaluation of this applied qualitative research methodology was carried out according to Mayring.

The brief introduction to the evolution of ethics serves to derive terminology and philosophical origins, naming the leading researchers, thinkers, visionaries, and their impulses. After introductory words, a short historical outline offers more depth and understanding of the background and discussion of human–technology interaction—especially for newcomers. There are initiatives and approaches to "Ethics in AI" at the German level (e.g. German Federal Government, German Ethics Council, German Ethics Commission), the European level (e.g. European Union and European Commission) and the international level (e.g. UN United Nations with defined sustainability goals, Catholic Church). They are important sources of inspiration for relevant considerations and potential steps of action that can be transferred to the field of Construction and Architecture.

Examples from research and user practice share new knowledge and experience. Approaches and findings from other disciplines enable the holistic view. This is an essential part of dealing with digital and AI developments in the sense of the common good. The interviews with experts are captured in case studies and provide valuable insights behind the scenes of user practice. Additionally, my research, performed since 2019, reveals tendencies for further developments and also deals critically with the dark side. Constructive, practice-oriented approaches for dealing with new technologies can be deduced. This book summarizes the quintessence. The range of topics closes with current book reviews, which invite further discussions and reflections.

The road was and is rocky. Thoughts about the integration of ethics, values, morals, and AI in the discipline of construction often meet with

reservations and rejection. Nevertheless, embedding such considerations into scientific research and practical application—with the help of the interdisciplinary expertise of philosophers, theologians, technology ethicists, IT, economics, political, legal, and social scientists—is progressive and serves sustainability along the entire value chain. When I took the first steps to embed interdisciplinary aspects of technical innovations, that go beyond technology, or illuminated them by questioning the construction branch critically as it comes to face our responsibility in the design of digitization and AI, I still come across individuals, institutions, and representatives holding others responsible.

Motivation enough to me as a Civil Engineer, to follow this special incentive and to get to the bottom of the subject. But what is the saying in the typical Rhineland cheerfulness? "Nix bliev, wie et wor." Nothing stays the way it is. Be open to innovations (Article 5, The Rhenish Basic Law. German: Et rheinisch Jrundjesetz). And Article 6 critically adds: "Kenne mer nit, bruche mer nit, fott domet." If we don't know, we don't need it, away with it. In a figurative sense, this does not mean to get rid of the technologies, but be critical when innovations get the upper hand and question them. This is the only way to shape good things and in a responsible way, because Article 8 applies: "Maach et joot, ävver nit zo off." Don't do it too often, because quality overrides quantity.

In short, my ethical approach in the Construction Industry is based on the fact that ethical principles are fundamentally developed neutrally and free of company names, i.e. without specifications from companies exclusively following the idea of neutrality and independence.

Civil Engineer through and through, enthusiastic about art and passionate about the piano, I have been working on this book since 2019. I am passionate about the lively discussion of the sustainability goals of the UN, the European Bauhaus, digital strategies and modern ethics along with my research on how best constructive solutions can be achieved in Construction and to the common good. The development and use of a trustworthy, sensibly used AI offer reliable support for humans.

What drives me: impatience. Freedom in mind. Burning for the topic. Staying on the ball even in the face of resistance. Added to this,

my passion for the craft, the people who work in this unique branch and curiosity about new technologies and all that is technically feasible.

Profound changes in the digital and human transformation can only shaped by us together, with adequate education, attention, and with foresight. Technological innovations come with high speed; humans, society, and environment can hardly keep up—though there are still unused potentials.

Whether large companies, medium-sized or small construction companies, start-ups, service providers or research and development, Construction 4.0 offers—regardless of company size and field of working focus—significant potential to innovate and create value, to increase attractiveness as an employer, to strengthen one's own competitiveness and the unique selling proposition.

This highly complex change due to data-driven technological advances is taking place around the globe. We humans have this high responsibility to perform technical progress driven by morality and values and with a well-balanced human–technic interaction, so that we can live and work together in a world that is more human, healthier, and more social for all of us. The publication of this English version comes with the German one. It not only facilitates worldwide access to this exciting topic that is on everyone's lips as well as in sciences communities and in all areas of life. Most of this entire book ensures access to references from these primary studies for further processing of this new field of research.

You, dear reader, will find out for yourself. Either you will see some reflections just as critical, or you will discover new opportunities, or make your constructive contribution in some other way. Or you are one of the experts sharing your highly appreciated experiences and perspectives. You have deliberately contributed to triggering eye-opening effects and raising awareness, strengthening the will to innovate and giving a strong push forward. You are a credible source of inspiration for the readers.

As my motivation and passion burn for deepening this research, your benefit from further gains does not stop.

Inspiration is provided by a foreword and a guest contribution by outstanding researchers, visionaries who act as driving forces around the globe. Prof. Dr. Armin Grunwald is a philosopher and technology ethicist, since 1999 he is the Head of the Institute for Technology

Assessment and Systems Analysis (ITAS) at the Karlsruhe Institute of Technology (KIT), since 2002 he is the Head of the Office for Technology Assessment at the German Bundestag (TAB) and since 2007, a Professor of Technology Ethics and Technology Philosophy at KIT. Since 2020 he has been co-chair of the National Monitoring Committee for Repository Search and has been a member of the German Ethics Council since 2021.

Prof. Dr. Ursula Nothelle-Wildfeuer is a Christian Social Ethicist at the Theological Faculty of the University of Freiburg and Head of the Department of Christian Social Teaching. Her current research focuses include church and religion in state and society and social justice issues. Among other things, she researches "How to deal with AI technologies—ethical principles and guidelines from a Christian perspective" and she conducts an exciting discourse far beyond disciplinary boundaries with workshops on 'New Works'. She is a consultant in many commissions and committees of politics, university, and church. She is involved in the expert committee of the Roman Herzog Institute (RHI).

Both experts are looking for ways, not limited to the digital transformation, to reconcile human–technology–society and to get to the bottom of ethical and moral questions.

A book would not have been possible in this form if it hadn't been accompanied by a hands-on spirit like this one. Since my first invitation to a conference to contribute technical and ethical aspects from Construction, I received a lot of encouragement from practice and research. German and international scientific journals took up my topic immediately. Approaches and position papers at the T20 Task Force group "Digital Transformation"—in preparation of the decision-making bases for the G20 Summit in October 2021 in Rome, Italy - were well received. As well as my Memorandum adressed to the T20 Task Force group "Meaningful Digital Connectivity, Cyber Security, Empowerment" - in preparation for G20 Summit in November 2022 in Bali, Indonesia. To a larger extent, my findings contribute to set standards for CDR that highlight its key factors and aim for broader guidance and awareness raising.

At that moment I knew, the topic and my research came at exactly the right time!

One or the other passage may be difficult for some readers, I am well aware of that. But it must not be missing in any way for the sake of technical completeness and to ensure good scientific practice. Much more, these passages are most relevant as to develop a deep understanding of the complex relationships, of where our values come from, from which we let ourselves be guided and which enable us to set value accents in Construction 4.0 at all.

There are ups and downs in scientific work, and when you get stuck, the encouragement in everyday life is immensely motivating, e.g. "Good luck on the home stretch" or from a science photographer: "You've done an enormous job there. And you have broken new ground. So keep going boldly, you grow over the hurdles." Or unexpected words from the reviewer from the journal SN Applied Sciences in the middle of proofreading on a sunny June day, 2021: "I think you did an excellent job. This is an excellent example of good peer review practice. I think your topic is extremely important and it should get enough media attention."

Towards the end of this book the innovative explosive power that women particularly represent in the development of artificial intelligence and other emerging technologies came more and more to light, namely an AI that is free of discrimination, filter bubbles and gender bias. Diversity and Inclusion represent drivers of success in the digital era and far beyond.

For Fast Readers: The Highlights at a Glance

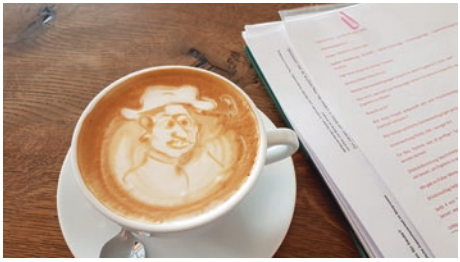
- Aspects of the interaction between construction—technology—digital technologies and AI—people, including ethical and moral issues
- Demonstrating the potential of data-driven technologies in construction and ways of dealing with corporate responsibility
- Identification of Corporate Digital Responsibility (CDR) with ethical principles as a key factor for success, resource-cost-time efficiency and sustainability through the use of digital technologies and AI in construction
- Raising awareness of opportunities and risks
- Key factors for successfully shaping the digital transformation

- Offering constructive solutions to shape this process for the benefit of companies and for the benefit of people and society
- Deep insights behind the scenes of research, development, and user practice
- Best practices based on experience
- Occupying the niche of civil engineering in the ongoing interdisciplinary debate of "Ethics in AI" and involvement in the national and international professional and scientific community

Acknowledgement

- *I would like to thank all contributors and experts interviewed for their valuable support. Numerous institutions, initiatives and associations contribute to the success of research with their experience. Their engineering and philosophical expertise greatly supported the foundation of the "Excellence Initiative for Sustainable, Human-Led AI in Construction"—part of a larger global network.*
- *Prof. Dr. Ursula Nothelle-Wildfeuer and Prof. Dr. Armin Grunwald. I am grateful for their personally sensitive and professional support not only for this book, but also for the lived interdisciplinary and inclusive processing of a successful human-technology relationship. When paths cross, new ones often emerge unpredictably.*
- *In particular, I would like to thank my dissertation supervisor Prof. Marzia Traverso (PhD), Head of the Chair of the Institute for Sustainability in Civil Engineering (INaB), Faculty of Civil Engineering at RWTH Aachen University.*
- *I would like to thank everyone who is working with me to anchor the ethics and diversity debate in the Construction Industry as a success driver for sustainable digital innovation for the great cooperation within the framework of this scientific research work.*

- *I thank all scientific reviewers on my journey into the world of Digitization, AI, Technology, Ethics, Philosophy, CDR.*
- *A very special thank you goes to my editor Frieder Kumm, who has contributed powerfully, critically and heartily to the success of this work.*
- *I am grateful for the energetic adhoc jump in of Amanda Allen who carefully proofread this English version. She also demonstrated that, no matter if connected from two continents, work and exchange of thoughts is always possible, and a question of digital technology and good will.*
- *I am deeply grateful for the valuable support of Dr. Annemarie Ohler and Dr. Norbert Ohler, Freiburg-Horben. They are proof that agility is not a question of age but of the spirit. And that virtues and democratic values are more modern than ever.*
- *My husband Jörn, who supports me with his thoughts from the mechanical engineering perspective with love and devotion. With his cooking qualities, he has sweetened many a moment of despair.*
- *I am forever grateful to my parents Roswitha & Klaus for their DNA and love.*



Source Bianca Weber-Lewerenz

Ethic Statement

Permission to publish was granted by all respondents. Some public statements, which come from internet sources, literature, and archive research, underline the quality and statistical values of the survey values obtained, limitations, and urgently necessary measures.

With the "*Excellence Initiative for Sustainable, Human-Led AI in Construction*", that I founded in 2020, the Construction Industry is brought into the general discourse around Digital Transformation and trustworthy, sustainable AI.

My research on "*Corporate Digital Responsibility in Construction—Ethical principles in dealing with digitization and AI*" is in cooperation with the Institute for Sustainability in Construction (INaB) at the Faculty of Civil Engineering at RWTH Aachen University.

I research externally and independently of any company or institution. My work is not financially supported by third-party funds, companies or other institutions.

The book was created in sole authorship. There are no conflicts of interest. Excerpts from previous publications are referred to accordingly.

My findings at the interface "Application—Engineering Sciences Research—Economic and Societal Communication Transfer" are based

on neutral, critical and inclusive research into the responsible use of digitization and AI. Observations and findings are given access to a wide audience without language barriers. This research aims to advance the ethics discourse on the groundbreaking technology "AI".

Contents

1 Introduction 1

2 Highlights and Outlook 11

3 Evolution of Ethics in the World of Technology: Philosophical Origins 17
- 3.1 Tech Meets Philosophy: Accents of Added Value in Construction 4.0 17
- 3.2 Living Ethics in Education and User Practice 27
- 3.3 Technical Ethics, Digital Ethics, CDR: Philosophical Origins 31

4 Engineering Science and Philosophy/Ethics—How Do They Fit Together? 37

5 State-of-the-Art 49
- 5.1 Technology is Not Value-Free 53
- 5.2 Brief History of BIM and AI 62

6 Increase in Understanding the Application of the Qualitative Method of Research 81
6.1 Approach to the Question of Research 81
6.2 Surprises, Obstacles and Other Ups and Downs During Research 98

7 Use Cases—Empirical Values from User Practice 107
7.1 Methods and Participants 113
7.2 User Practice 123
7.3 Societal and Political Support 153
7.4 Voices of the International Discourse 155
7.5 Outlook and Conclusion 156
7.6 Thinking Otherwise: Sustainable Performance by Integrating Existing Buildings into Smart Cities—Best Practice 158
7.6.1 Introduction 158
7.6.2 Digitale Revolution in Construction 163
7.6.3 Rethinking Citie—Best Practices in the Integration of Existing Buildings and in the Preservation of Monuments 165
7.6.4 Catalysts for Innovation: Education and Legal Regulation 175
7.6.5 Resumé and Outlook 181
7.7 Technological Dream or Safety Trauma? 182
7.7.1 Fire Protection in Smart Cities—Digitization and AI ensure burning ideas and a new Culture of Thinking in Construction 4.0 182
7.7.2 Introduction 182
7.7.3 Fire Protection in Smart Cities 185
7.7.4 Data Complexity—Basis for Smart Fire Protection Building Solutions in Smart Cities 189

7.7.5 Technological Dream or Safety Trauma? Best Practices Demonstrate a Sovereign Way 191
7.7.6 Resumé and Outlook 195
References 197

8 Construction 4.0—Key Factors for the Digital Change 205
8.1 Discussion 240
8.1.1 CDR in General 240
8.1.2 AI in Academic Teaching and Learning—Paving the Way for the Digital Transformation Process 242
8.1.2.1 Knowledge and AI Automate Learning Processes 247
8.1.2.2 New Focus in Academic Teaching and Training 248
8.1.2.3 The Engineer of Tomorrow 253
8.1.2.4 Women in Construction 4.0 264
8.1.2.5 Critical Look: Loss of Control, New World of Working, and the Corporate AI Strategy 265
8.1.3 Diversity—Strengthening Digital Innovations by Diversity 294
8.1.4 Regulation 308
8.1.5 Legislation, Standards, Compliance—Responsibility of Society and Politics 309
8.1.5.1 Corporate Compliance in the Digital 324
8.1.5.2 Aspects in User Practice 330
8.1.5.3 Ethical Principles 331
8.1.5.4 Need for Regulation 331
8.1.5.5 Outlook and Conclusion 333
8.1.6 CDR and CSR in Corporate Practice 335