ON THE BOOK SERIES

VERA BÜHLMANN, LUDGER HOVESTADT

Only one hundred years ago, hardly any scientist of renown would have been unaware of philosophy, and hardly any artist or architect uninformed about up-to-date technology and mathematics. Today, our ability to explain and explicate our own work within a shared horizon of assumptions and values beyond our specific scientific community has, perhaps paradoxically, turned into an inability and resulted to some degree in a kind of speechlessness. Only rarely now is it thought important that we relate our work to, and integrate it with, an overall context that is in itself "on the table" and up for consideration. More and more, that kind of context is taken for granted, without any need for active articulation, refinement or development. At the same time though, the media are full of news stories about catastrophes, crises, and an impending doom that cannot, it seems, be warded off. Climate change, shortage of resources and population growth, urbanization, and this is just naming a few of the critical issues today. Quite obviously, the notion of such an overall context, both implicit and assumed, is extremely strained, if not indeed overstretched today. This all is widely acknowledged—the UNESCO Division of Foresight, Philosophy and Human Sciences in Paris, for example, launched a discourse on this subject in their 21st-Century Talks and Dialogues under the heading *The Future of Values*. The companion book, published in several languages simultaneously in 2004, is structured in three parts, and includes one chapter on the ethical issues of values and nihilism lying ahead, another chapter on technological progress and globalization, as well as a third chapter on the future of science, knowledge, and future studies. What remains strangely implicit, and in that manner ignored here, in a way that is typical of this inarticulacy with regard to an overall context mentioned above, is the societal, scientific and cultural role that inevitably is ascribed to technology against the backdrop of such discussions, along with the expectations that are associated with that role of technology. In the Applied Virtuality Book Series, we tend to regard technology in an extended sense. Along with its respective

solution-oriented application to the sciences, culture, economics and politics, we think that technology needs to be considered more fundamentally, especially regarding the semiotic and mathematical-philosophical aspects it incorporates. From this perspective, we see in technology a common denominator for facilitating a discourse that seems to have been largely lost from today's discursive landscape, the degree of its disappearance inversely proportional to the increasingly central role technology plays in every domain of our lives. To us, such a discourse seems crucial if we are to develop adequate schemes for thinking through the potentials of today's technology, something that is in turn essential for all planning. Our stance is an architectural and, in the philosophical sense, an architectonic one. Our main interest centres on the potentials of information technology, and how we can get used to the utterly changed infrastructures they have brought us.
But have our infrastructures really changed substantially? Or is it merely the case that a new level of media networks have emerged on top of technology with which we are already familiar? Are the "new" and digital media simply populating and exploiting, in a parasitic sense, the capacities of modern industrial infrastructures that have brought prosperity and wealth to so many? In his contribution to the UNESCO dialogues, Paul Kennedy was still convinced: "In the Arabic world, 3% of the population has access to the internet. In Africa, it's less than 1%. This situation won't improve as long as the infrastructures remain in their current state. It won't change, as long as these countries lack electrification, telephone wiring and telephones, and as long as the people there can't afford either computers or software. If knowledge is indeed power, then the developing countries today are more powerless than they were thirty years ago, before the advent of the internet." Our experience since then has allowed us to see things a little differently. The "Arab Spring" that brought simultaneous political revolutions in several Arabic countries from the end of 2010 and in the first half of 2011, in a development that, at the time of writing, still continues, gives credence and facticity to the cultural impact of digital media, to a degree that was unexpected or previously deemed improbable by many. Meanwhile in India, by May 2011, an astounding 200 million people had been recorded as owning a mobile phone, even though they are living without electricity in their homes, or even in their villages (some 600 million people are still living without electricity in India), and need to take quite some trouble to provide power for them every once in a while. Every month, another 20 million become mobile phone users, in India alone. Here, information technology has achieved what no administration, no mechanical infrastructure, no research and no aid has been capable of: enabling people in developing areas of the world to use standard, state-of-the-art, technological infrastructures, for their own benefit.

We read these events as strong indicators for just how limited the applicability of our noetic schemes is for thinking through long-term developments. These schemes have evolved from our experience of prosperity in times of strong modern nation states and industrial technology with matching economics. They go along with notions of centredness for thinking about control, notions of linearity and nested recursion, of processes and grids, and of mechanical patterns of cause and effect used for planning. It is a truism, perhaps, to point out that these notions do not fit information technology very well. They are stressed and overstrained by the volatile associativity that emerges from logistic networks and disperses throughout user populations. Going by our inherited notions, industrial infrastructures appear to be used as a playground for what is called, somewhat helplessly, "consumer culture" or "the culture industry". But in the case of India, for example, what came back as a result of the success of mobile telephony, astonishingly, were new infrastructural solutions. With no banks and no cash machines on hand, people simply invented the means to transfer money and pay by SMS. Yet the standards developed for micro-banking today can be referred to and linked up with solutions that exist for other areas, such as energy provision maintained by photovoltaics and micro-grids, for example. But this is not the place to present scenarios. We would simply like to invite you to consider the profound extent to which codes, protocols, or algorithms, standards such as ASCII, barcodes, MP3, or the Google and Facebook algorithms, have challenged our established economic, political and cultural infrastructures. From this we get a sense of the potentials that come with information technology, directly proportional to these challenges. We deliberately call them potentials, because we are interested in developing adequate noetic schemes for integrating them into thinking about information technology from an infrastructural perspective. We are interested in how these potentials and dynamics can be applied to finding ways of dealing with the great topics of our time.

In another contribution to the UNESCO dialogues mentioned above, Michel Serres observed, somewhat emphatically: "Today's science has nothing to do with the science that existed just a few decades ago." Computers and IT bring us the tools for statistical modelling, simulation and visualization techniques, and an immense increase in accessibility of data and literature beyond disciplinary boundaries. With the conferences that are documented in the Applied Virtuality book series, of which this is the first volume, our main interest lies in how to gain a methodological apparatus for using the potentials and dynamics that are specific to information technology and applying them to dealing with the global challenges that are characteristic of our times, by referring them to a notion of reality we assume will never be "fully" understood.

The prerequisite for making this possible is a regard for, and estimation of, the power of invention, abstraction and symbolization that we have

been able to apply, in past centuries and millennia, in order to come up with ever evolving ways of looking at nature, cities, at trade and exchange, at knowledge and politics, the cosmos and matter, and increasingly reflected, at our ways of looking, speaking, representing. Rooted in their respective historical cognitive frames of reference, we have been able to find ever new solutions for existential challenges. There has most likely never been any such thing as a prototype for coordinate systems: their detachment from substance-space and its formal symbolization result from acts of abstraction. Plato may have already considered the idea of a vacuum, yet he thought it "inconceivable"; nevertheless, this notion of the vacuum inspired abstract thought for ages, before Otto von Guericke invented the first vacuum pump as a technological device in 1654. Electricity was thought of as sent by the gods in thunderstorms before the algebraic mathematics of imaginary and complex numbers were developed along with the structures that allowed us to domesticate it. Today, we imagine the atomic structure of matter by means of orbital models gained from a better understanding of electricity.

So, in short, we do not share the idea that characterizing our time as post-anything is very helpful. While we agree that we seem to be somewhat stuck within certain mindsets today, we do not consider it at all plausible that any kind of concept or model, political or otherwise, will ever come close to anything resembling a natural and objective closure. The concepts behind any assumption of an End to History—whether this be in the Hegelian, the Marxian, or the more recent Fukuyama sense—stem from the 19th century, when Europe was at its peak in terms of imperialist expansion. To resurrect them today, in the light of our demographic, climatic and resources-related problems, to us seems a romantically dangerous thing to do.

By now it is safe to say that technology is not simply technology, but has changed character over time, perhaps even, as Martin Heidegger put it, it has changed "modalities in its essence". In order to reflect this spectrum, we propose to engage with a twin story, which we postulate has always accompanied our technical evolution. Historically, the evolution of technics is commonly associated with the anthropological era called the Neolithic revolution, which marks the emergence of early settlements. We suggest calling our twin story Metalithicum. As the very means by which we have been able to articulate our historical accounts, metalithic technics has always accompanied Neolithic technics, yet in its symbolic character as both means and medium it has remained largely invisible. The Metalithicum is ill suited for apostles of a new origin, nor is it a utopian projection of times to come. Rather, we wish to see in it a stance for engaging with the historicity of our culture. As such, it might help to bring onto the stage as a theme of its own an empirical approach to the symbolics of the forms and schemes that humans have always applied for the purpose of making sense. This certainly is what drives our interest in the Metalithicum Conferences, which we organize twice a year in a concentrated, semi-public setting. As participants, we invite people from very different backgrounds—architects and engineers, human and natural scientists, scholars of humanities, historians—or, to put it more generally and simply, people who are interested in better understanding the wide cultural implications and potentials of contemporary technology. This characterizes the audience for whom this book is written as well.

We are very grateful for the opportunity of collaborating with the Werner Oechslin Library Foundation in Einsiedeln. The Library chiefly assembles source texts on architectural theory and related areas in original editions, extending from the 15th to the 20th century. Over 50,000 volumes document the development of theory and systematic attempts at comprehension and validation in the context of humanities and science. The core area of architecture is augmented, with stringent consistency, by related fields, ranging from art theory to cultural history, and from philosophy to mathematics. Thanks to the extraordinary range and completeness of relevant source texts and the academic and cultural projects based on them, the library is able to provide a comprehensive cultural history perspective. When we first talked to Werner Oechslin about the issue that troubled us most—the lost role of Euclidean geometry for our conceptions of knowledge, and the as yet philosophically unresolved concepts of imaginary and complex numbers and their algebraic modelling spaces—he immediately sensed an opportunity to pursue his passionate interest in what he calls "mental chin-ups" as a form of "mental workout", if not some kind of "thought acrobatics". We would like to express our thanks to him and his team for being such wonderful hosts. We would also like to thank the editors at Birkhäuser, Robert Steiger and Odine Oßwald, for all the support we have received for our project, and for realizing this first volume.

INTRODUCTION —PRINTED PHYSICS

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The topic Printed Physics takes as its starting point the phenomena observed in recent developments in information technology, by which materials can have their physical characteristics formally analysed, technologically constructed and (bio-)chemically synthesized on a symbolic level, and—hence the wording of the title—can be produced industrially, using printing technologies. This manipulation of materials, specifically upgrading them so they become capable of information-technological programming and control functions, is called "doping". Doped materials can be manufactured using a process that bears striking similarities to the printing technologies we are familiar with from the past. The manufacture of digital processors and memory chips for example is in fact reminiscent of lithography and copper etching, and the chemical printing of photographs, and thus comes to continue a line of earlier forms of analogue relief printing methods. In the case of printable solar cells, it can be said that instead of ink on paper, ions are literally being "imprinted" on silicon. Yet there is one important difference, which becomes apparent in the respective notions of "imprinting" and "doping". Unlike any other print product we have known before, this new printed matter plays a genuinely operational role, rather than a primarily descriptive or representational one. What we call printed physics actually refers to tiny electronic devices, produced and distributed on an industrial scale in processes that are akin to those used in the printing and distribution of newspapers.

From a philosophical perspective, there is something interesting that happens in this printing of doped materials. The rationally defined grid, which has been crucial to us for deducing all our physical descriptions of nature, serves here as a frame for projecting the fantastical. Could it not be, is the question we would like to pose with this book, that we are witnessing a development in the field of physical thinking similar to the one that occurred with the logification in geometry in the early 19th century? Are we seeing the appearance of non-naturally determined physics as a complement, as it were, to non-Euclidean, projective, algebraic geometry?

As a context for our discussions in the Printed Physics Conference, we suggested a thought experiment: suppose a new enlightenment of physicalist and naturalized rationality and logic were to be announced, brought about and carried by the qualitative and quantitative impacts of the doping of materials and their production through print. How could this be argued?

Polymer electronics printed onto a polyester film in several layers.

A THOUGHT EXPERIMENT For the purpose of this exercise, let us regard the pre-modern monasteries as proper "production plants" for the copying of the holy scriptures. The subsequent secularization of this process was brought about and carried by the qualitative and quantitative impact of printing, exemplified by the availability of "text" as a medium, the standardization of format and the freedom, for wide sections of society, to access what was once a ritual and sacred description of the world and to take an experimental approach to it. Astonishingly enough, in a reverse analogy, today's factories, businesses and bureaucracies, with their modern industrialization of secularized rationalism, appear like "monasteries" for the copying of physical "regularities". Systemically integrated into orders of higher and lesser function, and cybernetically implemented in multifarious information-technological infrastructures, these law-like regularities act as impulse generators for societal, scientific and economic processes. Our thought experiment suggests to test putting "functional infrastructures" in the place of the "holy scripture" in the pre-Gutenberg era, before the rise of modern, experimental science.

The question that we would like to propose for consideration, not so much as a scientific or philosophical hypothesis than as our thought experiment, arises from this and goes as follows: if the printing press promoted the secularization of mental horizons in philosophy and modern science, is it not possible that these new printing technologies could bring about a further secularization; the secularization of a naturalized rationality principle? There are plenty of indications to suggest that contemporary production methods assert the same principles as were used back in the days of Gutenberg, but on a new plateau. We want to consider this as a plausible scenario by following two lines of argument, one qualitative and one quantitative.

THE QUALITATIVE ARGUMENT It is neither a new nor a bold thesis, at this point, to posit that information technology is essentially concerned with symbolic operations, and that these symbolic operations—not only from a philosophical but also from a technological perspective—cannot appropriately be reduced to the causal connections that are formulated in physics. Information is information, not matter or energy, as Norbert Wiener suggested more than half a century ago.[1]

The effectiveness of information technology does not develop on the same level as the effectiveness of heat, levers, gears or any other mechanical device. Information technology controls the physical conditions symbolically. This means that information technology is operating on a different "substrate" from the physical-material technology of clearly identifiable cause and effect, its symbolicity turns it into a "medial" substrate—medial in the sense that it allows for different possible ways of operation.

A seemingly natural objection that might be raised at this point would perhaps be to regard the electric current as a type of "physicality", and in so doing lend a familiar substratum in the traditional vein to the "void"of the symbolic. This does not, however, solve the problem of defining the relationship between electricity and symbols: quite the opposite. To this day, there is no coherent proposal as to how we are to view electric currents from a physical perspective: should we regard its elements as fields, as waves, as particles or as impulses? The situation is no simpler from a philosophical perspective. All electronic technology is based on precisely that kind of algebraic analysis of symbolic operations which not only triggered, due to their genuine un-intuitivity and non-representationality, but also exacerbated what is known today as the foundation crisis of the sciences, around the turn of the 20th century. Nevertheless, we experience electric current on a daily basis as the ubiquitous availability of energy, as the potential for potential, so to speak. If one were to understand this availability not merely as a

1 Norbert Wiener, *Cybernetics*. MIT Press, Massachusetts 1948, p. 155.

phenomenal characteristic that has emerged as an afterthought, but as a constitutive element of electricity, a rift would open up in the relationship between symbolization and physics that is in no way inferior to the rift that exists between logical geometry a priori and geometric description of reality a posteriori.

THE QUANTITATIVE ARGUMENT If, since its invention, information technology has primarily been used to refine the regulating, switching and controlling operations of mechanical equipment, especially equipment that uses electric current, today a completely different dimension of application is being defined. With electronic and information-technological processes, materials can be modified and synthesized not only in their qualitative properties, but also in their physical behaviour, which is to say in their temporal energetic constitution. Artificial materials can now be produced by printing a synthesized ion and semiconductor structure (this is how silicon-based semiconductors are made, for example, but the principle is the same for organic carriers), and in combinations that are not familiar to us from nature. Photovoltaics are an example of this. They allow us to obtain energy directly from light without any combustion process and also without the interposition of other kinetic or dynamic transformers. It really is possible here to speak of "symbolic physics", not only because the "mechanics" are genuinely symbolically constructed (and not the inverse, which would have the symbolic structure derived from a "natural" mechanical context), but also on the basis of their industrial production processes, which today are rooted in information technology.

The principles of photovoltaics have been known for more than a century and yet they have only recently become a relevant component in the discussion about energy supply. It is only in the last few years that manufacturing techniques have become available that make the production of such programmed materials feasible on a large, industrial scale. It is now possible to produce them in printing processes that spew out physically functional apparatus, just like sheets of newsprint that come off the press at the *New York Times*. This goes hand in hand with a quantitative pricing and production development that is characteristic of information technology and is known as Moore's Law: a doubling of the total amount of produced instances every 18 months, which results in a cost reduction of 30% per year.

The quantitative line of argument assumes that every development requires a critical mass number of normalized instances in order to prevail. Such a large-scale fertile ground for these new dimensions of application in information technology has existed for just a few years now. Even so, with "smart" computer chips, this technology has rapidly established itself as an omnipresent feature of our living environment. These chips potentially allow all electrical devices to behave as components of variably configurable systems. The quantitative distribution of systems-capable entities, in fact symbolic-capable actants, seems in a more serious way than just metaphorically comparable to its antecedent, the modern printing revolution.

This comparison may at first glance seem somewhat exaggerated, but as in the wake of the printing press, we too have experienced several abrupt advances that could not have been foreseen: for example, it took only 10 years for 5 out of 7 billion people—approximately 70% of the current world population—to have potential access to wireless connections via information technology. Today we can, at least potentially, phone one out of two people in the world, irrespective of where on the planet they happen to be at that particular moment. Setting up and establishing the infrastructure needed for mobile telephony took only a decade and yet it already feels commonplace to us today. If we want to assess the meaning of this quantitative argument adequately, we must keep in mind that this same technology would be nearly meaningless, and not just in the case of mobile telephony, if there were only a few thousand instances of it throughout the world. What makes it meaningful is that it has reached critical mass, and rapidly. And in this case too, the technology's fast and wide propagation has its foundation in the exact same production and manufacturing processes: information-technological printing technology. The same structural principle applies to the propagation of TV screens as much as it does to internet access, global positioning systems and the efficacy of Google: what would happen if Google could "only" link 1 million sites and only had 10,000 users that sporadically used its search engines? It would be virtually insignificant. Instead, it has now achieved a level of standardization that no longer just renders some qualities or aspects of our practices or behaviour less meaningful—a side effect of any standardization—but rather tips us "over the edge" into a situation where we are now developing new qualities on the very basis of this quantitative standardization.

THE CONTENTS OF THIS BOOK We sent this thought experiment along with our invitation to the speakers of the Printed Physics Conference in early summer 2010. Their contributions, however, represent their independently formulated positions, and only indirectly refer to our overall theme, mainly in the discussions that followed their lectures. In this book, we print the manuscripts of these lectures as distinct chapters, and add brief summaries of the main lines of argument, as followed up in the discussions afterwards. These summaries take an indexing character; they are meant to provide a kind of conceptual mapping of the thematic landscapes through which we wandered, highlighting the most important topical reference points that were raised. In the first chapter, "A Fantastic Genealogy of the Printable", Ludger Hovestadt presents the current innovations in electronic engineering devices, available today for architectural application and integration, on all levels from design to construction and planning. Furthermore, he provides, in a historical account of what he calls "serious storytelling", a conceptual model for considering the specific potency of digital technology. The second chapter, "Technology and Modality", presents an article by Hans Poser who, as we should point out, was unable to attend the first conference in person, but has kindly allowed us to publish his article in our book. In it, he provides strong arguments as to why philosophy needs to pay attention to state-of-the-art technology when offering notions of reality and, directly related to that, notions of possibility and feasibility. In the third chapter, "Primary Abundance, Urban Philosophy—Information and the Form of Actuality", Vera Bühlmann suggests taking a capacity and capability oriented view of the study of information, and reflects on the intimate and co-constitutive relation between philosophical thought and an idea of citiness; her special emphasis thereby lies on the role of technology in that relationship. The fourth chapter, entitled "That Centre-Point Thing—The Theory Model in Model Theory", investigates the philosophical conditions for a machine-based episteme. Klaus Wassermann argues that we are currently experiencing an historic movement that he calls "de-centrement", and which he demarcates from the more common notions of decentralization and deterritorialization, in that this assumed turn towards ever-increasing de-centrement not only challenges any foundation, rules, structures, procedures and patterns that have served us so far for comprehending the world, but most crucially also urges us to calibrate anew the role of the model itself in order to arrive at a philosophical notion of information. In a fifth chapter entitled "Digital Cathedrals", Helmut Geisert challenges the book's emphasis on relating digital technology to earlier printing technology with a retro-projection of how, throughout the 19th and early 20th centuries, people had reflected on the relative cultural impact of Gutenberg's printing revolution. The article reveals a relationship that is as fundamental as it is troubling, between materialist thought and the problem of how to establish notions of proportionality and appropriateness within architecture that has become secularized and profane. In a final chapter, "Bringing and Positioning: Ways of Technology?" Hans-Dieter Bahr introduces Martin Heidegger's thought on technology, and his postulated change in modern technology's essential way of operating. By characterizing it as a "challenging-forth and ordering", rather than as a "setting and maintaining-in-place", Heidegger had introduced many of the core issues behind the conflict between support and control, which we are striving to come to terms with today with increasing urgency.