When Tineke Egyedi and Donna Mehos approached me to write a foreword to this remarkable book on Inverse Infrastructures, my first thought brought me back to the occasion of the inspiring inaugural lecture of Wim Vree at Delft University of Technology, 2003. He was the one who coined the concept of inverse infrastructures. He pointed out that the Internet itself is a striking example of an inverse infrastructure: a global infrastructure that emerged in less than three decades – not as the result of a well-designed master plan, but as the unplanned consequence of a defense research-originated network between knowledge institutes. It has given rise to a completely new concept of multi-functional and converging infrastructures: access to the Internet can be provided by competing, both fixed and wireless, infrastructure networks, and the Internet itself provides access to a range of services such as telephony and television that used to be provided by dedicated networks. Already, the Internet is enabling the emergence of ‘next generation’ information infrastructure based on the sensing and control networks used for our highways, inland waterways and flood protection system. In many ways, Wim Vree was ahead of his time. His inaugural lecture took place a year before we officially started with the Next Generation Infrastructures program in 2004. Now, seven years later, this book is one of the many fruits of knowledge showing how the program has matured.

The notion of inverse infrastructures makes us take a fresh look at the omnipresent infrastructure systems that support our economy and structure our way of living. To what extent is the mechanism of inverse infrastructure development really new? Historical research into the electricity, gas, water and railway infrastructure systems, for example, that we take for granted, reveals that these networks also emerged from decentralized, primarily private, initiatives. However, with the electricity infrastructure it took more than a century before the whole of continental Europe was interconnected in one synchronized network. It also took, and still takes, major public interference to ensure timely investment in the electricity transmission network. The Internet, in comparison, evolved far more rapidly, more or less spontaneously, driven by users to meet their emerging needs, and relying on private investment to create the global backbone structure. Especially the rapid succession of new generations of wireless telecommunication networks seems to drive the
evolution of new Internet-bound services forward. It is creating unprecedented momentum, which forces us to take the phenomenon of inverse infrastructures very seriously.

In the world of infrastructures, the time constant of innovation is changing drastically. The established order of many infrastructure systems is being disrupted by decentralized innovation initiatives. Think for example of the small-scale decentralized units being installed for the supply of ‘green’ electricity and gas, the promise of decentralized electricity storage enabled by the electric car, the overwhelming success of Skype as a substitute for the dedicated telephone networks, or the solid market position of point-to-point air traffic infrastructure won at the cost of the established hub-and-spoke networks. Whether being challenged by competing networks or being changed from within, the established infrastructure networks are forced to adapt lest they be outperformed and become obsolete.

Innovation policy makers should note that the innovations at play are not only concerned with new technologies. Innovative services and business models are equally, if not more importantly, arising either as innovations in their own right, or as innovations needed to accommodate technological change. This dimension is often neglected in innovation policy and in the reach of innovation policy instruments. Another lesson to be learned is the diminishing value of long term planning which used to dominate innovation in infrastructure networks. The volatility induced by the decreasing time constant of innovation in the world of infrastructure systems and services makes long term planning an illusion. Indeed, the very success of inverse infrastructures testifies to the victory of un-intentionality.

The new reality of infrastructure systems and services is one of daunting complexity, even literally so, as infrastructures are complex adaptive systems. Unless innovation policy makers are prepared to embrace that complexity and acknowledge the adaptive dynamics of infrastructure systems, they are bound to be disappointed by the lack of planned system outcomes. The notions of planning and design must be replaced by accommodation and conditioning: creating stimulating institutional conditions to encourage innovation in all relevant dimensions of infrastructure systems, and creating regulatory conditions to protect the interests of the end-users, consumers in particular, who fully depend on the uninterrupted supply of infrastructure bound services. In short, a paradigm shift is needed from technological systems to socio-technical systems satisfying user needs and accommodating user initiatives, from deterministic to complex systems showing emergent behavior, from static structures to dynamically evolving systems.

Looking back on seven years of research in the framework of Next Generation Infrastructures, I wholeheartedly recommend this book as a fine example of the inter-disciplinary and cross-sectoral approach to infrastructure systems.
advocated by the Next Generation Infrastructures program. With the insights this work presents into a newly emerging category of infrastructure systems and services together with a theoretical framework that helps to interpret the new developments, it is bound to contribute to the paradigm shift needed in the realms of innovation and infrastructure policy. Infrastructure systems are not the static systems that policy makers have considered them to be. They show surprising agility and hold tremendous potential for innovation. The Internet is a prime example of an infrastructure that rapidly acquired a multitude of new functionalities driven by user needs, in sync with the possibilities of new technologies. Hence, this book holds more than academic value; it is also a must read for innovation and infrastructure policy makers.

When Wim Vree presented his inaugural address in 2003, he did not foresee that his lecture was to become one of the Next Generation Infrastructures program’s cornerstones. In many ways, the Next Generation Infrastructures program is itself an inverse infrastructure: an inverse knowledge infrastructure, which evolved from a handful of inspired researchers in 2003 into an international knowledge network, involving hundreds of researchers and practitioners worldwide, driven by academic curiosity and practical knowledge needs, with some 150 research projects running to date. This book is an integrative interdisciplinary effort covering a variety of infrastructure sectors. I am most grateful to Tineke Egyedi for taking the initiative, with twenty co-authors, for this book. During the past two years while this work progressed it has only become more topical. I congratulate Tineke and her co-editor, Donna Mehos, with the completion of this formidable effort.

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