Editorial

Paulien M. Herder

Delft University of Technology,
2628 BX Delft, The Netherlands
E-mail: p.m.herder@tudelft.nl

Large-scale capital-intensive systems, such as the energy system, road and rail infrastructures and ICT infrastructures, cannot be changed overnight. The physical, social and institutional complexity of the system defies mono-dimensional solutions. The social and institutional complexity has increased dramatically in recent years as a consequence of deregulation, market liberalisation and (partial) privatisation. The behaviour of infrastructure systems as a whole cannot be understood by merely studying the structure and behaviour of either the physical subsystem or the social subsystem. They are intricately interconnected and influence each other's development (Herder et al., 2008).

Any strategy to change or redesign an infrastructure system will have to account for the fragmented, redundant and overlapping patchwork of governance structures, in which no single actor or institution has the commitment power to force change. More than before, technological innovations will have to be co-developed with appropriate institutions (Bauer and Herder, 2009). Owing to the limited possibilities to directly engineer and change the established physical networks of today's infrastructure systems, the challenge is to ensure that the collective actions of players are steered towards the desired overall system outcomes through adequate market design, adequate network regulation and additional legislation and regulation for safety, health, environment, etc. Also, in view of private actors' interests, insight is needed into how individual investment decisions in subsystems of the complex infrastructure system may be influenced.

A complex system shows emergent behaviour due to intractable interactions within and among the subsystems. The main difference between the two subsystems is that the components of the physical subsystem are technical or physical artefacts governed by *causal* relations, while those of the social subsystem are reflective actors, interacting through *intentional* relationships (Bruijn and Herder, 2009). Understanding how small-scale initiatives and niche applications evolve into large-scale socio-technical system changes requires a deep understanding of how technology and institutions co-evolve, and how these evolutionary processes can be nudged towards desirable outcomes by manipulating the 'rules of the game'.

This issue contains a number of contributions that address exactly this issue of the interplay of 'systems engineering' and 'social sciences'. The field is at the core of the Department of Technology, Policy and Management at the Delft University of Technology. The authors of the contributions in this issue are faculty of this department, and as a product of the ongoing effort to find similarities among different infrastructure systems and research perspectives, this set of papers was produced.

The first contribution is by Van Daalen and Bots, who describe the design of a problem solving process which includes stakeholder involvement. It is based in soft systems engineering. The second contribution is by Van der Lei, Kolfschoten and Beers.

It analyses how a system and an actor perspective are actually used in combination in research studies, and how that relates to the rigour of those studies. The third and fourth contributions focus on two specific infrastructures: the transportation infrastructure and the ICT infrastructure. Another contribution, from the energy infrastructure's perspective was published earlier in this journal (Herder et al., 2008). The transport system contribution in this issue, by Van Wee, showcases some dominant features of the transport system, elaborates on the difference in the goals of the public and private actors, and gives an overview of dominant theories and research methods in this area. The ICT infrastructure contribution, by Bouwman and Janssen, describes interrelatedness and co-evolution of the technological systems and the organisational domains for the design of end-user services.

References

Bauer, J. and Herder, P.M. (2009) 'Designing socio-technical systems', in Gabbay, D., Thagard, P. and Woods, J. (Eds.): *Handbook of the Philosophy of Science: Handbook Philosophy of Technology and Engineering Sciences*, Elsevier Publishers.

Bruijn, J.A. de and Herder, P.M. (2009) 'System and actor perspectives on sociotechnical systems', *IEEE Transactions on Systems Man and Cybernetics Part A – Systems and Humans*, Vol. 39, No. 5, pp.981–992.

Herder, P.M., Bouwmans, I., Dijkema, G.P.J., Stikkelman, R.M. and Weijnen, M.P.C. (2008) 'Designing infrastructures from a complex systems perspective', *Journal of Design Research*, Vol. 7, No. 1, pp.17–34.