Call for papers

IEEE Transactions of Engineering Management

Special Section: Designing Flexibility for Strategic Decision-Making in Infrastructure Projects, Real Options, and Managing Uncertainty

Guest Editors

Dr. Ilias Krystallis, corresponding guest editor

The Bartlett School of Sustainable Construction, University College London, UK

i.krystallis@ucl.ac.uk

Dr. Michel-Alexandre Cardin

Dyson School of Design Engineering, Imperial College London

m.cardin@imperial.ac.uk

Prof. Richard de Neufville

Institute for Data, Systems, and Society, Massachusetts Institute of Technology, USA

ardent@mit.edu

Area: Engineering Management

Overview

This special section signals a significant shift in infrastructure project management research. Infrastructure projects and programmes have been exerting increased pressure to address broader societal concerns. With an increasing recognition of the limitations of traditional project-oriented approaches, there is a pressing need to adopt an enterprise-wide perspective that extends beyond individual projects (Braglia and Frosolini, 2014; Krystallis, Locatelli and Papadonikolaki, 2023). For instance, economists call for a long-term commitment from the governments to invest in infrastructure to address capacity and connectivity challenges, especially in regions that lag in development compared to major urban centers (Curca, 2024). In the UK, the National Infrastructure Commission (NIC) stresses that growth strategies must persist over time to be effective. However, short-termism has been a persistent issue in UK policy-making and other countries globally (National Infrastructure Commission, 2023). In the United States, while many local governments have adopted forward-thinking initiatives, at the national level, infrastructure investments often face delays and piecemeal funding due to political gridlock. This short-term focus impacts critical areas like transportation and water systems, where delayed maintenance and inadequate investment could lead to costly repairs and inefficiencies in the future (United Nations, 2023). The broader struggle with short-termism is evident in global responses to climate-linked infrastructure. For instance, while large-scale pledges are made

at summits, actual implementation often remains underfunded or inconsistent, leaving projects incomplete or misaligned with broader sustainability goals (Caney, 2022).

This shift signifies a move away from merely managing risks to embracing the complexities of uncertainty, acknowledging the dynamic and unpredictable nature of modern business environments. Moreover, the timing of this call for papers could not be more significant, as project-based organizations grapple with unprecedented challenges and disruptions, necessitating innovative approaches to strategic decision-making.

Project management of infrastructure projects and programmes is typically irreversible, expensive, and last for multiple decades. Conventional project management approaches overlook the potential advantages of flexibility as a way to deal with uncertainty and risks leading to missed opportunities for enhancement (de Neufville and Scholtes, 2011). Instead, design flexibility in project management has the potential to manage uncertainty at a reduced cost by building infrastructure assets that can adapt to future needs (Atli and Krystallis, 2025). Traditionally, flexibility is described as undesirable in a project management context (Lenfle and Loch, 2010; Hansen and Olsson, 2011). Foundational project management scholars (Morris and Hough, 1987; Miller and Lessard, 2000; Dvir and Lechler, 2004), indicated that a clear project definition is a critical success factor and advocated that projects should be targeted, focused vehicles for the execution of defined tasks. The general consensus of this body of research warned against changes in projects once design development and specifications have been established (Dvir and Lechler, 2004).

In light of the above, design flexibility emerged as a multi-disciplinary concept (Saleh, Mark and Jordan, 2009; de Neufville and Scholtes, 2011; Cardin, 2014) that helps decision-makers cultivate capabilities to achieve cost-effective management of uncertainty and adaptability of their future needs. Design flexibility refers to the capacity of a product, system, or process to evolve or undergo modifications over time to address evolving needs, conditions, or requirements. This concept underscores the notion that flexibility extends beyond the completion of a singular project, such as the development of a single airport terminal, to encompass ongoing adaptations and adjustments throughout its operational lifespan (de Neufville and Odoni, 2013; Allaverdi and Browning, 2020; Krystallis, Laraqui Mahi and Di Maddaloni, 2024).

Scholars have conceptualized design flexibility by drawing insights from a wide range of theoretical perspectives, with real options receiving particular attention (Cardin, Mijic and Whyte, 2021). Real options theory comprises two approaches: Real Options Valuation (ROV) and Real Options Reasoning (ROR) (Trigeorgis and Reuer, 2017). While ROV employs formal analytical models to value options (Cardin, Mijic and Whyte, 2021; Caputo and Cardin, 2022), ROR relies on verbal theorizing without analytical modeling and is particularly applicable when key drivers of real options can be conceptually identified and synthesized (McGrath, 1997; Gil, Biesek and Freeman, 2015; Krystallis, Laraqui Mahi and Di Maddaloni, 2024). ROV literature is predominantly normative. In this field, research tends to adopt a prescriptive theoretical perspective, advocating a positivist and instrumentalist approach. For example, ROV research involves the development of tools and processes aimed at quantifying flexibility, thereby enabling decision-makers to assess and manage uncertainty more effectively throughout the project lifecycle. ROR literature on the other hand addresses flexibility in non-normative terms, and comprises of studies that seek to understand and describe design flexibility from 1. a descriptive perspective – by focusing on describing social systems with actors and interactions, and, 2. an enacting theory perspective – by focusing on describing the process through the identification of local

situated actions are materialized, that is often exploratory (Sandberg and Alvesson, 2021; Svejvig, 2021).

Design flexibility has also been implemented at various units of analysis ranging from individual decision-making (Jalali Sohi, Bosch-Rekveldt and Hertogh, 2021; Krystallis, Locatelli and Murtagh, 2021, 2022), organizations (Koppenjan *et al.*, 2011; Osipova and Eriksson, 2013), and inter-organizational projects (Gil, 2009; Gil and Tether, 2011), as well as applications in various sectors such as healthcare (Van Reedt Dortland, Voordijk and Dewulf, 2013), real estate (Cardin, De Neufville and Geltner, 2015; Geltner and de Neufville, 2018), oil and gas (Babajide, De Neufville and Cardin, 2009; Cardin, Ranjbar-Bourani and de Neufville, 2015), airports (Gil and Tether, 2011; de Neufville and Odoni, 2013) signifying a substantial scholarly interest that spans across many vital sectors of the modern economy.

With the academic and practitioner interest in design flexibility and real options on the rise, this special section of Transactions of Engineering Management is focused on research about contemporary design flexibility and the pressing need to adopt an enterprise-wide perspective that extends beyond individual projects. The main areas of interest surround how design flexibility might enable strategic decision-making for managing uncertainty while recognizing that this thinking may contradict conventional project management approaches, mindsets, processes, and goals surrounding these projects.

Potential research topics

This special issue sets to push forward the discussion on design flexibility in infrastructure project management research, and thus encourages submissions that address:

- In-depth qualitative studies (e.g., case studies, phenomenology, ethnography, surveys) that focus on the design and planning but also the implementation of design flexibility, focusing on the rationale behind the use of design flexibility.
- Quantitative studies (e.g., economic valuation, simulation, engineering design and risk analysis) that demonstrate the novel integration of frameworks, tools and approaches and their benefits to the respective organizations.

Topics of interest for this special issue include, but are not limited to:

Embedding uncertainty and flexibility thinking: Explore methods to integrate uncertainty and flexibility considerations into existing design and management processes within an enterprise perspective, fostering adaptability and resilience.

Identifying uncertainty drivers and quantifying risks: Investigate approaches to identify key uncertainty drivers, model uncertainties, and quantify risks specific to the enterprise, enabling more informed decision-making and risk management practices.

Developing valuable flexibility strategies: Examine how to generate and implement valuable flexibility strategies tailored to different forms of enterprises and projects/programmes/portfolios, considering factors such organizational structures, delivery models, and innovation.

Quantifying benefits and costs of flexibility: Explore methodologies to quantify and optimize the benefits and costs associated with flexibility within an enterprise perspective, emphasizing its role as a driver of value, sustainability, and resilience.

Managing flexibility at multiple levels: Discuss strategies for effectively managing the process of enabling and exercising flexibility, considering various units of analysis including

individuals, organizations, and inter-organizational dynamics to promote successful outcomes.

Submission Process

Please prepare the manuscript according to IEEE-TEM's guidelines and submit the journal's Manuscript Central site (https://mc.manuscriptcentral.com/tem-ieee) & clearly state that the submission is for this **Special Section** on '**Designing Flexibility for Strategic Decision-Making in Infrastructure Projects, Real Options, and Managing Uncertainty"**.

- Submission deadline: 31 December 2025

Guest Editor Bios

Ilias Krystallis is an Associate Professor in Engineering Project Management at the Bartlett School of Sustainable Construction, University College London. His research interests focus on uncertainty management, design flexibility, project performance, governance and coordination of complex projects and networks, and organisational change projects. He has published papers in *ASCE Management in Engineering, Construction Management and Economics, ICE Asset Management Journal, ICE Management, Procurement, and Law, IEEE Engineering Management Review, IEEE Transactions on Engineering Management, International Journal of Operations and Production Management, Production Planning and Control, and Project Management Journal.*

Michel-Alexandre Cardin is an Associate Professor (Reader) in Engineering Systems Design at the Dyson School of Design Engineering, Imperial College London, where he leads the Strategic Engineering Laboratory. His research focuses on translating the principles of real options theory into systems design & engineering practice. He develops and test tools, methods, and digital technologies deeply rooted in systems thinking to enable strategic flexibility in design & planning of complex engineered systems, with application in energy, transport and space infrastructures. He served as Associate Editor for academic journals like *ASME Journal of Mechanical Design*, *IISE Transactions*, *INCOSE Systems Engineering*, *IEEE Transactions on Engineering Management*.

Richard de Neufville, Professor of Engineering Systems in the MIT Institute for Data, Systems, and Society, is an innovator in engineering design. He has authored 7 major texts, most recently: "Flexibility and Real Estate Valuation under Uncertainty: A Practical Guide for Developers," "Flexibility in Engineering Design," and "Airport Systems Planning, Design, and Management." He founded the MIT Technology and Policy Program, recognized by the Sizer Award for the Most Significant Contribution to MIT Education. He received the McKelvey and the Horonjeff Awards for Aviation, and an honorary doctorate from the Delft University of Technology. His has held visiting appointments at the Judge Management School, Cambridge; University of California, Berkeley; University of Calgary; École Centrale and the Ecole Nationale des Ponts et Chaussées (Paris); Harvard; Instituto Superior Técnico (Lisbon); London Graduate School of Business; and Oxford University. He was part of MIT's collaboration to develop the Singapore University of Technology and Design.

References

Allaverdi, D. and Browning, T.R. (2020) ‘A methodology for identifying flexible design opportunities in large-scale systems’, *Systems Engineering*, 23(5), pp. 534–556. Available at: https://doi.org/10.1002/sys.21548.

Atli, K. and Krystallis, I. (2025) ‘Design flexibility in managing infrastructure projects: Contributing factors and research avenues’, *International Journal of Project Management*, 43(1), p. 102675. Available at: https://doi.org/10.1016/j.ijproman.2025.102675.

Babajide, A., De Neufville, R. and Cardin, M.-A. (2009) ‘Integrated Method for Designing Valuable Flexibility in Oil Development Projects’, *SPE Projects, Facilities & Construction*, 4(02), pp. 3–12. Available at: https://doi.org/10.2118/122710-PA.

Braglia, M. and Frosolini, M. (2014) ‘An integrated approach to implement Project Management Information Systems within the Extended Enterprise’, *International Journal of Project Management*, 32(1), pp. 18–29. Available at: https://doi.org/10.1016/j.ijproman.2012.12.003.

Caney, S. (2022) ‘Global Climate Governance, Short-Termism, and the Vulnerability of Future Generations’, *Ethics & International Affairs*, 36(2), pp. 137–155. Available at: https://doi.org/10.1017/S0892679422000181.

Caputo, C. and Cardin, M.-A. (2022) ‘Analyzing Real Options and Flexibility in Engineering Systems Design Using Decision Rules and Deep Reinforcement Learning’, *Journal of Mechanical Design*, 144(2), p. 021705. Available at: https://doi.org/10.1115/1.4052299.

Cardin, M., De Neufville, R. and Geltner, D.M. (2015) ‘Design Catalogs: A Systematic Approach to Design and Value Flexibility in Engineering Systems’, *Systems Engineering*, 18(5), pp. 453–471. Available at: https://doi.org/10.1002/sys.21323.

Cardin, M., Ranjbar-Bourani, M. and de Neufville, R. (2015) ‘Improving the Lifecycle Performance of Engineering Projects with Flexible Strategies: Example of On-Shore LNG Production Design’, *Systems Engineering*, 18(3), pp. 253–268. Available at: https://doi.org/10.1002/sys.21301.

Cardin, M.-A. (2014) ‘Enabling Flexibility in Engineering Systems: A Taxonomy of Procedures and a Design Framework’, *Journal of Mechanical Design*, 136(1), p. 011005. Available at: https://doi.org/10.1115/1.4025704.

Cardin, M.-A., Mijic, A. and Whyte, J. (2021) ‘Flexibility and Real Options in Engineering Systems Design’, in A. Maier, J. Oehmen, and P.E. Vermaas (eds) *Handbook of Engineering Systems Design*. Cham: Springer International Publishing, pp. 1–29. Available at: https://doi.org/10.1007/978-3-030-46054-9_35-1.

Curca, A. (2024) *The crucial role of long-term commitment to infrastructure investment: The HS2 case study*, *CBI*. Available at: https://www.cbi.org.uk/articles/the-crucial-role-of-long-term-commitment-to-infrastructure-investment/ (Accessed: 4 December 2024).

Dvir, D. and Lechler, T. (2004) ‘Plans are nothing, changing plans is everything: the impact of changes on project success’, *Research policy*, 33(1), pp. 1–15.

Geltner, D. and de Neufville, R. (2018) *Flexibility and Real Estate Valuation under Uncertainty: A Practical Guide for Developers*. John Wiley & Sons.

Gil, N. (2009) ‘Project Safeguards: Operationalizing Option-Like Strategic Thinking in Infrastructure Development’, *IEEE Transactions on Engineering Management*, 56(2), pp. 257–270. Available at: https://doi.org/10.1109/TEM.2009.2016063.

Gil, N., Biesek, G. and Freeman, J. (2015) ‘Interorganizational Development of Flexible Capital Designs: The Case of Future-Proofing Infrastructure’, *IEEE Transactions on Engineering Management*, 62(3), pp. 335–350. Available at: https://doi.org/10.1109/TEM.2015.2412456.

Gil, N. and Tether, B.S. (2011) ‘Project risk management and design flexibility: Analysing a case and conditions of complementarity’, *Research Policy*, 40(3), pp. 415–428. Available at: https://doi.org/10.1016/j.respol.2010.10.011.

Hansen, G.K. and Olsson, N.O.E. (2011) ‘Layered project-layered process: Lean thinking and flexible solutions’, *Architectural Engineering and Design Management*, 7(2), pp. 70–84. Available at: https://doi.org/10.1080/17452007.2011.582331.

Jalali Sohi, A., Bosch-Rekveldt, M. and Hertogh, M. (2021) ‘Practitioners’ Perspectives on Flexible Project Management’, *IEEE Transactions on Engineering Management*, 68(4), pp. 911–925. Available at: https://doi.org/10.1109/TEM.2019.2914833.

Koppenjan, J. *et al.* (2011) ‘Competing management approaches in large engineering projects: The Dutch RandstadRail project’, *International Journal of Project Management*, 29(6), pp. 740–750. Available at: https://doi.org/10.1016/j.ijproman.2010.07.003.

Krystallis, I., Laraqui Mahi, Z.A.A. and Di Maddaloni, F. (2024) ‘Flexible Infrastructure Design: A Real Options Reasoning Approach to Navigating Uncertainty in Large-Scale Projects’, *Journal of Management in Engineering*, 40(3), p. 04024012. Available at: https://doi.org/10.1061/JMENEA.MEENG-5678.

Krystallis, I., Locatelli, G. and Murtagh, N. (2021) ‘Futureproofing Complex Infrastructure Projects Using Real Options’, *IEEE Engineering Management Review*, 49(1), pp. 127–132. Available at: https://doi.org/10.1109/EMR.2020.3036446.

Krystallis, I., Locatelli, G. and Murtagh, N. (2022) ‘Talking About Futureproofing: Real Options Reasoning in Complex Infrastructure Projects’, *IEEE Transactions on Engineering Management*, 69(6), pp. 3009–3022. Available at: https://doi.org/10.1109/TEM.2020.3026454.

Krystallis, I., Locatelli, G. and Papadonikolaki, E. (2023) ‘Captain and conscript or companions in operational reconfiguration? The case of an infrastructure owner with projects and asset management units’, *Production Planning & Control*, pp. 1–18. Available at: https://doi.org/10.1080/09537287.2023.2249438.

Lenfle, S. and Loch, C. (2010) ‘Lost Roots: How Project Management Came to Emphasize Control over Flexibility and Novelty’, *California Management Review*, 53(1), pp. 32–55. Available at: https://doi.org/10.1525/cmr.2010.53.1.32.

McGrath, R.G. (1997) ‘A Real Options Logic for Initiating Technology Positioning Investments’, *The Academy of Management Review*, 22(4), p. 974. Available at: https://doi.org/10.2307/259251.

Miller, R. and Lessard, D.R. (2000) *The strategic management of large engineering projects: shaping institutions, risks, and governance*. Cambridge, Mass: MIT Press.

Morris, P.W.G. and Hough, G.H. (1987) *The anatomy of major projects: a study of the reality of project management*. Chichester , UK: Wiley.

National Infrastructure Commission (2023) *Infrastructure Progress Review*. London, UK: NIC, p. 93. Available at: https://nic.org.uk/app/uploads/IPR-2023-Final.pdf.

de Neufville, R. and Odoni, A.R. (2013) *Airport systems: planning, design, and management*. 2nd ed. New York: McGraw-Hill.

de Neufville, R. and Scholtes, S. (2011) *Flexibility in engineering design*. Cambridge, Massachusetts: MIT Press.

Osipova, E. and Eriksson, P.E. (2013) 'Balancing control and flexibility in joint risk management: Lessons learned from two construction projects', *International Journal of Project Management*, 31(3), pp. 391–399. Available at: https://doi.org/10.1016/j.ijproman.2012.09.007.

Saleh, J.H., Mark, G. and Jordan, N.C. (2009) 'Flexibility: a multi-disciplinary literature review and a research agenda for designing flexible engineering systems', *Journal of Engineering Design*, 20(3), pp. 307–323. Available at: https://doi.org/10.1080/09544820701870813.

Sandberg, J. and Alvesson, M. (2021) 'Meanings of Theory: Clarifying Theory through Typification', *Journal of Management Studies*, 58(2), pp. 487–516. Available at: https://doi.org/10.1111/joms.12587.

Svejvig, P. (2021) 'A Meta-theoretical framework for theory building in project management', *International Journal of Project Management*, 39(8), pp. 849–872. Available at: https://doi.org/10.1016/j.ijproman.2021.09.006.

Trigeorgis, L. and Reuer, J.J. (2017) 'Real options theory in strategic management', *Strategic Management Journal*, 38(1), pp. 42–63. Available at: https://doi.org/10.1002/smj.2593.

United Nations (2023) *Long-Term, Forward-Looking Solutions Paramount to Overcoming Interlinked Crises That Hinder Sustainable Development Goals Progress, High-Level Segment Hears | Meetings Coverage and Press Releases*. Available at: https://press.un.org/en/2023/ecosoc7142.doc.htm (Accessed: 4 December 2024).

Van Reedt Dortland, M., Voordijk, H. and Dewulf, G. (2013) 'Real options in project coalitions in Dutch health care: two case studies of construction projects', *Construction Management and Economics*, 31(3), pp. 266–286. Available at: https://doi.org/10.1080/01446193.2012.738921.