

Dr Robert Phaal - Curriculum Vitae

Personal details



Contact details

Address: Work: Institute for Manufacturing, University of Cambridge,
17 Charles Babbage Road, Cambridge, CB3 0FS
Home: 32 Laxton Avenue, Hardwick, Cambridgeshire, CB23 7XL

Telephone: Work: 01223 765824
Mob: 07468 425734
Home: 01954 211869

e-mail: Work: rp108@cam.ac.uk

Current employment

Organisation: University of Cambridge, Department of Engineering
Manufacturing and Management Division (Institute for Manufacturing, IfM)
Centre for Technology Management (CTM)

Dates: From March 1997

Position: Director of Research, STIM, CUED, Oct –
Principal Research Associate, July 2011 – Sept 2019
Senior Research Associate, March 1997 – June 2011

Responsibilities have focused on research, together with supporting a range of activities within the Institute for Manufacturing and Centre for Technology Management, including teaching, supervisions, examinations, publications, proposal generation, project management, network development and executive education and consulting, together with supporting general management and activities within the CTM, IfM and Department (e.g. member of the research ethics committee since 2014, reviewing more than 100 applications).

A key focus has been industrial engagement, in terms of research and dissemination to ensure impact, and to generate an industrial funding stream to invest in industrially relevant research and to support post-doc recruitment and retention, and funding for research students and academic exchange. This involves:

1. Close involvement with IfM ECS Ltd since 2002, a subsidiary company wholly owned by the University of Cambridge, set up to support dissemination, transfer and application of research

outputs, generating impact and a substantial research revenue (c£200K p.a.) to support current and future interest-led industrially relevant research. Elected to the Board of ECS October 2018.

2. Development and coordination of the 'STIM' programme¹, founded in 2013, a rolling annual subscription-based consortium, with the aim of facilitating research (post-doc and masters) with industry, and to provide a networking service to industry. Since 2013, this has generated approximately £1,200K of funding, involving about 40 corporations and 75 research projects.

An internationally leading reputation has been established in the field of strategic technology management, as evidenced by:

- 87 papers authored and co-authored published in peer-reviewed journals, together with 135 conference papers, and 28 contributions to books (authoring, editing, and contributing chapters), with an h-index of 41 (Google Scholar).
- 2009 excellence in research publication award from the International Association for Management of Technology (IAMOT) for being within the top percentile of researchers in Technology Innovation Management, based on academic journal publication record over the last five years. 2013 award for being on of the top 45 researchers in the technological innovation management field.
- Inclusion in the 2008 & 2014 Cambridge Department of Engineering Research Assessment Exercise (RAE) submission.
- The most cited journal paper relating to technology roadmapping², with more than 1210 citations (Google Scholar), and one of the 25 most downloaded papers of the journal (Technological Forecasting & Social Change).
- Numerous invited speaking, teaching and collaborative engagements in around the world.

Specific research activities involving lead or substantive responsibilities include:

- *Strategic technology roadmapping (2001, ongoing)*, this primary focus of effort explores how roadmapping and related approaches can be adapted for general strategic application. This work has been funded primarily through collaborative projects delivered via IfM ECS Ltd (more than 400 to date) with businesses, government agencies and other organisations. Examples companies worked with include ABB, Acado, Airbus, AstraZeneca, Atos, BAE Systems, BASF, Bosch, BP, BOC, BT, Carl Zeiss, Caterpillar, Crown Packaging, Daimler, GE, GKN, GSK, Henkel, Ineos, Lego, Mars, Microsoft, Nasa, Pfizer, RNLI, Rolls-Royce, Siemens, Tata, Unilever, and Vodafone. Increasingly the approach is being applied within the academic sector, including many collaborative projects in the University of Cambridge, to support research group strategy (e.g. bulk superconductors) and proposals, and University administration and leadership, for the Schools of Technology, Clinical Medicine and Humanities and Social Sciences, and recently a College.

National and sector level projects:

- UK Foresight Vehicle Technology Roadmap (2001, 2004), with DTI and SMMT
- Green chemical roadmap (2004), with Crystal Faraday Partnership
- UK Ministry of Defence technology roadmapping guidance (2005), with MoD
- 2020 roadmap for computational science (2006), with Microsoft
- UK measurement and standards for emerging technologies roadmap (2008), with NPL
- Mapping the future of the Australian rail supply network (2009), with ANU
- UK Technology Strategy Board (TSB, now Innovate UK) roadmapping initiative (2006-09).
- Automotive Australia 2020 (2010), with ANU

¹ www.ifm.eng.cam.ac.uk/research/ctm/stim

² Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2004), 'Technology roadmapping - a planning framework for evolution and revolution', *Technological Forecasting & Social Change*, 71(1-2), pp. 5-26.

- UK rail industry research route map, in collaboration with the Department for Transport (DfT) and the Technical Strategy Advisory Group (TSAG) of the Rail Safety and Standards Board (RSSB).
 - UK marine industries roadmap & capability study, 2011
 - The future of high value manufacturing in the UK – Pharmaceutical, Biopharmaceutical and medical device sectors, 2012
 - Stratified medicine in the UK – visual and roadmap, 2012
 - The future of synthetic biology, 2012
 - A landscape for the future of high value manufacturing in the UK, 2012
 - Kazakhstan upstream and oil and gas technology and R&D roadmap, 2013
 - Technology roadmap for the UK marine industries, 2015
- *Cambridge Integrated Knowledge Centre (CIKC) 'ACET' project (2007-10)*, using roadmapping methods to support exploitation of emerging technology in the field of molecular and macromolecular materials. The programme is funded by the EPSRC, involving collaboration with the Cambridge Centre for Advanced Photonics and Electronics (CAPE), the Cavendish Laboratory, Judge Business School and IfM.
 - *IfM Emerging Industries Programme 'Transitions' project (2007-10)*, developing strategic frameworks and tools to support organisations to navigate the complex process of industrial emergence, creating value from science and technology. The programme is funded by the EPSRC, as part of the IfM's Innovative Manufacturing Research Centre (IMRC) grant.
 - *Technology intelligence (2005, ongoing)*, developing frameworks, processes and tools for supporting organisations to mine, trawl, target and scan for external and future technology of strategic importance. The initial project was funded by the EPSRC, as part of the IfM's IMRC grant, extended with industrial funding in a consortium to explore the role of intermediaries.
 - *Technology insertion (2005, ongoing)*, developing frameworks, processes and tools for supporting organisations to insert new technological capability into complex in-service engineered systems, governed by a framework for military capability. This work has been funded by EPSRC, in collaboration with BAE Systems.
 - *Business Appraisal of Technology Potential & Marketing Technology (2004 to 2009)*, developing frameworks, processes and tools for appraising, valuing and marketing technology. Areas of focus included portfolio methods and value roadmapping. These projects were funded by the EPSRC, as part of the IfM's IMRC grant.
 - *Strategic technology management (1998-2001)* – the focus of this research was the development of methods for helping companies to initiate technology roadmapping processes. Outputs from this work included a published self-help guide ('T-Plan', translated into German, Japanese, Chinese and Spanish), training and facilitation services and an active user group. In addition, a high-level framework for supporting technology management has been developed, together with a general-purpose management tool catalogue ('T-Cat'). EPSRC referees rated this project as 'tending to outstanding'.
 - *Technology management processes (1997-98)* – how processes for managing technological knowledge can be identified and improved. A key output from this EPSRC funded research was a self-help guide ('TMAP'), published by the IEE in 2000.

Keynote presentations

- Gartner Enterprise Architecture & Technology Innovation Summit, 23 May 2018
- Roadmapping in der praxis, IAO Fraunhofer, 2016-17
- Roadmapping Technology Seminar, Heathrow, 2006 – 2016
- CORFU, Chile (Santiago & Concepción), 2015

- TATA CTO conference, Bangalore, 2010
- Aerospace & Defence KTN Conference, London, 27 April 2010
- Chinese Ministry of Science and Technology Seminar, Beijing, 15 September 2009
- Technology Roadmapping Seminar – Concepts, Practice and Perspectives, University of Sao Paulo, Brazil, 31 August 2009
- Chinese book launch, Beijing, 14 September 2009
- R&D Management Conference, 2-6 July 2007, Bremen,
- Global Advanced Technologies Innovation Consortium (GATIC), Kyoto, 30-31 October 2006
- Cutter Consortium Summit, Boston, 10 May 2006
- PICMET Conference (Innovation management in the technology-driven world), Seoul, 4 August

Teaching and executive education

- Regular contributions to teaching at under- and post-graduate levels (Manufacturing Engineering Tripos (MET), Masters in Industrial Systems, Manufacture and Management (ISMM), Manufacturing Leaders' Programme (MLP), including supervision of numerous masters research and in-company projects, acting as Advisor or Supervisor for 20 PhD projects since 1998.
- Development and delivery of public executive education courses on the concept and practice of strategic technology roadmapping and related frameworks and approaches (3 day-courses per annum, 2002 onwards), with more than 750 participants over the years.
- Development and delivery of customised executive education courses on the concept and practice of strategic roadmapping for companies and other organisations in Austria, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Estonia, Germany, Hong Kong, India, Ireland, Italy, Japan, Korea, Luxembourg, Malaysia, Mexico, Netherlands, Norway, Singapore, Slovakia, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, UK and the USA. (2003 onwards).
- Contribution to the United Nations Industrial Development Organisation (UNIDO) foresight training for government and industry, in Prague and Bratislava (2003-09).
- Development and delivery of specialist technical training courses relating to structural integrity assessment, TWI (1990-1997).

Previous employment

Organisation: The Welding Institute (TWI), Cambridge
 Dates: October 1990 to February 1997
 Job title: Senior Project Engineer / Section Manager

Based within the Structural Integrity Department at TWI, which provides technical services concerning materials joining technology to over 2,500 industrial member companies on an international basis, responsibilities included:

- Professional engineering consulting and applied research services, relating to structural integrity assessment of critical welded components. During six years at TWI more than 50 consulting, development, training and collaborative research projects were managed, including experimental and analytical work. Clients included companies in a wide range of industries, together with regulatory bodies and insurance companies.
- Management of a software section, providing general IT support to the Department, together with the development and marketing of a range of commercial software packages relating to structural integrity assessment and the automation of British Standards.

Education

- **PhD:** Computational Mechanics, 1987 - 1990, University of Cambridge, UK
Research focused on novel methods for analysis of shell structures using simple physical analogies. The work involved the development of a computational finite element model, together with experimental validation.
- **MSc:** Applied Mechanics, 1986 - 1987, University of Cape Town, South Africa
Applied and computational mechanics, with an emphasis on numerical (finite element) modelling. Research involved the analysis of flexible marine riser systems.
- **BSc:** Mechanical Engineering, 1982 - 1985, University of Cape Town, South Africa
General mechanical engineering, including design, structural mechanics, materials science, fluid mechanics, thermodynamics, engineering mathematics, computing, numerical modelling, production engineering, electrical engineering, acoustics, engineering physics and chemistry, engineering drawing, management accounting, contract law, etc.
Distinctions: First Class pass (1985)
South African Society of Mechanical Engineers Gold Medal for best final year design and research project (1985)
Class prize (1984)
- **Professional:** Chartered Engineer (1993 onwards), and Member of the IET

Journal publications

1. Vinayavekhin, S. and Phaal, R. (2019), 'Synchronization in strategic planning: a roadmapping framework', *International Journal of Innovation and Technology Management* (In Press, Corrected Proof): <https://doi.org/10.1142/S0219877019500445>.
2. Yip, M.H., Phaal, R. and Probert, D.R. (2017?), 'Integrating multiple stakeholders' interests into new product-service system conceptual design', *Engineering Management Journal* (In Press, Corrected Proof): <https://doi.org/10.1080/10429247.2019.1570456>.
3. Kerr, C.I.V.K., Phaal, R. and Thams, K. (2017), 'Customising and deploying roadmapping in an organisational setting: the LEGO Group experience', accepted by *Journal of Engineering and Technology Management*, vol, no, pp. [REFable] Available 31/10/17 (In Press, Corrected Proof)
4. Kerr, C. & Phaal, R. (2018), 'Directing the technology intelligence activity: An 'information needs' template for initiating the search', *Technological Forecasting & Social Change*, 134, pp. 265-276.
5. Hamilton, C., Maw, A., Gil, A., Phaal, R. and Pickard, J. (2017), 'Paediatric neurorehabilitation: finding and filling the gaps through the use of the Institute for Manufacturing strategic roadmapping method', *BMJ Innovations*, 3, pp. 137-143.
6. Kerr, C. and Phaal, R. (2017), 'An exploration into the visual aspects of roadmaps: the views from a panel of experts', *Journal of Technology Intelligence and Planning*, 11 (3), pp. 252-277.
7. Cetindamar, D., Phaal, R. and Probert, D. (2016), 'Technology management as a profession and the challenges ahead', *Journal of Engineering and Technology Management*, 41, pp. 1-13.
8. Broken, N.M.O., Rana, P., Athanassopoulou, N., Ilevbare, I. and Phaal, R. (2015), 'A strategy process for early stage ventures to develop sustainable value opportunities', *Sustainable Design and Manufacturing*, pp. 183-200.
9. Jeong, Y., Lee, K., Yoon, B. and Phaal, R. (2015), 'Development of a patent roadmap through the generative topographic mapping and bass diffusion model', *Journal of Engineering and Technology Management*, 38, Oct-Dec, pp. 53-70.
10. Yip, M.H., Probert, D.R. and Phaal, R. (2015), 'Characterising product-service systems in the healthcare industry', *Technology in Society*, 43, pp. 129-143.

11. Kerr, C. and Phaal, R. (2015), 'Visualizing roadmaps: a design-driven approach', *Research-Technology Management*, 58 (4), pp. 45-54.
12. Oliveira, M.G., Rozenfeld, H., Phaal, R. and Probert, D. (2015), 'Decision making at the front end of innovation: the hidden influence of knowledge and decision criteria', *R&D Management*, 45 (2), pp. 161-180.
13. Sugihara, T., Fujinami, T., Phaal, R. and Ikawa, Y. (2015), 'A technology roadmap of assistive technologies for dementia care in Japan', *Dementia*, 14 (1), pp. 80-103.
14. Ortiz-Gallardo, V.G., Tietze, F., Probert, D.R. and Phaal, R. (2014), 'Technology acquisition through collaboration: practical insights for technology suppliers', *International Journal of Technology Intelligence and Planning*, 10 (1), pp. 67-85.
15. Ilevbare, I.M., Probert, D. and Phaal, R. (2014), 'Towards risk-aware roadmapping: influencing factors and practical measures', *Technovation*, 34 (8), pp. 399-409.
16. Yip, M.H., Phaal, R. and Probert, D.R. (2014) 'Stakeholder engagement in early stage product-service-system development for healthcare informatics', *Engineering Management Journal*, 26 (3), pp. 52-62.
17. Ford, S.J., Routley, M.J., Phaal, R. and Probert, D.R. (2014), 'The industrial emergence of commercial inkjet printing', *European Journal of Innovation Management*, 17 (2), pp. 126-143. [Best paper]
18. Kerr, C.I.V., Phaal, R. and Probert, D.R. (2014) 'Depicting the future strategic plans of the Royal Australian Navy using a roadmapping framework as a visual composite canvas', *Technology Analysis & Strategic Management*, 26 (1), pp. 1-22.
19. Yoon, B. and Phaal, R. (2013), 'Structuring technological information for technology roadmapping: data mining approach', *Technology Analysis & Strategic Management*, 25 (9), pp. 1119-1137.
20. Probert, D.R., Ford, S.J., Routley, M.J., O'Sullivan, E. and Phaal, R. (2013), 'Understanding and navigating industrial emergence', *Proceedings of the Institution of Mechanical Engineers, Part B, Journal of Engineering Manufacture*, 227 (6), pp. 781-793.
21. Probert, D., Dissel, M., Farrukh, C., Mortara, L., Thorn, V. and Phaal, R. (2013), 'The process of making the business case for technology: a sales and marketing perspective for technologists', *Technology Forecasting & Social Change*, 80(6), pp. 1129-1139.
22. Kerr, C., Farrukh, C., Phaal, R. and Probert, D. (2013), 'Key principles for developing industrially relevant strategic technology management toolkits', *Technology Forecasting & Social Change*, 80(6), pp. 1050-1070.
23. Routley, M., Phaal, R. and Probert, D. (2013), 'Exploring industry dynamics and interactions', *Technological Forecasting & Social Change*, 80(6), pp. 1147-1161.
24. Routley, M., Phaal, R., Athanassopoulou, N. and Probert D. (2013), 'Mapping experience in organizations: a learning process for strategic technology planning', *Engineering Management Journal*, 25 (1), pp. 35-47.
25. Ilevbare, I.M., Probert, D. and Phaal, R. (2013), 'A review of TRIZ, and its benefits and challenges in practice', *Technovation*, 33 (2-3), pp. 30-37.
26. Lee, J.H., Phaal, R. and Lee, S-H. (2013), 'An integrated service-device-technology roadmap for smart city development', *Technology Forecasting & Social Change*, 80, pp. 286-306.
27. Kerr, C., Phaal, R. and Probert, D. (2012), 'Addressing the cognitive and social influence inhibitors during the ideation stages of technology roadmapping workshops', *International Journal of Innovation and Technology Management*, 9 (6), pp. 1-20 (DOI: 10.1142/S0219877012500460).
28. Lee, S., Mortara, L., Kerr, C., Phaal, R. and Probert, D (2012), 'Analysis of document-mining techniques and tools for technology intelligence: discovering knowledge from technical documents', *International Journal of Technology Management*, 60 (1-2), pp. 130-156.
29. van der Hoven, C., Probert, D., Phaal, R. and Goffin, K. (2012) 'Dynamic technology leadership: the adaptive role of the CTO', *Research-Technology Management*, 55 (5), pp. 24-33.
30. Kerr, C., Phaal, R. and Probert, D. (2012), 'Depicting options and investment appraisal information in roadmaps', *Journal of Innovation and Technology Management*, 9 (3), pp. 1-19.
31. Phaal, R., Kerr, C., Oughton, D. and Probert, D. (2012), 'Towards a modular toolkit for strategic technology management', *International Journal of Technology Intelligence and Planning*, 8 (2), pp. 161-181.
32. Ford, S.J., Routley, M.J., Phaal, R. and Probert, D.R. (2012), 'Capturing past experience: the expert scan visual mapping process', *International Journal of Technology Intelligence and Planning*, 8(1), pp. 47-59.
33. Phaal, R., Routley, M., Athanassopoulou, N. and Probert, D. (2012), 'Charting exploitation strategies for early stage technology', *Research-Technology Management*, 55 (2), March-April, pp. 34-42.
34. Kerr, C., Phaal, R. and Probert, D. (2012), 'Cogitate, articulate, communicate: the psychosocial reality of technology roadmapping and roadmaps', *R&D Management*, 42(1), pp. 1-13.

35. Lee, J.H., Kim, H. and Phaal, R. (2011), 'An analysis of factors improving technology roadmap credibility: a communications theory assessment of roadmapping processes', *Technological Forecasting & Social Change*, 79, pp. 263-280.
36. Oliveira, M.G., Phaal, R., Probert, D., Cunha, V.P. and Rozenfeld, H. (2011), 'A starting point for addressing product innovativeness in the fuzzy front-end', *International Journal of Technology Intelligence and Planning*, 7(4), pp. 309-326.
37. Keltch, J.-N., Probert, D.R. and Phaal, R. (2011), 'A process for configuring technology management tools', *International Journal of Technology Intelligence and Planning*, 7(3), pp. 181-200.
38. Lee, J.H., Phaal, R. and Lee, C. (2011), 'An empirical analysis of the determinants of technology roadmap utilization', *R&D Management*, 41(5), pp. 485-508.
39. Lee, S., Mortara, L., Kerr, C., Phaal, R. and Probert, D. (2011), 'Corporate document mining for technology intelligence: an analysis of needs, utilisation, an possibilities', *International Journal of Technology Intelligence and Planning*, 7 (2), pp. 110-127.
40. Thorn, V., Hunt, F., Michell, R., Probert, D. and Phaal, R. (2011), 'Internal technology valuation: real world issues', *International Journal of Technology Management*, 53(2-4), pp. 149-160.
41. Phaal, R., O'Sullivan, E., Routley, M., Ford, S. and Probert, D. (2011), 'A framework for mapping industrial emergence', *Technological Forecasting & Social Change*, 78, 8(1), pp. 217-230.
42. Mortara, L., Thomson, R., Moore, C., Armara, K., Phaal, R. and Probert, D. (2010), 'Developing a technology intelligence strategy at Kodak European Research: scan and target', *Research Technology Management*, 53(4), pp. 27-38.
43. Goenaga, J.M. and Phaal, R. (2010), 'El roadmapping en la industria: experiencias', *Dyna Mayo*, 85 (4), pp. 331-340.
44. Phaal, R. and Palmer, P.J. (2010), 'Technology management: structuring the strategic dialogue', *Engineering Management Journal*, 22(1), pp. 27-37.
45. Kerr, C., Phaal, R. and Probert, D. (2010), 'Ranking maritime upgrade options', *Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment*, 224(1), pp. 47-59.
46. Tao, L., Probert, D. and Phaal, R. (2010), 'Towards an integrated framework for managing the process of innovation', *R&D Management*, 40(1), pp. 19-30.
47. Dissel, M.C., Phaal, R., Farrukh, C.J. and Probert, D.R. (2009), 'Value roadmapping: a systematic approach for early stage technology investment decisions', *Research Technology Management*, Nov-Dec, pp. 45-53.
48. Goenaga, J.M. and Phaal, R. (2009), 'Agile strategy: lessons from the Basque Country', *Research Technology Management*, July-August, 52 (4), pp. 9-12.
49. Mortara, L., Kerr, C.I.V., Phaal, R. and Probert, D.R. (2009), 'Technology intelligence practice in UK technology-based companies', *International Journal of Technology Management*, 48 (1), pp. 115-135.
50. Farrukh, C., Dissel, M., Jackson, K., Phaal, R. and Probert, D. (2009), 'Valuing technology along a timeline of technological maturity', *International Journal of Technology Management*, 48 (1), pp. 42-55.
51. Mortara, L., Kerr, C.I.V., Phaal, R. and Probert, D.R. (2009), 'A toolbox of elements to build technology intelligence systems', *International Journal of Technology Management*, 47 (4), pp. 322-345.
52. Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2009), 'Visualising strategy: a classification of graphical roadmap forms', *International Journal of Technology Management*, 47 (4), pp. 286-305.
53. Cetindamar, D., Phaal, R. and Probert, D. (2009), 'Understanding technology management as a dynamic capability: a framework for technology management activities', *Technovation*, 29 (4), pp. 237-246.
54. Phaal, R., Muller, G. (2009), 'An architectural framework for roadmapping: towards visual strategy', *Technology Forecasting & Social Change*, 76 (1), pp. 39-49.
55. Beeton, D.A., Phaal, R. and Probert, D.R. (2008), 'Exploratory roadmapping for foresight', *International Journal of Technology Intelligence and Planning*, 4 (4), pp. 398-412.
56. Kerr, C., Phaal, R. and Probert, D. (2008), 'Technology insertion in the defence industry: a primer', *Proceedings of the Institute of Mechanical Engineers, Part B*, 222 (8), pp. 1009-1023.
57. Kerr, C., Phaal, R. and Probert, D. (2008), 'A strategic capabilities-based representation of the future British armed forces', *International Journal of Intelligent Defence Support Systems*, 1 (1), pp. 27-42.
58. Remo, R., Andrienko, G., Andrienko, N., Blackwell, A., Börner, K., Brodbeck, D., Dykes, J., Eppler, M., Fekete, J.-D., Grün, A., Herr, B., Huang, J., Kienreich, W., Koutamanis, A., Lang, S., Meagher, M., Perrin, D., Phaal, R., van de Moere, A. and Weber, W. (2007), 'Visualization Summit 2007: ten research goals for 2010', *Information Visualisation Journal*, 6 (3), pp. 169-188.
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60. Yoon, B., Phaal, R. and Probert, D.R. (2008), 'Morphology analysis for technology roadmapping: application of text mining', *R&D Management*, 38 (1), pp. 51-68.
61. Phaal, R., Farrukh, C.J. and Probert, D.R. (2007), 'Strategisches roadmapping: die verknüpfung von technologie, management und markt', *OrganisationsEntwicklung*, Nr. 2, pp. 81-86.
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63. Shehabuddeen, N., Probert, D. and Phaal, R. (2006), 'From theory to practice: challenges in operationalising a technology selection framework', *Technovation*, 26, pp. 324-355..
64. Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2006), 'Technology management tools: generalization, integration and configuration', *International Journal of Innovation and Technology Management*, 3 (3), pp. 1-19.
65. Kerr, C.I.V., Mortara, L., Phaal, R. and Probert, D.R. (2006), 'A conceptual model for technology intelligence', *International Journal of Technology Intelligence and Planning*, 2(1), pp. 73-93.
66. Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2006), 'Technology management tools: concept, development and application', *Technovation*, 26(3), pp. 336-344.
67. Hunt, F.H., Mitchell, R., Phaal, R. and Probert, D.R. (2004), 'Early valuation of technology: real options, hybrid models and beyond', *Journal of Instrument and Control Engineers*, 43(10) pp. 730-735.
68. Paramanathan, S., Farrukh, C.J.P., Phaal, R. and Probert, D.R. (2004), 'Implementing industrial sustainability: the research issues in technology management', *R&D Management Journal*, 34 (5), pp. 527-537.
69. Farrukh, C., Fraser, P., Hadjidakis, D. Phaal, R., Probert, D. and Tainsh, D. (2004), 'Developing an integrated technology management process', *Research Technology Management*, 47(4), pp. 39-46.
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71. Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2004), 'Customizing roadmapping', *Research Technology Management*, 47 (2), pp. 26-37.
72. Wells, R., Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2004), 'Technology roadmapping for a service organization', *Research Technology Management*, 47 (2), pp. 46-51.
73. Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2004), 'A framework for supporting the management of technological knowledge', *International Journal of Technology Management*, 27(1), pp. 1-15.
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