

Benny Raphael

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SUMMARY

Career and education

2023-	Head of the department, Civil Eng. Dept, IIT Madras
2013-present	Professor, Associate Professor, IIT Madras
2006-2013	Assistant professor, Dept. of building, NUS.
1997-2005	Post doctoral fellow, Fonctionnaire scientifique, chargee de cours (Lecturer), EPFL, Switzerland
1996-1997	Senior Systems Analyst, <i>Infosys Technologies</i> , Bangalore
1992-1995	PhD, Civil Eng., Univ. of Strathclyde, Glasgow, UK
1990-1992	MS, Structural Eng., IIT Madras
1986-1990	BTECH, Civil Eng., IIT Madras

Interests: Optimisation, Machine learning, BIM, Building automation and control, Construction automation, Sustainable and Green Buildings.

Awards and Achievements:

- JC Bose Patent award for the invention entitled “A climbing robotic system for automated construction of structural frames of buildings and methods thereof”, 2022.
- Best Paper Award: International Conference on Civil and Building Engineering Informatics, Tokyo, Japan, 2013.
- Distinguished R&D award (2011) from the Minister for National Development (Government of Singapore) for innovation in developing the Zero Energy Building.
- ASCE (American Society of Civil Engineers) best paper award (2008)
- ASCE (American Society of Civil Engineers) best paper award (2003)
- IBM and Intel sponsored first prize (gold) in the High Performance Computing Challenge 2009 under parallel computing category organised by NUS.
- IBM sponsored second prize in HPC Challenge 2006 under grid computing category organised by NUS.
- The book he wrote “Fundamentals of computer aided engineering” (Raphael and Smith, John Wiley, 2003) is used as a textbook in Universities such as Carnegie Mellon University (CMU) (USA), Delft (Netherlands), Cardiff (U.K.), National Taiwan University, (Taipei), NUS (Singapore) and EPFL (Switzerland).
- 60 papers in international journals, 60 papers in peer-reviewed conferences, 3 books and monographs. More than 2000 citations to his publications (excluding self citations).
- Institution of Engineers India gold medal for the best student paper (1990)

Positions held:

- Associate Editor, Automation in Construction, ranked number one among all civil engineering journals.

- Member of the editorial board of the journal, *Advanced Engineering Informatics*.
- Associate Editor, *Frontiers in Built Environment*
- Member of core committee of Indian Green Building Council (IGBC), Chennai Chapter
- Board member and international vice president of the International Association for Automation and Robotics in Construction (IAARC)

Projects:

- Infosys Daimler Benz project, 1996-1997. Code optimization of an existing finite element error analysis program
- RACOPRO, Risk assessment using CBR and probabilistic analysis, 1998-2001. Client: Steiner Engg SA, Switzerland
- KnowPrice, Cost estimation using derivational analogy, 2004-2005. Client: TEKHNE Management, Switzerland
- PGSL 1999-2004. Developed a general purpose global optimisation algorithm, used by many for tasks such as design, diagnosis, control, and parameter identification
- SICPA, 2004. Optimisation of mechanical design of a product of SICPA Switzerland
- Alexandra (Khoo Teck Puat) hospital, 2006. Total Building Performance Consultant to the Alexandra hospital at Yishun, Singapore.
- BCA Zero Energy Building, 2007. Collaborator in the research project that involved the construction of a zero energy building at the BCA Academy, Singapore.
- Future Cities Laboratory Co-PI in collaboration with ETH Zurich and EPFL, Switzerland (<http://www.futurecities.ethz.ch/people/>).
- Integrated Control of Indoor Environment Quality, NUS Research Project, 2006-2010. Developed a methodology for the control of indoor environment using multi-objective optimization of several performance criteria.
- Analysis of the global construction industry using computer-based cartography, Co-PI of NUS Research Project, 2007-2010.
- Establishment of a Building Automation Laboratory, Funded by the New Faculty Seed Grant, IIT Madras, 2013.
- MULTI-OBJECTIVE OPTIMIZATION OF DAY LIGHTING SYSTEMS, Funded by CEFIPRA and SGRI, 2015-present.
- Automated assembly of modular building structures, Funded by DST, 2016-present.
- 3D Printing and Construction Automation for Affordable Housing, Funded by DST IMPRINT, 2019-present.
- Condition assessment of railway bridges, Funded by Southern Railways, 2019-present.
- Solar Protection for Residences and Public Spaces, Funded by WEBDATACAST LLC., USA, 2019-present.

Doctoral Theses Supervised:

Active control of a tensegrity structure, EPFL, Switzerland, (2002).

System identification of civil engineering structures, EPFL, Switzerland, (2003).

Machine learning techniques for improving the reliability of system identification, EPFL, Switzerland, (2006)

Evaluation of Construction IT Business value, University of Salford, UK, (2013)

System identification for improving the accuracy of urban environment simulations, NUS, Singapore, (2015)

Sensor configuration for improving the accuracy of urban environment simulations, NUS, Singapore, (2015)

Multi-criteria optimization of project resources, IIT Madras, 2019.

Sensor placement, operation identification, and fault detection for automated construction monitoring, IIT Madras, 2021.

Thermal performance of light shelves, IIT Madras (2023)

Project performance of automated construction processes, IIT Madras (2024)

Computer vision for monitoring of 3D Printing (2025)

Teaching

1. Client server computing, distributed applications (Infosys, Bangalore)
2. Operating systems, Unix (Infosys, Bangalore)
3. Topics in Computer aided engineering (EPFL, Switzerland)
4. Computing skills (IIT Madras)
5. Structural engineering design studio (IIT Madras)
6. Visualization in design and technology (NUS, Singapore)
7. Structural Systems (NUS, Singapore)
8. I.T. for projects (NUS, Singapore)
9. Intelligent Facilities (NUS, Singapore)
10. CAD in Civil Engineering (IIT Madras)
11. Smart Buildings and Automation (IIT Madras)
12. Building Sciences Lab (IIT Madras)
13. Construction Software Laboratory (IIT Madras)
14. Machine Learning in Civil Engineering (IIT Madras)

More than 12 workshops conducted for industry and engineering colleges on construction automation and machine learning.

PUBLICATIONS

Books

1. B. Kumar and B. Raphael, Derivational analogy based structural design, Saxe-Coburg Publications, UK, (2001) (176 pages). (<http://www.saxe-coburg.co.uk/pubs/descrip/cbd.htm>)
2. B. Raphael and I.F.C. Smith, Fundamentals of computer aided engineering, John Wiley and sons, Ltd, 2003 (306 pages).
3. S. Saitta, B. Raphael and I.F.C. Smith, Data Mining: Applications in Civil Engineering, Saarbrücken: VDM Verlag, 2009. (184 pages).
4. B. Raphael and I.F.C. Smith, Engineering Informatics: Fundamentals of computer aided engineering, Edition 2, John Wiley and sons, Ltd, 2013 (333 pages).
5. B. Raphael, Construction and Building Automation: From Concepts to Implementation (1st ed.). Routledge. <https://doi.org/10.1201/9781003165620> 2022. (276 pages).

Journal papers

6. B.Raphael and C.S.Krishnamoorthy, Automating finite element development using object oriented techniques, *International journal of Engineering Computations*, Peneridge Press Ltd., vol 10, pp.267-278 (1993).
7. C.S.Krishnamoorthy, B.Raphael & S.Mukherjee, Meshing by successive superelement decomposition (MSD) - A new approach to quadrilateral mesh generation, *International journal of Finite Elements in Analysis and Design*, Elsevier Science B.V., 20, pp. 1-37, (1995).
8. B Raphael and B Kumar, Indexing and Retrieval of cases in a Case-based Design Systems, *International Journal of Artificial Intelligence in Engineering, Design, Analysis and Manufacture*, Cambridge University Press, 10, pages 47-63, March (1996).
9. B. Raphael and B. Kumar, Object-oriented Representation of Design Cases, *International Journal of Computers and Structures*, Pergamon Press, Vol 63, No. 4, pages 663-668, (1997).
10. B Kumar and B Raphael, Reconstructive Memory in Case-based Design, *International Journal of Artificial Intelligence in Engineering*, Elsevier Science, Vol. 11, pages 245-258 (1997).
11. B Kumar and B Raphael, CADREM: A Case-based System for Conceptual Structural Design, *International Journal of Engineering with Computers*, Springer-Verlag London Ltd., Vol. 13, pages 153-164, (1997).

12. Raphael, B. and I Smith. Case-based model selection for engineering diagnosis, *Advances in Case-Based Reasoning*, Computer Science, LNAI 1488, Springer, Heidelberg, pp 112-125, (1998).
13. B.Raphael and I.Smith, Finding the right model for bridge diagnosis, *In Artificial intelligence in structural engineering, Information technology for design, collaboration, maintenance and monitoring*, Lecture notes in artificial intelligence 1454, pp.308-319, Springer, (1998).
14. P. Svanerudh, B. Raphael, I.F.C.Smith, Lowering costs of timber shear-wall design using global search, *Engineering with computers*, Springer, Vol 18, No 2, 2002, pp 93-108.
15. B. Raphael, G. Bhatnagar, and I.F.C. Smith, "Creation of flexible graphical user interfaces through model composition, *AIEDAM*, Vol 16, No 3, 2002, pp 173-184.
16. B. Raphael and I.F.C. Smith, A direct stochastic algorithm for global search, *J of Applied Mathematics and Computation*, Vol 146, No 2-3, 2003, pp 729-758.
17. B. Domer, B. Raphael, K. Shea and I.F.C. Smith, "A study of two stochastic search methods for structural control", *Journal of Computing in Civil Engineering*, (JCCE), Vol 17, No 3, 2003, pp 132-141.
18. B. Raphael and I.F.C. Smith, "Global search through sampling using a PDF", *Lecture Notes in Computer Science*, Vol 2827, 2003, pp 71-82.
19. A. Patil, B. Raphael, P. Rastogi, Generalized phase-shifting interferometry using direct stochastic algorithm for global search, *Optics Letters*, 29, pp. 1381-1383, 2004.
20. A. Patil, B. Raphael, P. Rastogi, Introduction of stochastic methods to phase shifting interferometry, *Journal of Modern Optics*, 52, pp. 33-44, 2005.
21. A. Patil, P. Rastogi, B. Raphael, A stochastic method for generalised data reduction in holographic moiré, *Optics communications*, 248, 395-405 (2005).
22. Y. Robert-Nicoud, B. Raphael and I.F.C. Smith, System identification through model composition and stochastic search, *ASCE journal of Computing in Civil Engineering*, (JCCE), Vol 19, No 3, 2005, pp. 239-247.
23. Y. Robert-Nicoud, B. Raphael and I.F.C. Smith, Configuration of measurement systems using Shannon's entropy function, *Computers and Structures*, 83, pp. 599-612, 2005.
24. Y. Robert-Nicoud, B. Raphael, O. Burdet and I.F.C. Smith, Model identification of bridges using measurement data, Vol. 20, 2, *journal of Computer Aided Civil and Infrastructure Engineering*, 2005, pp. 118-131.

25. Saitta, S., Raphael, B. and Smith, I.F.C. "Data mining techniques for improving the reliability of system identification" *Advanced Engineering Informatics*, Vol 19, No 4, 2005, pp 289-298.
26. Patil A, Rastogi P, Raphael B, Phase-shifting interferometry by a covariance-based method, *Appl Opt.* 2005 Sep 20;44(27), pp. 5778-85.
27. Domer B., Raphael B., Saitta S., KnowPrice2: Intelligent cost estimation for construction projects, *Lecture Notes in Computer Science*, 4200, LNAI, pp. 147-152, 2006.
28. Raphael B., Derivational analogy: Challenges and opportunities, *Lecture Notes in Computer Science* 4200 LNAI, pp. 545-553, 2006.
29. Saitta, S., Raphael, B., Smith, I.F.C., Data mining for decision support in multiple-model system identification, *WSEAS Transactions on Systems* 5 (12) , pp. 2795-2800, 2006.
30. Saitta S., Raphael B., Smith I.F.C., Combining two data mining methods for system identification, *Lecture Notes in Computer Science*, 4200 LNAI, pp. 606-614, 2006.
31. Saitta S., B. Raphael and I.F.C. smith, "A bounded index for cluster validity". *Lecture Notes In Computer Science*, 4571 (2007): 174-187.
32. Saitta, S., B. Raphael and I.F.C. Smith, "A comprehensive validity index for clustering". *Intelligent Data Analysis*, 12, no. 6 (2008): 529-548.
33. Low, S P, B. Raphael, F M Arain and S Soh, "Analyzing construction-related market trends in APEC countries using GIS". *Business Review*, 2, no. 2 (2007): 29-46. (Pakistan).
34. Raphael B., B. Domer, S. Saitta and I.F.C. Smith, "Incremental development of CBR strategies for computing project cost probabilities". *Advanced Engineering Informatics*, 21 (2007): 311-321.
35. Saitta, S, P Kripakaran, B. Raphael and I.F.C. Smith, "Improving system identification using clustering". *JOURNAL OF COMPUTING IN CIVIL ENGINEERING*, 22, no. 5 (2008): 292-302.
36. Raphael, B., "Promoting Efficient Use of Visualization Tools through Education". *JOURNAL OF COMPUTING IN CIVIL ENGINEERING*, 23, no. 6 (2008): 428-435.
37. Lim S.P., Low S.P., and B. Raphael, "Analyzing construction trends in the European Union using Geographic Information Systems". *Journal of Construction in Developing Countries*, 13, no. 1 (2008): 1-26. (Malaysia).

38. TEOH, M C, B. Raphael and S P Low, "Lean construction principles and their practice in Singapore". Construction Information Quarterly, 11, no. 1 (2008): 24-28. (United Kingdom).
39. Saitta, Sandro, Prakash Kripakaran, B. Raphael and I.F.C. Smith, "Feature Selection using Stochastic Search: An Application to System Identification". JOURNAL OF COMPUTING IN CIVIL ENGINEERING, 24, no. 1 (2010): 3-10.
40. Raphael, B., "Active Control of Daylighting Features in Buildings". COMPUTER-AIDED CIVIL AND INFRASTRUCTURE ENGINEERING, 26(5), (2011), pp. 393-405.
41. LIM T.H.B, Y.Y Ling, C. William Ibbs, B. Raphael and G Ofori, "An empirical analysis of the determinants of organizational flexibility in construction business". Journal of Construction Engineering and Management-ASCE, 137, no. 3 (2011): 225-237.
42. Raphael B., Multi-criteria decision making for collaborative design optimization of buildings, Built Environment Project and Asset Management, (Emerald publishers), Vol 1, Issue 2, Nov, 2011.
43. LIM T.H.B, Ling Y.Y.F., William Ibbs C., Raphael B. and Ofori G., Mathematical models for predicting organizational flexibility of construction firms in Singapore, Journal of Construction Engineering and Management-ASCE, 138, (2012), pp. 361-375.
44. Pantelic J., Raphael B., Tham K.W., A Preference Driven Multi-Criteria Optimization Tool For HVAC Design And Operation, Energy and Buildings, 55, (2012), pp. 118-126.
45. Y.Chen, B. Raphael, C.S.Sekhar, Individual control of a personalized ventilation system integrated with an ambient mixing ventilation system, HVAC&R, 18(6), (2012), pp. 1136-1152.
46. YANG, J, S C Sekhar, K W Cheong and Benny Raphael, "CFD study and evaluation of different personalized exhaust devices". HVAC&R Research, Volume 19, Issue 8, 17 November 2013, pp. 934-946.
47. YANG, J, S C Sekhar, K W Cheong and Benny Raphael, Performance Evaluation of an Integrated Personalized Ventilation-Personalized Exhaust System in Conjunction with Two Background Ventilation Systems, Building and Environment, Vol 78, 2014, pp. 102-110.
48. YANG, J, S C Sekhar, K W Cheong and Benny Raphael, Performance Evaluation of a novel Personalised Ventilation – Personalised Exhaust system for Airborne Infection Control, Indoor Air, Volume 25, Issue 2, pages 176–187, April 2015.
49. Didier G. Vernay, Benny Raphael and Ian F.C. Smith, Augmenting Simulations Of Airflow Around Buildings Using Field Measurements, Advanced Engineering Informatics, Volume 28, Issue 4, October 2014, Pages 412-424.

50. Maria Papadopoulou, Benny Raphael, Ian F.C. Smith, Chandra Sekhar, Hierarchical sensor placement using joint entropy and the effect of modeling error, *Entropy*, 16, 2014, pp. 5078-510.
51. YANG, J, S C Sekhar, K W Cheong and Benny Raphael, A Time-Based Analysis Of The Personalized Exhaust System For Airborne Infection Control In Healthcare Settings, *Science and Technology for the Built Environment*, Volume 21, Issue 2, 2015, pp. 172-178.
52. Didier G. Vernay, Benny Raphael and Ian F.C. Smith, A Model-Based Data-Interpretation Framework For Improving Wind Predictions Around Buildings, *Journal of Wind Engineering & Industrial Aerodynamics*, Volume 145, October 2015, Pages 219-228.
53. Didier G. Vernay, Benny Raphael and Ian F.C. Smith, Improving simulation predictions of wind around buildings using measurements through system identification techniques, *Building and Environment*, 94, 2015, pp. 620 - 631.
54. Benny Raphael and Krishna Sai Jadhav, Sensor Placement for Structural Monitoring of Transmission Line Towers, *Frontiers in Built Environment*, 25 November, 2015.
55. Y.Chen, B. Raphael, C.S.Sekhar, Experimental and simulated energy performance of a personalized ventilation system with individual airflow control in a hot and humid climate, *Building and Environment*, Volume 96, 1 February 2016, Pages 283–292.
56. Papadopoulou, M., Raphael, B., Smith, I.F.C., Sekhar, C., Evaluating predictive performance of sensor configurations in wind studies around buildings, (2016) *Advanced Engineering Informatics*, 30 (2), pp. 127-142.
57. Maria Papadopoulou, Benny Raphael, Ian F.C. Smith, Optimal Sensor Placement For Time-Dependent Systems: Application To Wind Studies Around Buildings, *ASCE Journal of Computing in Civil Engineering*, 30(2), 2016.
58. Ranjith K. Soman, Benny Raphael, Koshy Varghese, A System Identification Methodology to monitor construction activities using structural responses, *Automation in Construction*, Volume 75, March 2017, pp. 79–90.
59. Warriar, G.A., Raphael, B., Performance evaluation of light shelves, *Energy and Buildings*, Volume 140, 1 April 2017, Pages 19-27.
60. Marimuthu K, Benny Raphael, Ananthanarayanan K, and Koshy Varghese (2017), "Current resource management practices in Indian building construction projects: is it an art or a science?", *NICMAR-Journal of Construction Management*, Vol.XXXII, No.II, April-June-2017, pp. 43-54.
61. Marimuthu Kannimuthu, Benny Raphael, Kuppuswamy Ananthanarayanan, Palaneeswaran Ekambaram, Evaluation of Quality Assessment Framework in

Indian Building Construction Projects, NICMAR-Journal of Construction Management, Vol. XXXIII April - June 2018, No. II, pp. 15-23.

62. K. Sai Kiran, Benny Raphael, Performance Evaluation of a High-Influx, Bubble dehumidifier, *Energy and Buildings*, Volume 173, 15 August 2018, Pages 291–301
63. Marimuthu Kannimuthu, Palaneeswaran Ekambaram, Benny Raphael, Ananthanarayanan Kuppuswamy, "Resource Unconstrained and Constrained Project Scheduling Problems and Practices in a Multiproject Environment," *Advances in Civil Engineering*, vol. 2018, Article ID 9579273, 13 pages, 2018. <https://doi.org/10.1155/2018/9579273/>
64. Stefie J. Stephen, Benny Raphael, Ravindra Gettu and Sujatha Jose, Determination of the tensile constitutive relations of fiber reinforced concrete using inverse analysis, *Construction & Building Materials*, 195, 2019, pp. 405–414.
65. Marimuthu Kannimuthu, Benny Raphael, Ekambaram Palaneeswaran, Ananthanarayanan Kuppuswamy, (2019) "Optimizing time, cost and quality in multi-mode resource-constrained project scheduling", *Built Environment Project and Asset Management*, Volume 9, Issue 1, pp. 44-63. <https://doi.org/10.1108/BEPAM-04-2018-0075>.
66. Marimuthu Kannimuthu, Benny Raphael, Ekambaram Palaneeswaran, Ananthanarayanan Kuppuswamy, (2019). Comparing optimization modeling approaches for the multi-mode resource-constrained multi-project scheduling problem, *Engineering, Construction and Architectural Management*.
67. Benny Raphael, Aparna Harichandran, (2020). Sensor Data Interpretation in Bridge Monitoring—A Case Study, *Frontiers in Built Environment*, Vol. 5, pp. 148.
68. Aparna Harichandran, Benny Raphael, and Abhijit Mukherjee, A Hierarchical Machine Learning Framework for Identification of Automated Construction Operations, DOI: 10.36680/j.itcon.2021.031, *Journal of Information Technology in Construction*, Vol. 26 (2021), pp. 591-623.
69. Sundararaman Krishnamoorthi and Benny Raphael, Performance Evaluation of Automated Construction Processes, *Built Environment Project and Asset Management*, 12, 5, 2021.
70. Benny Raphael, Shanmugaraj Senthilnathan, Abhishek Patel and Saqib Bhat, A review of concrete 3D printed structural members, *Frontiers in Built Environment*, January 2023. <https://doi.org/10.3389/fbuil.2022.1034020>
71. Archana P. Ambadi, Benny Raphael, Experimental evaluation of radiant heat transmitted by light shelves, *Journal of Building Engineering*, Volume 63, Part B, 2023, 105534, ISSN 2352-7102, <https://doi.org/10.1016/j.jobbe.2022.105534>

72. Senthilnathan, S.; Raphael, B. Using Computer Vision for Monitoring the Quality of 3D-Printed Concrete Structures. *Sustainability* 2022, 14, 15682. <https://doi.org/10.3390/su142315682>
73. Sundararaman Krishnamoorthi and Benny Raphael, Identifying the right level of automation through model composition and stochastic search, *CSI Transactions on ICT*, <https://doi.org/10.1007/S40012-022-00358-7> , Springer, 2022.
74. Harichandran, A., Raphael, B., & Mukherjee, A. (2022). Equipment activity recognition and early fault detection in automated construction through a hybrid machine learning framework. *Computer-Aided Civil and Infrastructure Engineering*, 00, 1-16. <https://doi.org/10.1111/mice.12848>
75. Krishnamoorthi S., Raphael B. A review of methodologies for performance evaluation of automated construction processes *Built Environment Project and Asset Management*, 12(5), (2022). <https://doi.org/10.1108/BEPAM-03-2021-0059>
76. Archana P. Ambadi, Benny Raphael, Experimental investigation on thermal performance of an actively cooled light shelf, *Solar Energy*, accepted for publication, July 2023.
77. Harichandran, A., Raphael, B., & Mukherjee, A., Relevance of deep sequence models for recognising automated construction activities: a case study on a low-rise construction system, *Journal of Information Technology in Construction*, Vol. 28, pg. 458-481 (2023). <https://doi.org/10.36680/j.itcon.2023.023>
78. Krishnamoorthi, S., Raphael, B., A review of methodologies for performance evaluation of automated construction processes, *Built Environment Project and Asset Management*, 12 (5), pp. 719 - 737, DOI: 10.1108/BEPAM-03-2021-0059, (2022).
79. Senthilnathan S., Raphael B., Using Computer Vision for Monitoring the Quality of 3D-Printed Concrete Structures *Sustainability* (Switzerland), 14 (23), art. no. 15682, (2022). DOI: 10.3390/su142315682
80. P. Ambadi A., Raphael B., Experimental evaluation of radiant heat transmitted by light shelves, *Journal of Building Engineering*, 63, art. no. 105534, (2023) DOI: 10.1016/j.jobbe.2022.105534
81. Senthilnathan S., Raphael B., Predicting Buildability Using the Surface Texture of 3D Printed Concrete Elements, *Journal of Architectural Engineering*, 31 (2), art. no. 04025010, (2025). DOI: 10.1061/JAEIED.AEENG-1936
82. Santhosh S.G., Raphael B., Santhanam M., Concrete 3D Printing of Shape-Optimized Lattice Beams Incorporating Nature-Inspired Patterns, *Journal of Architectural Engineering*, 31 (3), art. no. 04025025, (2025). DOI: 10.1061/JAEIED.AEENG-1942

Papers in conference proceedings (refereed)

83. B.Raphael, Cumulative deflection approach for the analysis of continuous beams, In the *proceedings of fourth Indian Engineering Congress*, held at Bhubaneswar, (1990).
84. B.Raphael and B.Kumar, Representing design cases, In *Knowledge based systems for civil and structural engineering*, (ed. B.H.V.Topping), pp. 259-264, CIVIL-COMP Press, Edinburgh, (1993).
85. B.Raphael, B.Kumar and I.A.MacLeod, Representing design cases based on methods, In *Computing in Civil Engineering*, vol 2, pp. 285-292, American Society of Civil Engineers (ASCE), New York, (1994).
86. B. Kumar, B. Raphael and Ian McLeod, Case-based Reasoning for Structural Design, *First Workshop of the European Group for Structural Engineering Applications of Artificial Intelligence*, Lausanne, March 21-22, (1994).
87. B.Raphael, B.Kumar and I.A.MacLeod, Potential roles for cases in a design system, In *Proceedings of the 6-th International conference of computing in civil and building engineering*, Berlin, (1995).
88. B.Raphael, B.Kumar and I.A.MacLeod, Learning retrieval strategies through examples in a case-based design system, In *proceedings of CIVIL-COMP 1995*, CIVIL-COMP Press, Edinburgh, (1995).
89. B.Raphael, K.Shea and I.Smith, A task and software independent CAE course, In *AICIVIL-COMP99: The fifth international conference on the applications of AI to Civil and Structural Engineering*, Oxford, England, 13-15 September, (1999).
90. I.Smith, and B. Raphael, Development of an undergraduate course on the fundamentals of CAE, *Civil Engineering Learning Technology*, Thomas Telford, London, pp 153-156, (1999).
91. I.Smith, and B. Raphael, "Managing assumptions and models for evaluations of existing structures", *Wydawnictwa Naukowo-Techniczne*, Warsaw, pp 231-234, (1999).
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93. Raphael, B and Smith, I.F.C "A probabilistic search algorithm for finding optimally directed solutions", *Proceedings of Construction Information Technology 2000*, Icelandic Building Research Institute, Reykjavik, 2000, pp 708-721.

94. Smith, I.F.C. and Raphael, B. "A course on the fundamentals of computer-aided engineering" Computing in Civil and Building Engineering ICCCBE VIII, American Society of Civil Engineers, Reston, VA, USA, 2000, pp 681-685.
95. Raphael, B., Bhatnagar, G. and Smith, I.F.C. "A model-based approach for the creation of flexible graphical user interfaces", Artificial Intelligence in Construction and Structural Engineering, CICE, Loughborough University, 2001, pp 43-52.
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97. Y. Robert-Nicoud, B. Raphael, I. F.C. Smith, "Decision support for system identification" Advances in Intelligent Computing in Engineering, 9th International Workshop of EG-ICE, Darmstadt University of Technology, Fortschritt-Berichte, Vol 4, No 180, M. Schnellenbach-Held, H. Denk (Eds.), VDI Verlag Düsseldorf, 2002, pp 92-101.
98. Y. Robert-Nicoud, B. Raphael, I. F.C. Smith, "A methodology for model selection using measurements", Decision Making in Urban and Civil Engineering, London, 2002, pp 1-8 +CDROM
99. B. Raphael, Y. Robert-Nicoud, I. F.C. Smith, "Computing probabilities of costs using cases", Computing in Civil Engineering, ASCE Proceedings IT2002 Washington, American Society of Civil Engineers, Reston, VA, USA, 2002, pp 103-112.
100. Robert-Nicoud, Y., Raphael, B. and Smith, I.F.C. "Improving the reliability of system identification" Next Generation Intelligent Systems in Engineering, Fortschritt-Berichte VDI, 4, No 199, VDI Verlag, 2004, pp 100-109.
101. Robert-Nicoud, Y., Raphael, B. and Smith, I.F.C. "Using entropy to maximize the usefulness of data collection" Xth International Conf. on Computing in Civil and Building Engineering (ICCCBE), Bauhaus-Universität Weimar Universitätsverlag, Weimar, Germany, Karl Beucke, Berthold Firmenich, Dirk Donath, Renate Fruchter, Kim Roddis (eds.), 2004, pp 52-52 + CD.
102. Raphael, B. and Smith, I.F.C. "Engineering Applications of a Direct Search Algorithm, PGSL" Computing in Civil Engineering, Proceedings of the 2005 ASCE Computing Conference, L. Soibelman , F. Pena-Mora (eds), American Society of Civil Engineers, Reston VA, USA, 2005, CDROM.
103. Saitta, S. Raphael, B. and Smith, I.F.C. "Supporting Engineers during System Identification" Computing in Civil Engineering, Proceedings of the 2005 ASCE Computing Conference, American Society of Civil Engineers, Reston VA, USA, 2005, CDROM.

104. Saitta, S. Raphael, B. and Smith, I.F.C. "Data Mining for System Identification Support", 12th EG-ICE Workshop, Borkowski A. (ed.), Poland, 2005, CD-ROM.
105. B. Raphael and S. Saitta, Knowprice: using derivational analogy to estimate project costs, Proceedings of the eighth international conference on the application of artificial intelligence to civil, structural and environmental engineering, B.H.V. Topping, (ed.), Civil-Comp Press, 2005.
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