KNOWLEDGE BASED SYSTEMS FOR CIVIL AND STRUCTURAL ENGINEERING

KNOWLEDGE BASED SYSTEMS FOR CIVIL AND STRUCTURAL ENGINEERING

Edited by B. H. V. TOPPING



CIVIL-COMP PRESS

10 Saxe-Coburg Place Edinburgh, EH3 5BR, UK

© 1993, Civil-Comp Limited

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

ISBN 0-948749-19-9

Printed in Scotland by MEIGLE PRINTERS LTD Galashiels

1 INTEGRATED SYSTEMS FOR DESIGN AND CONSTRUCTION

	1.1	REPRESENTATION ISSUES FOR CIVIL ENGINEERING DESIGN, I.A. Mac- Leod, Department of Civil Engineering, University of Strathclyde, Glasgow, Scot-	
	1.2	land AN AGENT BASED APPROACH TO INFORMATION FOR CONSTRUC-	1
	1.3	TION, I.A. MacLeod [†] and D.G. McGregor [‡] , [†] Department of Civil Engineering, [‡] Department of Computer Science, University of Strathclyde, Glasgow, Scotland INTERDISCIPLINARY COMMUNICATION MEDIUM FOR COLLABORA- TIVE DESIGN, R. Fruchter [†] , M. Clayton [†] , H. Krawinkler [‡] , J. Kunz [†] and P.	5
	1.4	Teicholz [†] , [†] Center for Integrated Facility Engineering, [‡] Department of Civil En- gineering, Stanford University, Stanford, California, United States of America . PROBLEM CENTERED APPROACH TO CONTROL OF AGENTS IN A DE- SIGN ENVIRONMENT, M. Terk and S. J. Fenves, ERDC, Carnegie Mellon Uni-	7
	1.5	versity, Pittsburgh, United States of America	17
	1.6	United States of America	27 37
2	INT	EGRATION OF KBS IN ENGINEERING SOFTWARE	
	2.1	A BLACKBOARD APPROACH FOR THE INTEGRATION OF AN INTELLI- GENT KNOWLEDGE BASED SYSTEM INTO ENGINEERING SOFTWARE, M. Petridis and B. Knight, School of Mathematics Statistics & Computing, The University of Greenwich, Woolwich, London, England	49
3	CO	NSTRUCTION ENGINEERING	
	3.1	INTEGRATION OF BUILDING DESIGN AND CONSTRUCTION DATA: AN OBJECT ORIENTED MODEL, M.S. Kiwan and A.K. Munns, Civil Engineering Department, University of Dundee, Dundee, Scotland	57
	3.2	PROCESS-ORIENTED INTELLIGENT PLANNING FOR THE FABRICATION AND PLACEMENT OF CONCRETE REINFORCEMENT, M. Salim and L.E. Bernold, Department of Civil Engineering, North Carolina State University, Raleigh,	
	3.3	United States of America	67
	3.4	of Science and Technology, University of Teesside, Middleborough, England HISCHED - AN EXPERT SYSTEM FOR CONSTRUCTION PLANNING OF HIGH RISE BUILDINGS, O. Shaked and A. Warszawski, Technion - Israel In-	73
		stitute of Technlogy and National Building Research Institute, Haifa, Israel	81
4	KN 4.1	OWLEDGE ACQUISITION, ELICITATION & SYSTEM EVALUATION KNOWLEDGE ACQUISITION AND REPRESENTATION IN THE GEOTECH- NICAL DESIGN DOMAIN - A CASE STUDY, S. Rowlinson, Department of Surveying, The University of Hong Kong, Hong Kong	85

	4.2	DERIVING RULES FOR BRIDGE AESTHETICS, J.C. Miles, C.J. Moore and S.N. Evans, School of Engineering, University of Cardiff, Cardiff, Wales	91
	4.3	URBAN RAIL CORRIDOR CONTROL THROUGH MACHINE LEARNING: AN IVHS APPROACH, S. Khasnabis [†] , T. Arciszewski [†] , S.K. Hoda [†] and W. Ziarko [‡] , [†] Department of Civil and Environmental Engineering, Wayne State University, Detroit, Michigan, United States of America, [‡] Department of Computer	51
	4.4	Science, University of Regina, Regina, Saskatchewan, Canada	97
	4.5	ough, England	
-	a a i		
5	5.1	NSTRUCTION MANAGEMENT COMMON-OBJECTS: AN OBJECT ORIENTED INFERENCE SYSTEM SHA- RED BY THREE CONSTRUCTION KNOWLEDGE-BASES, I. Watson, P. Bran- don and A. Basden, Department of Surveying, University of Salford, Salford,	
	5.2	England	119
		ucation, Stockport, England	127
6	WA	TER ENGINEERING	
	6.1	A KNOWLEDGE-BASED SYSTEM FOR THE QUALITY CONTROL OF TEL- EMETRY DATA IN WATER DISTRIBUTION NETWORKS, P.J. Watts and B. Knight, School of Mathematics, Statistics & Computing, The University of Greenwich, Woolwich, London, England	135
	6.2	A DECISION SUPPORT SYSTEM TO ASSIST STAKEHOLDERS EVALU- ATE A WATER RESOURCE PROJECT, W.J. Grenney [†] W.W. Wallace [‡] and T. Senti [†] , [†] Utah Water Research Laboratory, Utah State University, [‡] Terrestrial Ecosystems Regional Research and Analysis Laboratory, Fort Collins, Colorado,	100
		United States of America	145
7	GEO	DTECHNICAL ENGINEERING	
	7.1	INTERPRETING BOREHOLE INFORMATION, N. Vaptismas and D.G. Toll, Geotechnical Systems Group, School of Engineering and Computer Science, Uni- versity of Durham, Durham, England	153
	7.2	KNOWLEDGE ACQUISITION AND EVALUATION FOR SELECTION OF SLOPE-PROTECTION STRUCTURES, M. Hirokane, I. Mikami, K. Yagashira, K. Kawano and S. Ohmori, Fukken Chosa Sekkei Co Ltd, Hikarimachi, Higashiku,	
	7.3	Hiroshima, Japan	
		ing and Computer Science, University of Durham, Durham, England	171

8 TRANSPORT & TRAFFIC ENGINEERING

0	110	ANSI ORI & IRAFFIC ENGINEERING	
	8.1	EXPERT SYSTEMS IN TRANSPORTATION ENGINEERING, M. Zaman, G. Bozai, A.S. Mangaokar, A. Soltansi, J.F. Harp, J.L. Gattis and J.G. Laguros, School of Civil Engineering and Environmental Science, The University of Oklahoma, Norman, Oklahoma, United States of America	183
	8.2	DEVELOPMENT OF A REAL TIME IMAGE ANALYSIS SYSTEM FOR TRAF- FIC MONITORING APPLICATIONS, M.S. Thomson [†] , C.L. Wan [†] and T.D. Binnie [‡] , [†] Department of Civil and Transportation Engineering, [‡] Department of	
	8.3	Electronic and Computer Engineering, Napier University, Edinburgh, Scotland . A NATURAL LANGUAGE PROCESSOR FOR ROAD ACCIDENT DATA AN- ALYSIS, J. Wu and B.G. Heydecker, Center for Transport Studies, University College London, London	
•			
9	EA 9.1	RTHQUAKE ENGINEERING AND ASEISMIC DESIGN CONCEPTION OF THE STRUCTURAL SYSTEM OF BUILDINGS BY AN EXPERT SYSTEM, C.A. Syrmakezis and G.K. Mikroudis, Institute for Struc- tural Analysis and Aseismic Research, National Technical University, Athens,	
		Greece	209
	9.2	ESAS - A KNOWLEDGE-BASED EXPERT SYSTEM FOR SEISMIC EVALUA- TION OF RC BUILDINGS, I. Perus and P. Fajfar, Department of Civil Eng, Uni- versity of Ljubljana, Institute of Structural and Earthquake Engineering, Ljubl-	
		jana, Slovenia	217
10	STL	RUCTURAL ANALYSIS	
10		REDRAW - DIAGRAMMATIC REASONING SYSTEM FOR QUALITATIVE STRUCTURAL ANALYSIS, S. Tessler [†] , Y. Iwasaki [†] and K.H. Law [‡] , [†] Knowledge Systems Laboratory, Department of Computer Science, Stanford University, [‡] Dep- artment of Civil Engineering, Stanford University, Stanford, California, United	
	10. 2	States of America	227
		Engineering, Indian Institute of Technology, Madras, India	235
	10.3	STATICALLY INDETERMINATE TRUSSES PROGRAMMED IN LOGIC, V.K. Koumousis, Institute of Structural Analysis & Aseismic Research, National Tech-	
		nical University, Athens, Greece	245
11	DES	SIGN	
	11.1	CASE-BASED DECISION SUPPORT FOR THE DESIGN OF CASTING PRO- CEDURES, D.F. Cowell [†] , B. Knight [†] and K. Preddy [‡] , [†] School of Mathematics, Statistics & Computing, The University of Greenwich, Woolwich, London, Eng- land [‡] K. Preddy Stone Foundries, Woolwich, London, England	251
	11. 2	REPRESENTING DESIGN CASES, B. Raphael and B. Kumar, Department of	
	11.3	Civil Engineering, University of Strathclyde, Glasgow, Scotland	259
		D.T. Ndumu, D. Lloyd Smith and B.A. Izzuddin, Department of Civil Engineer-	
	11 4	ing, Imperial College of Science, Technology & Medicine, London, England	265
	11.4	AN OBJECT-ORIENTED APPROACH FOR BUILDING ENVIRONMENTAL MODELLING, D. Tang and G. Saluia, Department of Civil Engineering, Survey-	

MODELLING, D. Tang and G. Saluja, Department of Civil Engineering, Surveying & Building, Dundee Institute of Technology, Dundee, Scotland 277

12 CONCEPTUAL AND PRELIMINARY DESIGN

12.1	AN INTERACTIVE COMPUTER ASSISTED SYSTEM FOR CONCEPTUAL	
	DESIGN OF STEEL BUILDINGS, H. Fuyamat, H. Krawinklert and K.H. Lawt,	
	†Takasago Research and Development Center, Mitsubishi Heavy Industries Ltd,	
	Takasago, Japan, ‡Department of Civil Engineering, Stanford University, Stan-	
	ford, California, United States of America	285
199	EMPIRICAL EVALUATION OF ENGINEERS' REQUIREMENTS FOR THE	200
12.2	USER-INTERFACE OF A CONCEPTUAL BRIDGE DESIGN EXPERT SYS-	
	TEM, B.T. Philbeyt, C. Milest and J.C. Miles, †School of Psychology, ‡School of	
		007
10.0	Engineering University of Wales College of Cardiff, Cardiff, Wales	291
12.3	DEVELOPMENT OF AN EXPERT SYSTEM FOR THE FUNCTIONAL PLAN-	
	NING OF FARM PRODUCTION BUILDINGS, K. Karstila [†] , J. Pallas [†] , K.	
	Kaustell‡ and E. Heinonen‡, †Laboratory of Urban Planning and Building Design,	
	Technical Research Centre of Finland, Espoo, Finland, ‡Department of Agricul-	
	tural Engineering and Household Technology, University of Helsinki, Faculty of	
	Agriculture and Forestry, Helsinki, Finland	303
12.4	AN INTELLIGENT ASSISTANT FOR THE DESIGN OF GREEN AREAS, J.L.	
	Perez-Cruzt, R. Conejot, L. Mandowt, M.V. Belmontet, R. Moralest and J.I.	
	Garcia-Vinas [‡] , †Dpto L.C. de la Computacion Universidad de Malaga, Malaga,	
	Spain, ‡Dpto Botanica, Universidad de Malaga, Malaga, Spain	311
12.5	PRELIMINARY DESIGN OF TALL BUILDINGS: A KNOWLEDGE BASED	0
12.0	APPROACH, P. Jayachandran, N. Tsapatsaris and B.R. Goldstein, Department	
	of Civil Engineering, Worcester Polytechnic Institute, Worcester, Massachusetts,	
	United States of America	210
	United States of America	319

\circ **PREFACE** \circ

This volume contains some of the papers presented at *CIVIL-COMP93*, The Fifth International Conference on Civil and Structural Engineering Computing and *Artificial Intelligence CIVIL-COMP93*, The Third International Conference in the Application of Artifical Intelligence to Civil and Structural Engineering. These conferences were held currently from 17th - 19th August 1993 at Heriot-Watt University, Edinburgh, Scotland. Other papers from these conferences are published in:

- Information Technology for Civil and Structural Engineers, Civil-Comp Press, (ISBN 0-948749-16-14)
- Developments in Civil and Construction Engineering Computing, Civil-Comp Press, (ISBN 0-948749-17-2)
- Developments in Structural Engineering Computing, Civil-Comp Press, (ISBN 0-948749-20-2)
- Developments in Computational Engineering Mechanics, Civil-Comp Press, (ISBN 0-948749-21-0)
- Neural Networks and Combinatorial Optimization in Civil and Structural Engineering, Civil-Comp Press, (ISBN 0-948749-18-0)

I should like to thank all the authors for their contribution and in particular those who travelled to Edinburgh to present their papers at the Conferences. I should also like to thank members of the Conference Advisory Boards for their assistance.

The members of the CIVIL-COMP93 Conference Advisory Board were: Dr T.J.A. Agar, University of Glasgow, U.K.; Dr R.J. Allwood, University of Technology, Loughborough, U.K.; Dr M.R. Barnes, The City University, London, U.K.; Dr P. Bhatt, University of Glasgow, U.K.; Dr J.W. Bull, University of Newcastle upon Tyne, U.K.; Dr H.C. Chan, University of Hong Kong, Hong Kong; Professor Chang-Koon Choi, Korea Advanced Institute of Science and Technology, South Korea; Professor J Christian, University of Brunswick, Canada; Professor B.M. Das, Southern Illinois University at Carbondale, United States of America; Professor H. Eschenauer, University of Seigen, Germany; Professor D. Frangopol, University of Colorado at Boulder, United States of America; Professor J.A. Teixeira de Freitas, Universidade Tecnica de Lisboa, Portugal; Professor D.E. Grierson, University of Waterloo, Canada; Professor G. Guerlement, Faculte Polytechnique Mons, Belgium; Professor E. Hinton, University College of Wales, Swansea, U.K.; Professor K.C. Hover, Cornell University, United States of America; Professor A. Jennings, The Queen's University of Belfast, U.K.; Professor A. Kaveh, Iran University of Science and Technology, Iran; A.I. Khan, Heriot-Watt University, Edinburgh, U.K.; Professor U. Kirsch, Technion - Israel Institute of Technology, Israel, Dr R Levy, Technion - Israel Institute of Technology, Israel; Professor I.A. MacLeod, University of Strathclyde, Glasgow, U.K.; Professor I. May, Heriot-Watt University, Edinburgh, U.K.; Professor R. McCaffer, University of Technology, Loughborough, U.K.; Professor J.L. Meek, University of Queensland, Australia; Professor R.E. Melchers, The University of Newcastle, Australia; Professor M. Papadrakakis, National Technical University of Athens, Greece; Dr F. Papp; Technical University of Budapest, Hungary; Dr M. Pavlovic, Imperial College, London, U.K.; Dr R. Powell, Brunel University, U.K.; Professor R. Richard, The University of Arizona, United States of America; Professor G. De Roeck, Katholieke Universiteit te Leuven, Belgium; Professor G. Rozvany, University of Essen, Germany; Professor R.L. Sack, University of Oklahoma, United States of America; Professor M.P. Saka, University of Bahrain, State of Bahrain; Professor A. Samartin, Mechanica de los Medios Continuos, Spain; Professor N. Shiraishi, Kyoto University, Japan; Professor L.M.C. Simoes, University of Coimbra, Portugal; Dr G. Singh, University of Leeds, U.K.; Dr T.D. Sloan,

The Queen's University of Belfast, U.K.; Dr D. Lloyd Smith, Imperial College, London, U.K.; Gordon Smyrell, University of Teesside, U.K.; Professor W.R. Spillers, New Jersey Institute of Technology, United States of America; Professor R.M. Stark, University of Delaware, United States of America; Professor H. Sugimoto, Muroran Institute of Technology, Japan; David Taffs, Ove Arup & Partners, London, U.K.; Professor A.B. Templeman, University of Liverpool, U.K.; Professor G. Thierauf, University of Essen, Germany; Dr D.G. Toll, University of Durham, U.K.; Professor N.S. Trahair, The University of Sydney, Australia; Dr G.J. Turvey, University of Lancaster, U.K.; Professor K.S. Virdi, The City University, London, U.K.; Dr S. Walker, National Rivers Authority, Warrington, U.K.; Dr A. Watson, Leeds University, U.K.; Dr F.L. Wong, University of Hertfordshire, U.K.; and Professor Yong Bin Yang, National Taiwan University Taipei, Taiwan.

The members of the Artificial Intelligence CIVIL-COMP93 Advisory Board were: Dr M. Alshawi, University of Salford, U.K.; Professor T. Arciszewski, Wayne State University, United States of America; Dr E Balagurusamy, National Centre for Expert Systems, India; Dr R Beheshti, Delft University of Technology, The Netherlands; Professor D.I. Blockley, University of Bristol, U.K.; Dr D.A. Bradley, University of Lancaster, U.K.; Dr C. Burgoyne, University of Cambridge, U.K.; D. Chamberlain, The City University, U.K.; W.T. Chan, National University of Singapore; Dr T. Cornick, University of Reading, U.K.; Dr R. Coyne, The University of Sydney, Australia; Dr I.E.G. Davey-Wilson, Oxford Polytechnic, U.K.; Dr C.L. Dym, University of Massachusetts, United States of America; E.W. East, US Army Construction Engineering Research Laboratory, United States of America; Professor S.J. Fenves, Carnegie-Mellon University, United States of America; Dr M.A. Fischer, Stanford University, United States of America; Dr R. Fruchter, Stanford University, United States of America; Dr H. Furuta, Kyoto University, Japan; Professor J.M. De La Garza, Virginia Polytechnic Institute and State University, United States of America; Professor J.S. Gero, The University of Sydney, Australia; Professor F.C. Hadipriono, Ohio State University, United States of America; Professor P. Hajela, Rensselaer Polytechnic Institute, United States of America; Dr B.G. Heydecker, University College, London, U.K.; K. Kahkonen, Technical Research Centre of Finland, Espoo, Finland; A.I. Khan, Heriot-Watt University, Edinburgh, U.K.; Dr B. Knight, The University of Greenwich, London, U.K.; Dr V.K. Koumousis, National Technical University of Athens, Greece; Professor C.S. Krishnamoorthy, Indian Institute of Technology - Madras, India; Dr B. Kumar, University of Strathclyde, Glasgow, U.K.; J. Lansdown, Middlesex Polytechnic, U.K.; Professor K.H. Law, Stanford University, United States of America; Professor K.L. Lawrence, The University of Texas at Arlington, United States of America; Professor Liu Xihui, China Academy of Electronics & Information Technology, Beijing, P R China; Professor I.A. MacLeod, University of Strathclyde, Glasgow, U.K.; Professor M.L. Maher, University of Sydney, Australia; Dr J. Miles, University of Wales, Cardiff, U.K.; Dr S.G. Ritchie, University of California, Irvine, United States of America; Dr S. Rowlinson, Hong Kong University; Dr G.G. Roy, The University of Western Australia, Australia; Dr H.C. Shah, Stanford University, United States of America; Dr C.-K. Soh, Nanyang Technological Institute, Singapore; Dr W.J. Spencer, Swimburne Institute of Technology, Australia; Professor D. Sriram, Massachusetts Institute of Technology, Cambridge, United States of America; Professor G. Yagawa, University of Tokyo, Japan; and Dr K. Zreik, Association EuropIA, Paris, France.

Finally, I should like to thank the other members of the Heriot-Watt University's Structural Engineering Computational Technology Research Group in particular: Asad Khan, János Sziveri, Jørgen Stang, Ardeshir Bahreininejad, João P. de Barros Leite and Janet Wilson.

> B.H.V. Topping Heriot-Watt University Edinburgh