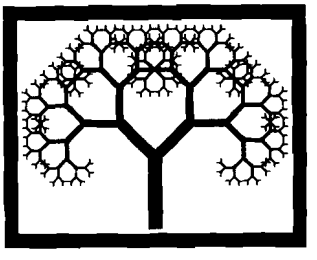
ADVANCES IN COMPUTATIONAL MECHANICS WITH HIGH PERFORMANCE COMPUTING

ADVANCES IN COMPUTATIONAL MECHANICS WITH HIGH PERFORMANCE COMPUTING

Edited by
B.H.V. Topping



CIVIL-COMP PRESS

CIVIL-COMP PRESS
10A Saxe-Coburg Place
Edinburgh, EH3 5BR, UK

CIVIL-COMP PRESS is an imprint of Civil-Comp Limited

©1998, Civil-Comp Limited

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN 0-948749-54-7

Printed in the Scottish Borders
by
MEIGLE PRINTERS LIMITED
Galashiels, Scotland

❖CONTENTS❖

1. VISUALISATION, PREPROCESSING AND MESH GENERATION

1.1 PARALLEL VISUALISATION OF COMPUTATIONAL ENGINEERING DATA, J.W. Jones and N.P. Weatherill, Department of Civil Engineering, University of Wales Swansea, United Kingdom 1

1.2 PARALLEL MESH GENERATION, L. Laemmer* and M. Burghardt#, *Heriot-Watt University, Edinburgh, United Kingdom, #Darmstadt University of Technology, Germany 11

1.3 USING PadFEM FOR PARALLEL MESH REFINEMENT, F. Neugebauer and J. Hungershofer, Paderborn Center for Parallel Computing, Paderborn, Germany 19

1.4 THREE DIMENSIONAL FINITE ELEMENT ANALYSIS OF ALUMINUM EXTRUSION, B.J.E. van Rens, W.A.M. Brekelmans and F.P.T. Baaijens, Faculty of Mechanical Engineering, Technical University of Eindhoven, The Netherlands 25

2. NUMA ARCHITECTURES

2.1 DATA ACCESS COLLECTION AND DATA PARTITIONING FOR NUMA ARCHITECTURES, C. R. Calidonna and M. Mango Furnari, Institute of Cybernetics, Italian National Research Council, Arco Felice, Naples, Italy 33

3. DOMAIN DECOMPOSITION

3.1 A METHOD OF FINITE ELEMENT TEARING AND INTERCONNECTING FOR THE HELMHOLTZ PROBLEM, A. de La Bourdonnaye+, C. Farhat#, A. Macedo#, F. Magoules* and F.-X. Roux*, +INRIA, France, #University of Colorado, Boulder, United States of America, *ONERA, Chatillon, France 41

3.2 COMPARISON OF MULTI-LEVEL APPROACHES IN DOMAIN DECOMPOSITION FOR STRUCTURAL ANALYSIS, P. Ladeveze and D. Dureisseix, Laboratory of Mechanics and Technology, ENS Cachan, CNRS, University of Paris VI, Cachan, France 55

3.3 DIRECT DOMAIN DECOMPOSITION METHOD ON A DISTRIBUTED MEMORY ARCHITECTURE, J.F. Lassignardie, Y. Escaig and G. Touzot, INSA de Rouen, St Etienne du Rouvray, France 65

4. PARALLEL P VERSION FINITE ELEMENT ANALYSIS

4.1 A PARALLEL P-VERSION FINITE ELEMENT APPROACH FOR STRUCTURAL ENGINEERING, M. Ruecker, M. Krafczyk and E. Rank, Lehrstuhl fuer Bauinformatik, Technische Universitaet Munchen, Munich, Germany 73

4.2 COMPUTATIONALLY EFFICIENT METHODS FOR PARALLEL ADAPTIVE FINITE ELEMENT ANALYSIS, M. Papadrakakis and D.C. Harbis, Institute of Structural Analysis and Seismic Research, National Technical University of Athens, Greece 79

5. NON-LINEAR ANALYSIS

5.1 DOMAIN DECOMPOSITION METHODS FOR THE SOLUTION OF NON-LINEAR PROBLEMS IN SOLID MECHANICS, S. Meynen, Department of Numerical Methods in Mechanical Engineering, Technical University of Darmstadt, Germany 87

5.2 FULLY PARALLEL NONLINEAR FINITE ELEMENT COMPUTATIONS USING THE PRE-CONDITIONED LANCZOS METHOD FOR SOLVING LINEAR EQUATIONS, Th Rottner*, K. Schweizerhof*, I. Lenhardt+, and G. Alefeld+, *Insitute for Mechanics, University of Karlsruhe, Germany, +Institute for Applied Mathematics, University of Karlsruhe, Germany 95

6. SOLUTION OF ENGINEERING PROBLEMS USING HIGH PERFORMANCE COMPUTING

6.1 ANALYSIS OF REINFORCED CONCRETE STRUCTURES USING A CLUSTER OF PCS, M.L. Romero* and J.I. Aliaga+, *Department of Technology, +Department of Informatics, University Jaume I de Castellon, Spain 103

6.2 PARALLEL PARAMETER ESTIMATION FOR GROUND-WATER FLOW MODELS, L. Laemmer* and M. Burghardt#, *Heriot-Watt University, Edinburgh, United Kingdom, #Darmstadt University of Technology, Germany 109

6.3 PARALLEL ALGORITHMS FOR FE-BE COUPLING, R. Perera and E. Alarcon, Department of Structural Mechanics, Technical University of Madrid, Madrid, Spain 117

6.4 AN OPEN SOFTWARE FRAMEWORK FOR MULTIPHYSICS APPLICATIONS IN COMPUTATIONAL MECHANICS ON PARALLEL AND DISTRIBUTED COMPUTERS, P. Chow*, C. Bailey**, K. McManus**, M. Cross** and C. Addison*, *Fujitsu European Centre for Information Technology Limited, Uxbridge, United Kingdom, **University of Greenwich, London, United Kingdom 127

6.5 MULTI-PHYSICS MODELLING FOR INTERCONNECTION TECHNOLOGY, C. Bailey, D. Wheeler and M. Cross, Department of Computing and Mathematical Sciences, University of Greenwich, London, United Kingdom 135

6.6 AN EQUIVALENCE METHOD TO COMPUTE MECHANICAL PROPERTIES OF REPETITIVE STRUCTURES, M. de Benedetti*, R. Baldassarri+ and C. Scarponi*, *Aerospace Department, University of Rome "La Sapienza", Rome, Italy, +Alenia Aerospazio Div. Spazio, Rome, Italy 141

7. DYNAMIC LOAD BALANCING

7.1 A COMPARISON OF SOME DYNAMIC LOAD BALANCING ALGORITHMS FOR A PARALLEL ADAPTIVE FLOW SOLVER, N. Touheed, P. Selwood, P.K. Jimack and M. Berzins, School of Computer Studies, University of Leeds, United Kingdom 153

7.2 PARALLEL DYNAMIC MESH RE-PARTITIONING IN FEM CODES, B. Maerten*, A. Basermann#, J. Fingberg#, G. Lonsdale# and D.Roose*, *Department of Computer Science, KU Leuven, Belgium, #C&C Research Laboratories, NEC Europe Ltd., Germany 163

8. OBJECT ORIENTED TECHNIQUES FOR PARALLEL PROCESSING

8.1 PERFORMANCES OF STATIC AND DYNAMIC SOLVERS ON A SUB-DOMAINS OBJECT ORIENTED FINITE ELEMENT ARCHITECTURE, P. de Vincenzo, I. Klapka and M. Geradin, LTAS Dynamics of Structures,University of Liege, Belgium 169

8.2 A PARALLEL FINITE ELEMENT PACKAGE FOR NON-LINEAR PROBLEMS: APPLICATION TO DAMAGE MECHANICS, F.J. Lingen, Department of Civil Engineering, Delft University of Technology, The Netherlands 181

9. OPTIMIZATION AND DESIGN

9.1 SHAPE DESIGN AND SHAPE OPTIMIZATION BY GENETIC ALGORITHMS, J. Lampinen and J. Alander, University of Vaasa, Finland 187

9.2 PARALLEL DESIGN OF CABLE-MEMBRANE STRUCTURES: THE DEVELOPMENT OF PREPROCESSING TOOLS, P. Ivanyi, B.H.V. Topping and J. Muylle, Heriot-Watt University, Edinburgh, United Kingdom 197

❖PREFACE❖

This volume contains the research papers presented at *The Second Euro-Conference on Parallel and Distributed Computing for Computational Mechanics*, held in Sintra, Portugal between 4th-9th April 1998. The Euro-Conference was supported by the European Commission Training and Mobility of Researchers Programme under contract no: ERBMMACT960072 with Civil-Comp Limited. We are grateful for the assistance of Marc De Cock of the European Commission's TMR programme for his kind advice and assistance with this series of Euro-Conferences. The third conference in this series will be held in Germany during March 1999.

The research papers in this volume include the following topics:

- Visualisation, Preprocessing and Mesh Generation
- NUMA Architectures
- Domain Decomposition
- Parallel P Version Finite Element Analysis
- Non-Linear Analysis
- Solution of Engineering Problems using High Performance Computing
- Dynamic Load Balancing
- Object Oriented Techniques for Parallel Processing
- Optimization and Design

As well as the presentation of these research papers, a number of lectures were presented at the Second Euro-Conference. The text of these lectures will be published in "High Performance Computing for Computational Mechanics", Edited by B.H.V. Topping and L. Lämmer, Saxe-Coburg Publications, Edinburgh, ISBN 1-874672-06-7, 1998.

I am grateful for the valued help of many people in the organisation of the Second Euro-Conference. In particular, I should like to thank Dr P. Jimack, Dr L. Lämmer and Professor N.P. Weatherill for their advice. My thanks are also due to all at Civil-Comp Limited for their help and perseverance in the realisation of this conference, particularly Dr Martin Sales. The assistance of members of the Structural Engineering Computational Technology Research Group at Heriot-Watt University, Edinburgh is gratefully acknowledged, particularly from Péter Iványi and Jelle Muylle.

Barry H.V. Topping
Department of Mechanical and Chemical Engineering
Heriot-Watt University, Edinburgh
July 1998