DISTRIBUTED INFORMATION SYSTEMS AND SIMULATION OF PROJECT ACTIVITY NETWORKS

by
RAJINDER KUMAR SACHDEVA

Thesis submitted
in fulfilment of the requirements
for the award of the degree of
DOCTOR OF PHILOSOPHY

Department of Computer Science and Engineering
INDIAN INSTITUTE OF TECHNOLOGY, DELHI

August, 1989

CERTIFICATE

Certified that the thesis entitled 'DISTRIBUTED INFORMATION SYSTEMS AND SIMULATION OF PROJECT ACTIVITY NETWORKS' being submitted by Mr. R.K.Sachdeva, is a record of work carried out by him under my supervision and guidance. The matter embodied in this thesis has not been submitted for the award of any other degree.

August 14, 1989.

PROF. R.K. ARORA

Professor, Department of Computer Science and Engineering;
Head, Computer Services centre,
Indian Institute of Technology,
New Delhi.

ACKNOWLEDGEMENTS

I am indeed grateful to my supervisor Professor R.K.Arora, for his constructive and inspiring guidance during the course of this work. His keen and persistent interest and untiring efforts have made it possible to shape this thesis in its present form.

I am also grateful to all other faculty and staff of the Deptt. of Computer Science & Engineering and Computer Services Centre for their help in many ways.

It is not possible to list the names of all those people who have helped directly or indirectly in the production of this thesis. I am grateful to them all. Finally, I am grateful to my wife RASHMI and children ABHISHEK and AASTHA for bearing with me during the 'ups and downs' of this work. Above all, I am grateful to my parents who are primarily instrumental in making me worthy of this thesis.

R. K. SACHDEVA

ABSTRACT

This thesis deals with the distributed information systems and distributed simulation of project activity networks for both time analysis as well as resource and cost analysis.

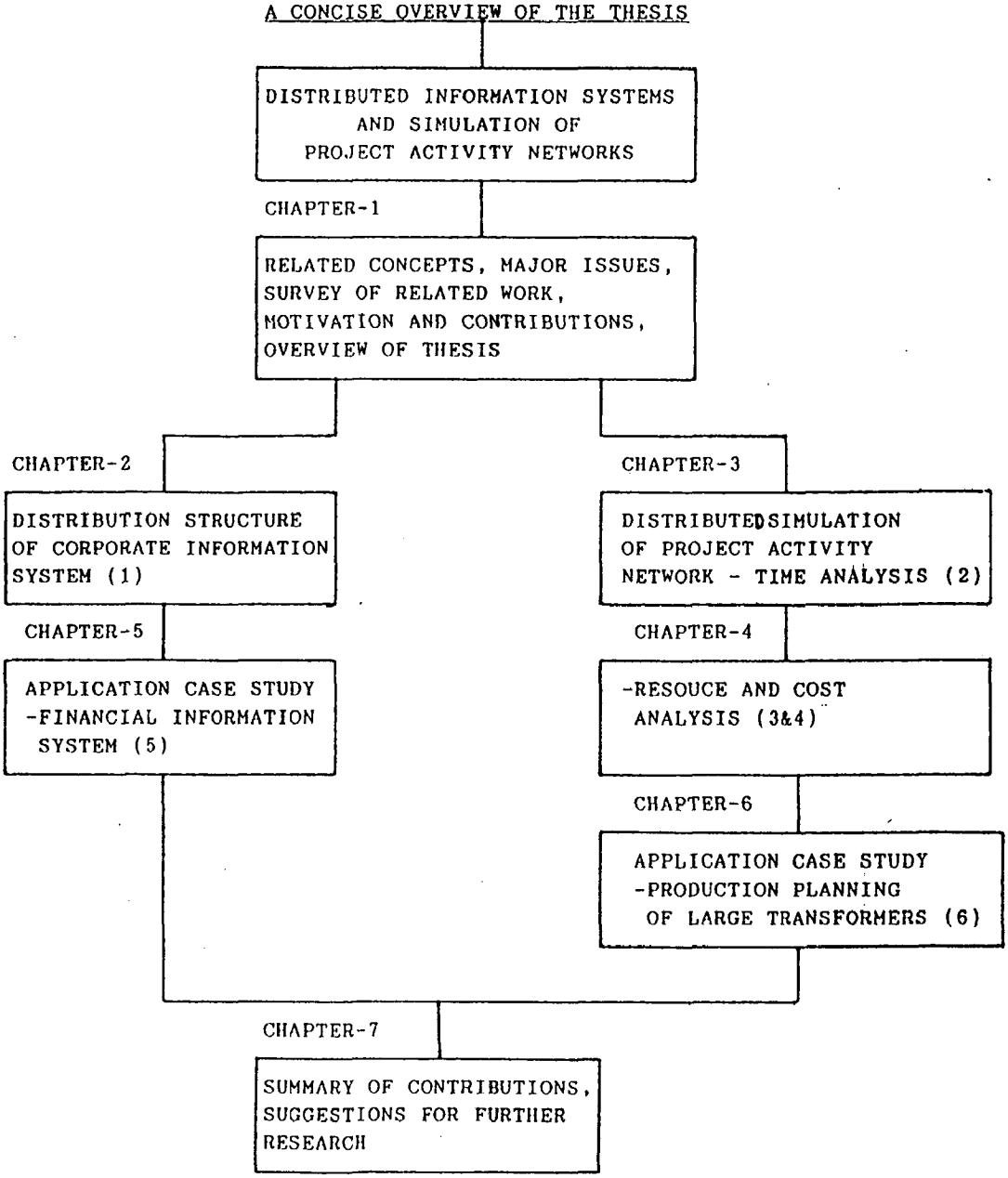
The first part of the thesis relates to optimal design of the distribution structure of Corporate Information System as a comprehensive problem involving network configuration, topology, allocation of data files and program modules over the network of computer systems. The relationship between the information system and the decision making system has been studied instead of treating the information system as a mere transaction processing system as in the previous works. A practical approach to the design problem has been evolved using a composite cost-effectiveness function consisting of cost, response time, reliability and availability. The incremental analysis approach recommended involves starting from a highly centralised structure and moving step by step towards more decentralised form. The optimal structure is achieved when on the margin, the incremental cost of decentralisation is equal to the incremental value of performance characteristics.

The next part of the thesis deals with problems relating to distributed simulation of project activity networks for time analysis, resource and cost analysis. It has been shown how activity networks can be simulated in a distributed manner by partitioning the project into sub-projects and allocating sub-projects to different processing systems. Conditions under which project activity network can be decomposed into sub-project networks so that the sub-projects can be simulated independently, have been analysed. The precedence relationships between sub-projects can be represented in the form of an acyclic network of sub-projects. The sub-projects can be simulated independently at the allocated processing systems or computers from beginning to end without need for communication with other sub-projects. Communication between sub-projects is necessary only at the end of simulation of one sub-project and before the beginning of simulation of another sub-project. Such communication is only by passing messages over input-output channels. The proposed distributed algorithm for Resource Constrained Project Scheduling involves storage of total resource availability of the project at a central computer system. The central system

receives "activity time vector" from individual sub-projects as and when an activity becomes eligible for scheduling and returns the "activity schedule vector" after the activity has been scheduled.

Finally, the application of the proposals made on the distribution structure and distributed simulation of project activity networks has been demonstrated in two practical case studies. The first case study deals with the financial information system in an Indian State Government. This case study illustrates the application of the incremental analysis approach to the distribution structure of the information system. The second case study deals with the production planning system for an existing Indian organisation engaged in the manufacture of large transformers. This case study illustrates the application of distributed simulation of project activity networks to production planning of large complex products.

A CONCISE OVERVIEW OF THE THESIS



(1) Arora, R.K. and R.K. Sachdeva, Distribution Structure of Corporate Information System, Productivity, Vol.XXIX, No.2 (July-Sept. 1988), pp.109-116.

(2) Arora, R.K. and R.K. Sachdeva, Distributed Simulation of Activity Networks, Computers and Operations Research, Vol.15, No.2 (Mar. 1988), pp.179-188.

(3) Arora, R.K. and R.K. Sachdeva, Distributed Simulation of Resource Constrained Project Scheduling, Computers and Operations Research, Vol.16, No.4 (1989), pp.295-304.

(4) Sachdeva, R.K., Projektmanagement: Plannung, Ausfuhrung, Kontrolle, Echo aus Deutschland (West Germany), June, 1985, pp.13-14.

(5) Sachdeva, R.K. and R.G. Kajrekar, Computerised Financial Information System in Govt. of Gujarat, Proceedings of the IFIP TC8 Conference on Governmental and Municipal Information Systems, Budapest, Sept. 1987, Peter Kovacs and Elek Straub (editors), North-Holland.

(6) Arora, R.K. and R.K. Sachdeva, Distributed Analysis of Project Activity Networks - Application to Production Planning, Productivity, submitted for publication, 1989.

CONTENTS