PROJECT PLANNING STUDIES WITH RENEWABLE AND NON-RENEWABLE RESOURCES

by

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A thesis submitted in fulfilment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

to the

Department of Mechanical Engineering

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

MARCH, 1985

CERTIFICATE

This is to certify that the thesis entitled "PROJECT PLANNING STUDIES WITH RENEWABLE AND NON-RENEWABLE RESOURCES" which is being submitted by Mr. Arun Kanda to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy in Mechanical Engineering, is a record of bonafide research work carried out by him. He has worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis, which has attained the standard required for a Ph.D. degree of this institute. The results presented in this thesis have not been submitted elsewhere for the award of any degree or diploma.

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ACKNOWLEDGEMENTS

I am grateful to both my research supervisors, Prof. U.R.K. Rao of the department of Mechanical Engineering and Prof. P.S. Satsangi of the department of Electrical Engineering for their guidance and encouragement throughout this research work. It was Prof. Satsangi who introduced me to the area of Physical System Theory through a pre-Ph.D. course and subsequently provided the motivation for a number of applications of this area to project planning. I deeply value his association in this research.

I am indebted to Prof. K.P.K. Nair of the University of New Brunswick, Canada who first introduced me to Network Flow Theory and provided valuable research insights.

I treasure the friendly advice and help from Prof. P.G. Awate of I.I.T., Bombay through informal discussions relating to this research.

I owe special thanks to Prof. S.N. Maheshwari of the department of Computer Science and Engineering, I.I.T., Delhi for his assistance in evaluating the computational complexity of the algorithms developed in this thesis.

I would like to thank Prof. B.L. Juneja, Head, Mechanical Engineering, I.I.T., Delhi and all my colleagues for providing relief from teaching work for one semester to facilitate this research.

Lastly I would like to thank Shri D.R. Joshi for the typing of this thesis and Shri N.K. Choudhry for making the drawings.

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ABSTRACT

This thesis aims at developing special models and algorithms for some project planning problems with renewable and non-renewable resources. The existing methods for handling such problems are reviewed and classified on the basis of function and methodology. The review identifies the need for the development of efficient optimal procedures in this area which currently abounds with heuristic approaches.

Among the problems with non-renewable resources, the problem of project crashing with linear or piecewise linear penalty costs beyond due dates has been treated by a network flow procedure capable of generating the entire project duration-cost efficient frontier. An alternative viewpoint to solve this problem by defining complementary across and through variables corresponding to each arc in a modified network is also adopted. It is shown how this problem may be solved by Iri's step by step procedure for the general linear network flow problem. Other mathematical programming formulations are given for the cases when the penalty and reward functions are piecewise linear, discontinuous or discrete. An illustrative case study with a reward for timely project completion and piecewise linear penalty costs for delay is included.

In the renewable resource category, the problem of minimum project duration with constrained resources is viewed as a problem with across and through variables on a modified network, similar to a "closed" system in Physical System Theory. This results in

a linear programming formulation with an additional quadratic constraint for which a simplex based algorithm combined with flow labelling is developed. Network reduction to reduce the computational burden is also discussed. Another algorithm using time-labelling and flow-labelling to systematically reduce the critical sequence in a project with limited resources is also developed. Extensions to resource levelling are illustrated.

The consideration of both renewable and non-renewable resources together in a multi-objective framework is achieved through a goal-programming model which retains the basic Physical System Theory framework developed for renewable resources.

The models and procedures developed in this thesis employ concepts from network flows and Physical System Theory. The advantages of these formulations lie both in the physical interpretation of the problem as a single or multi-commodity flow problem on a network as well as the development of "efficient" network based optimization procedures.

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