

Advanced Project Management

F L HARRISON

Gower

© F. L. Harrison, 1981

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without the prior permission of Gower Publishing Company Limited.

Published by Gower Publishing Company Limited, Gower House, Croft Road, Aldershot, Hants, England



British Library Cataloguing in Publication Data

Harrison, F. L.

Advanced project management.

- 1. Industrial project management
- I. Title

658.4'04 HD69.P75

ISBN 0-566-02249-4

Printed and bound in Great Britain by Biddles Ltd, Guildford and King's Lynn

ADVANCED PROJECT MANAGEMENT

Preface

Project management is a highly professional branch of management which is used in all areas of industry, commerce and government. It involves the application of many specialist concepts and techniques, but all too often people working on projects receive little or no education or training in project management. As a result, the same mistakes are made over and over again, and projects cost more, and take longer, than necessary.

This book aims to bridge the gap between introductory books on project management, planning and control, and advanced professional practice. There are light-years of difference between, say, a training in simple critical path analysis adequate to plan and control a small project, and the training and experience required to handle the problems encountered in the management, planning and control of the typical manufacturing or construction project. Thus, this book is intended to be:-

- a professional level guide to the management, planning and control for engineers, accountants, managers, architects, chartered surveyors and others involved in project work.
- an advanced text-book for senior undergraduates and post-graduate students taking the courses in project and construction management which have been, or are being, introduced in many universities, business schools and colleges.

Over the last ten years, our knowledge and experience of project management, planning and control have increased

considerably, and methods have been developed to overcome many of the problems encountered. This book describes how these modern concepts and techniques can save time and money. It draws on many years' experience of project management, planning and control, developments on North Sea Oil related projects and the US aerospace/weapons industries, experience with modern computer-based information systems, and organisation and human behaviour theories.

The book begins by describing the different forms of organisation structure used in project work, and enlarges on the 'matrix' form for single and multi-company project organisations.

The next three chapters deal with how to organise the planning process. They discuss who should do the planning, the role of the planner in 'real-time' planning, and the common misapplications of planning techniques, and describe the characteristic evolutionary life cycle of project planning, the various stages and levels of planning.

This part of the book also looks at the importance of manpower planning, critically reviews and compares the basic planning techniques and outlines the difficulties involved in applying these techniques to the larger project. It outlines the requirements of modern project computing systems and planning packages and describes how these systems can be used in conjunction with such techniques as milestone charting and S charts. The use of planning library modules, multi-project planning and control, and the Line of Balance technique are all explored in detail.

Chapters 5 to 10 contain a thorough treatment of estimating, budgeting and cost control. They outline the modern approach to project control, involving an integrated project management information system based on the use of the work breakdown structure, the work package concept, and forward-looking performance analysis integrating schedule and cost control.

The final chapter examines the all-important problems of human relations in the context of project management, including the basis for the 'authority' of the project manager, methods of coping with 'we-they' attitudes and conflict, and how to develop teamwork.

Acknowledgements

Many people have contributed, directly or indirectly, to this book. In particular I would like to thank:

Sally and Maureen for the typing and retyping of my manuscript without a grumble;

all those from the following companies, who have helped me alone the way to learn my trade, and encouraged me to try out the concepts and techniques outlines in the book - N.C.B., Cementation, I.C.I., Imperial Oil (Canada), Anderson Strathclyde and the Defense Systems Management College, Virginia;

my long suffering family for their patience, sacrifice and support.

F. L. Harrison January 1981

Contents

		page
Lis	st of illustrations	vii
Preface		хi
1	Introduction	1
	Why project management? — Traditional management theory and project management	
2	Project Organisation	11
	In-company project organisation — Global project organisation — Work breakdown structure	
3	The Art of Planning	31
	Managerial philosophy of planning — Level of detail — Real time planning — Planning the planning process — Hierarchy of project plans	
4	The Science of Project Planning	67
	Manpower planning — CPM PERT-network analysis — Bar charts versus CPM PERT — Modern computer-based techniques — Modern project planning systems	
5	Modern Project Planning Methods	95
	S curves — Milestone charts — Management of float — Operational plan and schedule — Planning library modules — Multi-project planning and control — Planning the very large project — The line of balance technique	

		page
6	Estimating the Project Cost Importance of cost estimating — Escalation of costs — Inflation of project costs — The characteristic flow of estimating information — Evolution of a project cost estimate — Proposal and evolutionary phase — Preliminary design phase — Design and purchasing phase — Contingency versus job schedule — Form of Contract — Lump sum form of contract — Cost plus form of contract — Other forms of contract — Example of a cost escalation clause	145
7	Budgeting, Analysis and Control Cost accounting and cost control — Budgeting — Cash flow forecasting — Variance analysis for project control	174
8	Modern Methods of Project Control Control centres — Work packages — Overheads — Cost accounts — Performance analysis — Forecasting the final cost — Project management systems	192
9	Additional Factors in the Control of Projects Introduction — Cost consciousness in design — Control of changes to a project — Productivity	232
10	Planning and Control of Procurement Project liaison — Buying — Inspection — Progressing and expediting — Analysis and reports	259
11	Human Behaviour in the Project Setting The authority problem in project management — Authority, organisation and managerial philosophy — The engineer as a manager — Interpersonal behaviour in the project setting — Groups in the project setting — Team development — Intergroup conflict in the project setting	275
Bib	Bibliography	
Index		315

Illustrations

Figures	Figures	
2.1	Matrix organisation	16
2.2	Global project organisation	19
2.3	Matrix of responsibilities	21
2.4	Arrow diagram	23
2.5	A work breakdown structure	24
2.6	Work breakdown structure of a ship system	26
2.7	Integration of work breakdown structure and organisation	27
3.1	Typical petrochemical project design plan	55
3.2	S chart for design	56
3.3	A hierarchy of network plans	61
3.4	A hierarchy of bar charts	62
4.1	Manpower plan for critical trades	70
4.2	Project manpower	71
4.3	Productivity with overtime	74
4.4	Bar chart	75
4.5	Time analysis	79
5.1	Data base for an activity	96
5.2	Computer produced bar chart	98
5.3	Manpower chart	99

		page
5.4	Plan for electrical instrument design	100
5.5	Time analysis report	102
5.6	S chart for construction	104
5.7	S curve for electrical design	105
5.8	S curve for project	109
5.9	Milestone report	112
5.10	Milestone chart	113
5.11	Skeleton bar chart showing free float	115
5.12	Free float monitor	116
5.13	Electrical designers required after rescheduling	120
5.14	Drawing office plan after rescheduling	121
5.15	Draughtsmen required after rescheduling	122
5.16	Macroplanning module	126
5.17	Standard microplanning modules (A)	127
5.18	Standard microplanning modules (B)	128
5.19	WBS for a multi-unit project	130
5.20	Programme for a single unit in LOB Example	140
5.21	S chart for programme	141
5.22	Line of balance	142
5.23	LOB at week 40 for typica petrochemical project	144
6.1	Effect of inflation on project expenditure	151
6.2	Level of uncertainty of project estimate versus time	155
6.3	S chart for design (showing construction and purchasing)	156
6.4	Contingency versus schedule	161
6.5	Emphasis on cost control	163

Project plan for simple example	180
Project budget	181
Hysteresis cash flow	186
Variance analysis	187
WBS and estimates for simple project	200
Manual calculation of project budget for cost accounts	204
Calculation of budgeted cost of work performance (BCWP) for period 3	207
Typical project S curve	209
S curve for cost account 3	210
Performance report for period 2	211
Performance report for period 3	212
Integration of cost and schedule	213
Flow chart for computer programs	219
Data files for simple example	231
Distribution of project cost between phases	234
Relative influence of each phase on basic cost of the project	236
Change request form	249
	Project budget Hysteresis cash flow Variance analysis WBS and estimates for simple project Manual calculation of project budget for cost accounts Calculation of budgeted cost of work performance (BCWP) for period 3 Typical project S curve S curve for cost account 3 Performance report for period 2 Performance report for period 3 Integration of cost and schedule Flow chart for computer programs Data files for simple example Distribution of project cost between phases Relative influence of each phase on basic cost of the project

1 Introduction

A project can be defined as a non-routine, non-repetitive, one-off undertaking, normally with discrete time, financial and technical performance goals. Since the late 1950s the terms project engineer, project co-ordinator, programme or project manager have become common and are signs of the increasing use of projects in all areas of industry, commerce and government.

Organisations using projects are, knowingly or unknowingly. involved in a relatively new concept of management, namely, project management. The management of projects is very different from the normal management of operations, and involves specialised forms of organisation and methods of planning and control. Training and experience in general management, or even in construction management, are not sufficient for effective project management, which has grown to become a separate, highly sophisticated area of management. The definition of the project management concept as a specialist area of management came about initially in the US Aerospace Weapons Research and Development Industries. The Manhattan Project during World War II was an early example, but it was not until the 1950s that project management began to crystallise into its present form. The problems of taking an aircraft, or weapons system from early research through technical development, design and manufacture are fraught with complexity, uncertainties and difficulties. This is particularly so when working on the frontiers of technology. Planning and cost control in these kinds of projects are very difficult, and different organisation structures, authority and responsibility patterns, and specialist

techniques are necessary. Other important users of the project management concept, from its earliest days, are the oil and chemical industries, with the engineering contractors involved in these industries. The management of engineering, design and construction projects in these process industries involves many of the same difficulties as in aerospace weapons projects.

These two industries are today probably the most professional in the application of the project management concept, and make widespread use of the most sophisticated techniques. Professional project managers in the large oil and chemical design and construction contractors are employed on an international, worldwide basis.

Large civil engineering contractors have also implicitly employed the project manager concept in contract management for centuries. However, in the past their projects tended to be not as complex as the aerospace/weapons and oil/chemical industry projects, and specialised organisation structures, planning and control techniques were not explicitly recognised or used. Today this has changed, and project management concepts and techniques are in common use in the civil engineering industry.

The project concept is also used in high technology research and development, in the engineering and manufacturing industries for new product development and manufacture, and in the design and construction of new plant and equipment. Building a new steel plant, manufacturing a boiler for a power station, adding a plant extension, developing and beginning the manufacture of a new product, designing, manufacturing and installing a heating and ventilation system are all projects, with similar problems and require similar management and techniques.

The design and introduction of computer systems, and the development and introduction of new suites of computer program also uses the project management concept. Thus the computing industry and the computing function within companies, both employ project management.

Outside the engineering field we find that the concept of product management in marketing is very similar to that of project management; the organisational forms, managerial problems, planning and control techniques are almost identical. Similarly, the introduction of new products, the feasibility study for a company take-over, and the improvement of industrial relations in a company can all be treated as projects, and can benefit from the use of the project management concepts and techniques.

Many firms who have traditionally not been involved in project work are being forced to adopt project management concepts. This is partly because of the benefits obtained, but principally because customers, particularly foreign customers, are insisting on one firm taking overall responsibility for all the work involved in manufacturing, supplying and, or, constructing large and complex orders or contracts.

Therefore, projects, and as a consequence (explicitly or implicitly) project management, are being increasingly used in all areas of engineering, construction, manufacturing, research and development. These projects have similar management needs and problems, and thus the concepts and techniques of project management transcend industry barriers and all areas of engineering.

Projects and project management are used in some form or other, on many small scale ventures with good results, but it is on large scale applications that good project management is a really significant factor. The problems of man-management, financial management, planning and control, where many firms are involved, with long time spans, large uncertainties and very large sums of money, can lead to inefficiency, delays in completion and wasted money, unless effective project management is used.

Why project management?

The principal reason for the development of the project management concept, organisation, and specialised, often highly sophisticated techniques, is that the traditional forms of organisation structure and management techniques do not handle project type work effectively. There is a need for different forms of organisation, specialised information systems, managers skilled in the techniques of project planning,

financial management, control and the particular human problem arising in project work, because of the special characteristics of projects and the problems caused by them.

Projects are essentially temporary activities for those concerned, with typical lives of from six months to five years. Management, organisation and information systems have to be established anew for each project, and there can also be only a very limited learning curve for those involved. Perhaps a manager may only pass through each phase of a project once, every year to five years. In addition, decision making in project work tends not to be repetitive and bad decisions at any stage in a project affect a project throughout its life, and it is not generally possible to recover from early deficiencies in project management.

Normally, projects involve several departments of a company working together and in the majority of cases more than one company is involved in work on one project. Often these departments, or companies are working on several projects at the same time, each at different stages in the project life cycle. Project work is therefore necessarily complex with respect to interdependencies between the departments and companies involved. This involves, explicitly, a complex organisation, including people from many different professions, backgrounds, trades, departments and companies. Additionally, these relationships and interdependencies are dynamic and never static. Typically at the start of a project, work emphasis may be in research and development; it then changes to engineering design, to purchasing and procurement. to manufacturing and, or construction, to testing and commissioning, and finally to operation. No one functional department or company is the most important over the whole life of the project and thus no individual functional manager can assume the leading management role for the complete project.

Because projects are unique one-off undertakings, there are problems in defining work, organisation, allocating responsibility, budgeting, planning, control, communication and co-ordination. Many projects have suffered difficulties because of a lack of clear definition of organisation structure, which in turn compounds these problems. Great emphasis

must be given in project work to the planning and control activities, and many projects have suffered delays and over-expenditure because of inadequate planning and control systems. Special project orientated information systems are also required for effective project communication, co-ordination and control, and these systems are different from, and generally have to be separate from, the information systems in the normal traditional management organisation. There are also particular difficulties involved in achieving effective communication and co-ordination with several different organisations involved in a project, and as projects get larger and more complex, communication and co-ordination become more and more difficult, and yet more vital to the success of project work.

Usually, project work involves large capital expenditures, and the financial management and control of projects is thus extremely important, to minimise the overall cost of the project.

Finally, the temporary, complex and often loose nature of the relationships and authority patterns involved in project work, combined with the number of different departments and companies involved in any one project, whose objectives and management styles may differ, leads to human behaviour problems and a tendency for conflict between groups and individuals. Thus the traditional management theory and organisational structures have to be modified in project management.

Traditional management theory and project management

The traditional model of an organisational structure is based upon three organisational concepts, which are all violated in the management of projects, namely

- 1. The functional division of management.
- 2. The hierarchical concept of superior subordinate relationships.
- 3. A number of so-called principles of management.

The conventional form of company organisation divides the