
ENGINEERING MANAGEMENT OF CAPITAL PROJECTS

A PRACTICAL GUIDE

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To Lori, who believed in this book
and, from the beginning,
believed in its author

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Instrumental in laying the groundwork for this book over the past twenty years were my many mentors, not the least of whom were: Earl Jelter, Willy Weydemuller, Earl Johnson, John Watson, and Boyd Henderson. Particular thanks go to : Boyd Henderson and Ed Amos, who reviewed the manuscript and offered many useful suggestions; Rita Papantoniou, who toiled cheerfully at typing from my scrawl; and finally, my editor, Peter Matthews, who lent unflagging support to the project and proved once and for all that talented editors still exist.

Dan Mackie, P.Eng.
February, 1984

FOREWORD

There is an old saying about the two types of project managers: if one is calm, collected and confident that he is on top of his project, while the other is scurrying frantically and tearing his hair out, you can be sure that no one has told the first man what is going on.

There is enough truth in this comparison to make clear the need for everyone involved in running projects to understand the underlying principles of project management and to be reminded of them at frequent intervals.

The construction industry, which creates wealth and improves industrial productivity, is one of the major driving forces in any economy. This is particularly true in Canada. The direct employment it gives in the engineering office, in the manufacturer's plant, and on the site itself probably makes it the largest single industry in the world economy. In addition, it provides new plants and facilities for the efficient manufacture of modern products, for transporting them more economically, or even, as in the case of the garden shed in Chapter 1 of this book, for storing them better. Unfortunately, the construction industry in North America is not in good health. This is due not only to the downturn in the economy: over the past decade the industry has experienced a sobering drop in site productivity at a time when the introduction of new equipment and techniques should have heralded a dramatic improvement.

In the United States the Business Roundtable, a forum which brings together the chief executives of many of the largest private companies in the country, has just completed a four-year,

in-depth study of the construction industry. It concluded that poor project management, in conjunction with outmoded labor practices and unnecessary government restrictions, has resulted in a 20 percent increase in real field construction costs over the last ten years. In other words, twenty cents out of every dollar spent on the site for new plant construction has been wasted. This loss has had a direct impact on our domestic costs and on our competitiveness in the foreign marketplace. And perhaps most serious of all, it restricts the amount of capital available for other investment. This decline is of vital concern to all of us if we are to maintain our high living standards. It underlines the serious challenge facing project managers in today's environment.

A simple but accurate definition of project management is that it establishes what is to be done and how it is to be measured — no more and no less. In recent years, the development of sophisticated and often computerized project control techniques has focused attention on project management as a separate discipline. This has encouraged people to stand back and analyze actions which previously had been almost instinctive. It has also given rise, unfortunately, to a plethora of publications which are minutely researched, erudite in the extreme, largely incomprehensible, and, ultimately, useless. It often seems that, in striving to find the best way to do the job, we are forgetting what the job is — to build a good plant, on time, and within budget.

It is necessary to go back to fundamentals and to develop a basic understanding of how to manage a project. This book will give the young manager this understanding and will remind the experienced manager of the underlying principles involved in project management.

W.B. Henderson, P.Eng.
February, 1984

PREFACE

Some time ago, when I was asked to present a seminar on project management to a mining company, I approached the task with some trepidation. I knew the company well, and that's just what bothered me. They already had a fairly good project team on staff which was performing not too badly. What, I wondered, could I tell them, short of nitpicking at their operation?

They had some weaknesses, to be sure, but I decided to avoid any head-on confrontations. Instead, it seemed to make sense to give a general dissertation on project management, using their own people in the presentations and hoping that this would lead them to discover some truths about themselves. I have always found this technique to be the most effective and to give the most long-lasting results. It is an easier pill to swallow than criticism coming from someone else.

Out of a group of forty attending the seminar, three were project managers and the rest were engineers, estimators, schedulers, cost controllers, administrators, and construction superintendents. Guests included a couple of senior people, the president, and the chief executive officer. Only two from the specialty groups were slated to become project managers at some time in the future. According to the president of the company, all were satisfactory—to-excellent in their fields of specialization.

It had been the president's objective to strengthen his projects group so that cost and schedule overruns would virtually disappear, a tall order in those inflationary and unpredictable times. But there were a large number of capital projects planned for the next five years, and this added to his concern. With a good team

in place, it made me wonder what key element would stimulate some sort of overall improvement. An infinitesimal improvement — maybe. Far reaching? — hardly.

The presentation given was a standard outline of procedures in each specialized area of project management. There was a description of how things were being done in the company versus how they *should* be done. In many cases, the two were the same, give-or-take a few details.

Despite strong leadership in their projects, the company's project managers were found to lack an understanding of some basic principles. Trend forecasting was their main weakness — the area that is most often misunderstood by both project managers and company officers. Overall, seeing a comprehensive package on project management and the debates resulting from the presentation sensitized the project managers to the weaknesses of individual departments and uncovered some weaknesses in task force members.

Specialty leaders, on the other hand, were made acutely aware of their lack of understanding of the project management process and of how their own work was coordinated with other disciplines. Many expressed surprise and delight ("So *that's* how it works!") and admitted that they had been too busy doing their own jobs in the past to consider what the rest of the task force was doing.

Even more surprising was the positive response received from the senior officers of the company. It seems that they, too, benefited from learning how project management works.

Clearly, the exercise revealed a definite need for an understanding of project management, not just by the project managers and participants, but by the *whole organization*. This notion was reinforced by requests from other departments — financial, maintenance, and research — for another seminar. At the senior officer level, it was felt that the senior corporate officers needed to be reeducated so that they could better understand the forces that generate requests for large capital expenditures.

Two follow-up seminars were conducted: one for the remaining departments and one for senior management. A project management procedures manual was prepared, using input from the specialty groups, and corporate policy regarding capital spending was included in it, bridging a wide communications gap that

had hitherto gone unrecognized. The manual has since become a valuable handbook for all levels of the organization.

Some time later, I received a telephone call from a vice president of an engineering company which had been engaged to do work for the mining company that I have just described.

“Operating companies are usually their own worst enemies when it comes to dealing with projects,” he said. “Usually, we have to do considerable management of our clients. It sure is refreshing to work with one who really understands project management. Thanks.”

After a further exchange of pleasantries, he added. “You know, you really should write a book. The industry needs it.”

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CHAPTER 1

SETTING OFF IN THE RIGHT DIRECTION

DEFINITIONS AND OBJECTIVES

To begin with, let us define project management as both the art and science of spending capital resources to realize a useful physical structure. To say that it is an art as well as a science is to emphasize that a great deal of intuition and good judgement is essential to achieving success in project management. To say that a useful physical structure must result is to suggest that the project management process can cover a gamut of projects and, further, that the size of those projects is irrelevant. Indeed, the principles outlined in this book are applicable to industrial and commercial projects ranging in capital cost from a few hundred thousand dollars to megaprojects worth many millions. For the sake of clarity, however, very simple examples will be used to illustrate the way things work.

A project manager usually heads up a team that performs capital works. The overall project is often referred to as EPC —

Engineer-Procure-Construct — although confusion of definitions runs rampant in industry. Project managers are referred to by electronic data processing firms as those responsible for managing or setting up computer systems. Some engineering consulting companies dilute the title of project manager by making anyone who has control of or responsibility for a piece of work a project manager, even though the work may be part of a larger project. Other companies refer to the project manager as the project engineer, while still others have project engineers who work for project managers. In this book, a project manager is someone who has total responsibility for EPC from the beginning of the project to start up of the plant, mine, or refinery or to the opening of the building, dam, highway, or park.

A successful project can be defined as one that is:

- On time
- On budget
- Meets design criteria

The project manager is not the only one who needs to understand the process of project management. Indeed, he can be rendered quite impotent by trying to manage in an atmosphere of ignorance. If he is trying to play a game of stud poker and everyone else at the table thinks it is gin, then he has lost before the first card is dealt. Too often, the success of the project is thought to rest entirely on the shoulders of the project manager, and after all, what does responsibility matter in big business? It is that kind of thinking that results in projects that are estimated at \$46 million and come in two years late at \$90 million. You may ask: So what? Doesn't everyone get paid? Doesn't the owner still make money?

Well, if that company makes automobile tires, you, the public, will have to pay more for them. If they make cheese, then the price of cheese will go up. And if they make aluminum, the cost of airplanes and homes will rise. In other words, a botched project hurts everyone.

Finally, it is assumed in this book that the project manager is on the owner's side of the project, that management will be directly under his control, whether or not a consulting company is needed to assist. The methods and systems described here can be used by an owner to run his own projects directly, or they