RESEARCH AND DEVELOPMENT MANAGEMENT

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PREFACE

Not too long ago engineering was a cloistered profession, hidden behind the protective barriers of special skills and special language. Its practioners, men and women of intellect and vision, created devices and machines that irrevocably changed the human dominion and reached down to shake the fabric of our everyday lives, yet they, the creators, were themselves largely unmoved. This could be so because, for the most part, the fruits of their technology had indirect impact on the world. The connecting threads between their innovative doings and worldly events was but dimly perceived.

The growth of technology, however, has been exponential. Once the curve took on its upward aspect, it became apparent that our culture was not only tied to the labors of science, but driven and pulled such that its plastic face was set in a new expression, reflecting directly the nature of those shaping forces.

No more than a few decades ago engineers could comfortably pursue their specific technological problems without troubling themselves about the consequent effects. Today's engineers must come out from behind this convenient barricade and face a world that is not entirely content with their performance. They have created a technology whose power to induce change is scarcely comprehended. The systems they have created have a vast potential for both good and bad. The public has become disenchanted with their miracles and demands an active part in the "laying on of hands."

A new breed of engineer is required, one who questions the desirability of his or her latest brainchild in terms of social and environmental impact, who sees with the larger perspective of a worldly citizen, and who communicates actively with society. Furthermore, engineers must understand that not only was there a technological revolution, but a social one as well, which bred a host of governmental regulations and an army of concerned consumers.

Explicitly, the new development engineer is faced with a spectrum of demands and limits that his or her predecessors never dreamed of. Among these are:

- Dramatically shortened life cycle of product and product line.
- As a consequence, development times have been halved and halved again.
- There is the constant need to predict the future and to stay in the vanguard of that prediction.
- There is a need to be aware not only of consumer desires but of new laws, regulations, and environmental factors.
- New products must now be thought of in terms of the energy they consume, not only in their use but in all phases of their manufacture.

As a result of all these limits, constraints, and demands, products must be viewed through a different set of filters than formerly. Technologists who perform the research and development function must sit in a different seat. They must be aware of:

- Market factors
- Financial trends
- Environmental and energy factors
- Social acceptability
- Laws and regulations
- The direction of future technology
- The condition of world resources
- And others

It is no longer enough to be a good or even an excellent engineer. It is no longer enough to think of a company in terms of its basic product lines. One must now think of the company in terms of its mission—a much broader view. One must think of alternative strategies, contingencies, goals, and objectives. The engineer must be a functioning part of all this if the company is to prosper.

Conceptually, the idea of the systems approach to management has been well developed for specific engineering programs. One learns to view the totality of program requirements in a holistic fashion and to build back into hardware specifications from these overall analyses. On the business end of the scale, such experts as Alfred P. Sloan view the management of a company from the total-enterprise point of view.

Engineering, however sophisticated it has been in individual projects, has tended to attack each set of problems in isolation. This is no longer a reasonable mode of operation. One of the key points of focus here is on the interaction of all parts of the business with engineering and of the interaction of synergistic programs within engineering. In addition, considerable attention is paid to the human aspects of these various interactive situations.

The primary purpose of this book is to provide a basic understanding of the role that the R&D engineer must play now and in the future, which rushes ever faster. Here we explore these new job functions, describe them, and provide the discipline needed to work within the demands and constraints. The book is intended for those who would become leaders and managers of these new and expanding horizons.

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This book represents the condensate of twenty-five years of research and development experience. I therefore first acknowledge the guidance, help, and management knowhow transmitted to me by the many able engineer–managers with whom it was my good fortune to associate over those learning years.

Once the book was conceived I faced the usual trials and frustrations in bringing it to fruition. During this period I had the help and encouragement of a number of wonderful people. I would like therefore to extend my thanks to Jim Murdock and Debby Andrews, who read and criticized the manuscript during the initial stages; to Dr. W. J Fabrycky, whose review and general comments were most helpful; and to Dr. J. H. Mize, who helped organize the book into its present form.

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CONTENTS

INTRODUCTION

The usual way to construct a book of this genre would be to lay out the process of product development from inception to delivered item, showing how each step is performed and how it leads to the next step. The appropriate engineering relationships with the rest of the firm would be defined as we went along.

This technique, although providing a delicious sense of order and method, does not attack the many and varied problems of the relationships. We can state readily enough that at a given stage one should prepare a specific body of data for transmission to the marketing department, but this does not make us aware of the basic and human problems inherent in the transfer mechanism. We cannot know that in a given situation a peculiar kind of catalysis is needed.

The tenants of each business element or unit, because of their experience and training, will have a unique view of any given situation. To effect a useful exchange requires that we be *aware* of these potentially different attitudes. Usually, this awareness comes to the individual with the passage of time and is called experience.

Today's world does not allow the luxury of 10 or 20 years in the business to assimilate that experience. The young engineer must be made aware early in the game if he or she is to be an effective leader.

To this end several hundred case histories have been distilled and their essence incorporated into statements, anecdotes, and lectures which are woven into the fabric of the 14 chapters presented here. The objective is to create in the student an awareness

of the diversity of human response and business situations without the necessity of wading through the voyage of time generally thought to be required to acquire this depth of understanding.

LAYOUT OF THE BOOK

The book is divided into three major parts. The first part looks at the problem of a product development starting with the total problem and proceeding to details. The second part looks at products as they relate to the total business, again starting with a holistic view of the strategic plan and moving into details. The third part is simply a grouping of four independent lectures encompassing specific problem areas that affect the engineer's activities in all aspects of the business, but not in an easily related way. Here the author has attacked certain general weaknesses that he has observed over the years.

The primary purpose of a manager is to promote specific desired activities along a path of optimum accomplishment. Appropriate to this purpose is a grasp of the necessary technical tools and means to motivate subordinates, peers, and supervisors. The technical aspects of management can be characterized in relatively few classes of problems. The kinds of requisite technical tools are correspondingly limited. The human condition, however, occurs in infinite variety, and although there are only a few basic laws that govern human behavior, the response to each explicit situation must be precisely tailored to achieve maximum effect.

Each chapter contains within it an exposition of several kinds of situations of a high probability density to promote the quality of human awareness. This should provide sufficient stimulus to enable students to expand themselves beyond the necessarily limited scope of the book.

part I

PRODUCT DEVELOPMENT

Assuming an idea or concept that the engineer feels is worthy of becoming part of the company's ongoing business, it is incumbent upon him or her to visualize fully the extent of activity required in the growth of that idea to maturity.

Once we have a grasp of the effort needed, we must inquire into the fit between product needs and company structure and capability. If the garment suits the wearer, we move on to explore pertinent interactions between engineering and the marketing and finance units. Having this understanding, we can begin to tailor the development effort to the company structure, using the operational plan as our vehicle. Part I explores the various aspects of these elements of activity.

1. PLANNING A PRODUCT DEVELOPMENT

An exposure to the total effort in the development of a product.

2. PRODUCT EVALUATION

The essential first step that tells us whether or not the product fits the company.

3. CONCEPTS IN MARKETING

Details of the interactions with marketing during product development.

4. ENGINEERING/FINANCE INTERACTIONS

Details of the expectations of engineering vis-à-vis finance during product development.

5. ENGINEERING AND THE OPERATIONAL PLAN

Explores the mechanism of matching the product development with the rest of the company's activity.

chapter 1

PLANNING A PRODUCT DEVELOPMENT

The principal objective of this book is to provide the development engineer with insight into the interplay of forces that influence modern-day development of a product. It is a further objective to provide a rational method of integrating these forces into a successful program.

These two objectives are best brought into focus by examining an overview of the total activity to be encompassed in a product development. The evolution of the product development plan provides a convenient window on the necessary work to be done. Later we will see that the product development plan is an integral part of the company's strategic and operational plans, while itself being a functioning organism.

BOUNDING THE PROBLEM

Assuming that we have a good idea that the company is interested in developing this concept into a product and that the world is ready for our great innovation, we must now evolve a sequence of required actions. To be sure, we have a technical problem that needs solving and for most engineers that seems to represent the focus of the challenge and the direction of their efforts. Certainly, for engineers it is the principal activity with which they should be involved. However, if they are in the

position of being prime motivators (managers) of any development, the questions to which they should devote themselves are of a much broader nature. Even when there are business managers involved, development engineers should be aware of the total scope of any effort, because all parts of it will affect their design in one way or another.

The actual extent of the problems associated with product development is introduced in this chapter and expanded in later parts of the book. This chapter is thus in the nature of a general outline to indicate the methodology of planning.

To get some feeling for how big our problem is, we set forth a few representative first-order questions that should be addressed in the body of the plan. These are:

1. What problem are we trying to solve? What are the critical technical issues?
2. What is it that we must bring to the marketplace? A component, system, pretty package, or neat sound?
3. Who can buy? The purchasing agent, another engineer, mother, teenage son?
4. What is the market timing? Are we just about right, or must we hurry?
5. What/who is our competition? Now? In the future? Must we make it longer, faster, less costly?
6. What constitutes the incentive to buy? Efficiency, power, capacity, cute wrapping?
7. What are the key milestones to acceptance? Should it be maintenance free, fully automatic, have a wide body or amazing pickup?
8. Is our solution compatible with current technology? Do we need an incredible invention to make it work?
9. What type of selling is needed? Must we carry it door to door? Should we make it erectable in parts?
10. What are the legal constraints? Safety? Pollution? Is a radar detector within the law?
11. What is the force to develop it? Required by legislative action, by developing need?
12. Is there a requirement, or must we create one? Do people really need a self-lighting cigar, or must we dazzle them with advertising?

As we try to answer these questions[1] we will find that the solutions tend to reflect themselves back into the technical development effort, perhaps causing compromises. If so, we are proceeding along the best possible path. That path is defined by the plan, and the plan must be constructed in such a way that a set of critical objectives is satisfied. Later we look at a sample set of objectives and an associated

[1]The questions developed here are merely an example. Specific questions should be developed for a specific program.