# MANAGEMENT PLANNING AND CONTROL TECHNIQUE

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Since the close of World War II, a period identified as one of high military hardware production within the defense industry, there has emerged an aerospace industry with low volume production of very intricate and sophisticated equipment for use within and without the earth's atmosphere.

Relatively low volume reduces the need for a large labor force yet, conversely, this force must contain higher mental and physical capabilities than ever before. With over one-third of the aerospace industry's effort devoted to research and development, creating and managing a labor pool able to cope with the technology of the future presents a tremendous challenge to management.

Out of the past few harried years have come many management techniques to cope with the increasing complexity of aerospace projects. Some were refinements of older systems, while others were originated for specific purposes. Various organizational shapings and reshaping have taken place to cope with the problem of efficient operation in an environment of change. Most popular today is the systems management of projects approach. Proper utilization of both functional and project organizations can provide an excellent check and balance as well as "purposeful conflict." Martin Company has for over ten years used successfully the Input-Output method of control within a combined functional project type of organization for hardware type projects. But, could this system or any system be applied to the ever increasing research and development efforts?

Management's answer was "yes"; research must and can be controlled to a plan. Although planning and management of research has been a controversial subject for many years, our experience indicates most attention devoted to the problem has focused on criticizing management methods rather than seeking techniques to assess research performance. Dissenters argue that you cannot sample and realistically portray the productivity of a creative or inventive mind. On the surface, this skepticism seems reasonable because of the apparent gulf between research and production. However, the difference is not as functional as it appears. Hardware production is accomplished through a logical series of events from problem to concept, through study and experimentation to feasibility. These milestones may be mostly mental, but they do exist and are every bit as important as the tangible milestones of a production effort.

Our problem at Martin was not how to manage research, since we knew our existing system was workable, but rather how to integrate the research planning and control into the overall division planning and control mechanism. This will be discussed in detail, but rather than start with the broad brush treatment and work down to a research task, let's take the research task and work up the system.

## Research Control-An Example

Let us go through the flow and control of a single research task. A hypothetical task called Contract "X" is a research task to investigate and analyze design specifications data for microwave antennas in unfriendly atmosphere. An authorizing document, known as an Operations Directive (OD) is issued, which names the technical and support staff necessary to carry out the work called for in the contract. The task leader issues a technical statement of work, the finance representative issues a dollar limitation, and the planner issues a master plan. In coordination, the planner, task leader, and finance man develop a detailed work schedule for manpower, procurement, travel, and support effort which we call a Gantt chart. From this is developed a budget plan or cash forecast which we call the Input. A chronological list of schedule events, activities or milestones, against which a dollar figure has been placed becomes the required Output. This list is also used to develop the master planning schedule page, which is used as the monitoring document. At this point we have developed all the documents the planner needs to monitor and control the project. However, these working forms are too detailed for review by top management. To provide top management with a document that is easily read, we next develop what we call an Input-Output performance chart.

On this chart we display general information, such as task name, dollar value, and time parameters at the top. This is followed by a listing of the scope of the work to be performed, the deliverable items, and space for additional comments. Next come the customer and key customer personnel, key Martin personnel, and the critical skills required for the task. Below this is the master plan by key work items plotted against time. Thus, we have displayed "What is to be done by Whom for Whom for How much Where and When." In the performance chart we show how we intend to spend our resources and how well we are following the plan. A graph is made showing planned dollars plotted against actual dollars spent (Figure 23). Immediately below the graph is a cost breakdown covering manpower, consulting services, travel, computer services, materials, and facilities. The last block on the chart gives the current status which is posted weekly. This one chart gives top management a consolidated reference showing the requirements of the task and the progress made from the start and the current status.

In our research control room we have a chart to cover every company-funded or contractual task being performed. These provide the Director of Research, other interested directors, or the General Manager, a method of rapidly assessing the overall research effort. However, since the time of top management is at a premium, we use the "Management by Exception" principle, wherein problem areas are highlighted by a "panic button" which is placed right on this planning chart. Now, you could go into any control room and find the same type Input—Output charts and the same method of operation as outlined here. A single system of management control is used throughout. We have discussed the planning process and reviewed the mechanism used to display the necessary information, but what really makes the system work? Teamwork is the answer.

The Planner is a catalyst, an unbiased third party, whose questioning, monitoring, analyses, and evaluation pinpoint problems and coordinate the actions of the technical and support team. He must live with the program, be able to intelligently discuss the technical as well as the administrative aspects of the task. He must, of necessity, be a many faceted person. Ideally, the research planner should be technically competent in all scientific disciplines. However, such an individual would be the Director of Research, rather than the planner. Our planners do have basic scientific backgrounds and great percentage possess master degrees in Business Administration or other disciplines. Above all, the planner must be able to determine problem areas, evaluate the impact on the program, and report with clarity to management and recommend suitable solutions.

Now we can ask, "Is the technique successful?" Most of those concerned say that it is, although to different degrees, depending on whether you are talking to a planner, a director, lab manager, or an individual researcher. The system perhaps is most beneficial to top managers in that they have a continuous current status, which allows them to make rapid decisions where required. As you go down the scale from director to individual research scientist, the acceptance is less, as is to be expected, since the work of the manager, task leader, and individual researcher is being subjected to continuous and close scrutiny. However, after a year of operation, it is our firm belief that most of the individuals whose work is being monitored concede that control helps them do a better job.

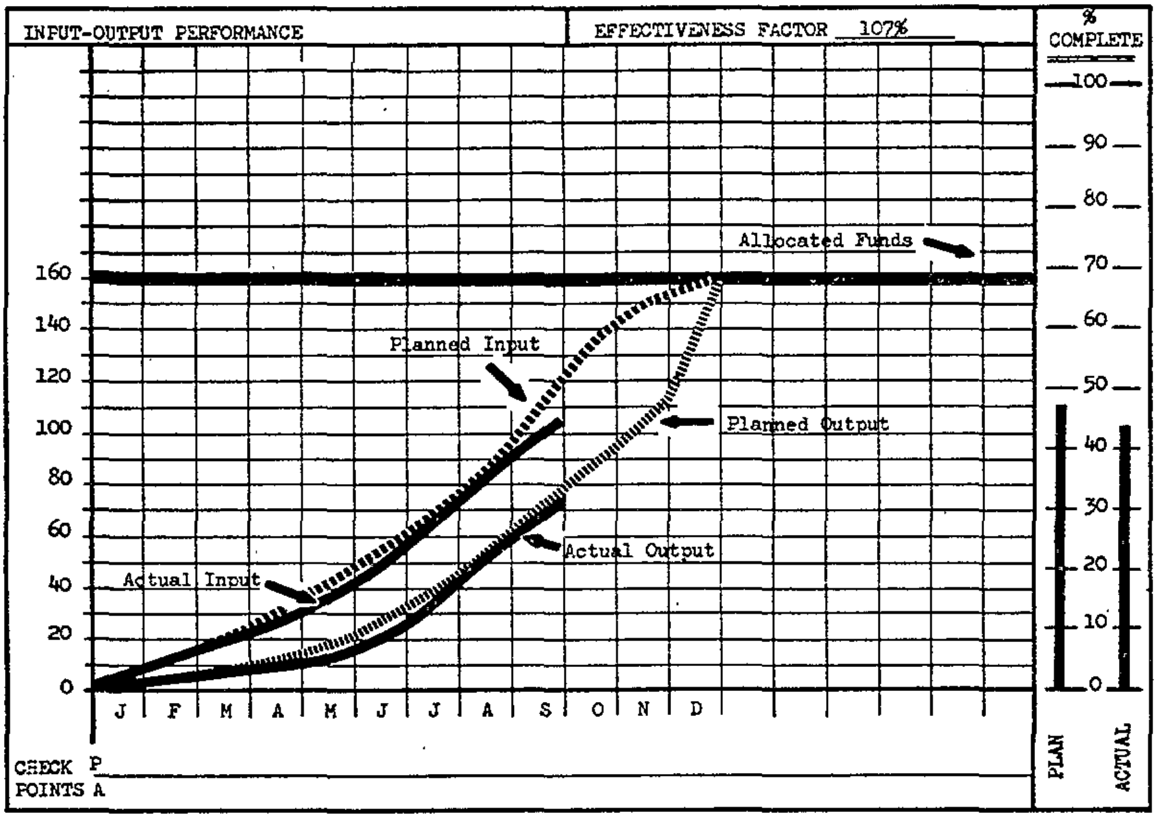
As an example of this, Martin has been able to achieve less than a 3% overall deviation from the planned output and cost on all research tasks during the past year. Early recognition of potential underruns in conjunction with on schedule performance enables management to reallocate funds to other desired, but unfunded tasks. Further, analysis of Input-Output performance permitted management the flexibility to expand the scope of work on critical programs in support of the long range plan. Control of this nature maximizes the return on all research dollars spent.

Let us turn our attention to the problem of "Planning Research" to meet the long-range needs of the industry. An Advanced Program Division must be responsible for new business, determination of future requirements of the customer, and the long-range planning necessary to accomplish future tasks. We use a committee system of long-range planning which we call the NEBAG Committee (New Business Acquisition Group). Each product area of interest to our organization, such as electronics, aerospace defense, air-to-surface missiles, surface-to-surface missiles, and communications has such a committee made up of representatives from Advance Programs, Design and Development, Research, Market Analysis, and Planning. These committees determine the requirements of the customer as they are known or as study indicates, for the next ten to fifteen years in the future. We use what we call a "bubble chart" (Figure 24). This chart is for tactical missiles, air-to-surface, and shows the required systems as projected from existing systems from each of our major customers.

As an example, let us look at the bomber advanced system. You can see we have projected this out through 1967, when we feel a multiple reconnaissance strike system will be required, and then out to a spacecraft ASM in 1972. Notice that under each of the bubbles we have listed the critical items of research and/or development required for each system. As an example, for the tactical fighter in the year 1970 we have determined that a critical requirement is for an all-weather high explosive launch leave and forget air-to-surface missile. We have identified future critical items of research and/or development required by 1970; in this case a low cost IG, a minimum area tracker, and long range for the missile. You will notice on this chart that each of the bubbles has identified under it critical needs which have been agreed to by the above-mentioned NEBAG Committee. Each critical need is developed into a program plan. The program plan depicted in Figure 25 is for a universal air defense system. This plan lists all the critical needs as determined, and bar charted to show what needs to be done in order to reach a particular state-of-the-art at a specified time. For example, let us take the computer-controlled sensors, the last critical item listed under this program. You will notice that in 1964 we have research funded and that we show there is research required in 1965 and 1966, study required during 1964 and 1965, start final design study in 1966, and establish development requirements in 1966. This critical need is then further defined in a critical need plan which gives a detailed definition of the critical need, a description of the proposed solution, and a plan setting forth the required research. The critical research tasks are then funded, and the planning process described at the beginning of this presentation is again put into operation.

The various bubble charts and critical need plans become the basis for the division long-range operational plan which is monitored and updated constantly. Requests for new tasks and our permission to bid RFP's are closely monitored through the NEBAG Committee in the first instance and in the Bid and Proposal Committee in the second instance to insure the proposed work does indeed meet the requirements of the long-range plan. As an example, the Bid and Proposal Committee uses the form shown in Figure 26 in making the determination on a bid or no bid decision. Technical evaluation has been made concerning the compatibility of the RFP with the long-range plan, competing programs, competing contractors, technical strength versus competition, and teaming requirements. Notice that an evaluation is also made of financial status, cost ratios, cost advantages, cost tradeoffs, engineering manpower requirements, skills required versus skills available, key technical people by name, sales intelligence and market analysis about the firmness of the requirement, critical elements of the system, what contracts have been awarded competition in this area, facilities and manufacturing requirements, and management considerations.

This method of long-range planning allows us to integrate the entire efforts of the division into the best possible package for future success of the division. It also permits us to maximize profit, and that is what we are in business for. However, if we had accepted the theory that research could not be planned and controlled, long-range planning would be of little or no value. Creativity can be planned and controlled-it's part of our daily routine at Martin.




| | | | |
|---|---|---|---|
| PROFESSIONAL EQUIVALENT MEN 6 | $ 78,000 | COMPUTER SERVICES | $ 6,000 |
| NON-PROFESSIONAL EQUIV. MEN 4 | $ 40,000 | MATERIALS | $ 20,000 |
| CONSULTANT SERVICES | $ 7,000 | FACILITIES | $ 4,000 |
| TRAVEL | $ 5,000 | TOTAL | $160,000 |

CURRENT STATUS

MICROWAVE ANTENNA
6983

Monthly Progress Report scheduled to be available on Oct. 1, 1964 is promised Oct. 5, 1964. This report will be internally delinquent but will not jeopardize contract. Preliminary detail electrical design was completed this week. Fabrication of second test model pending decision of customer.

Figure 23. Input–Output Performance Chart

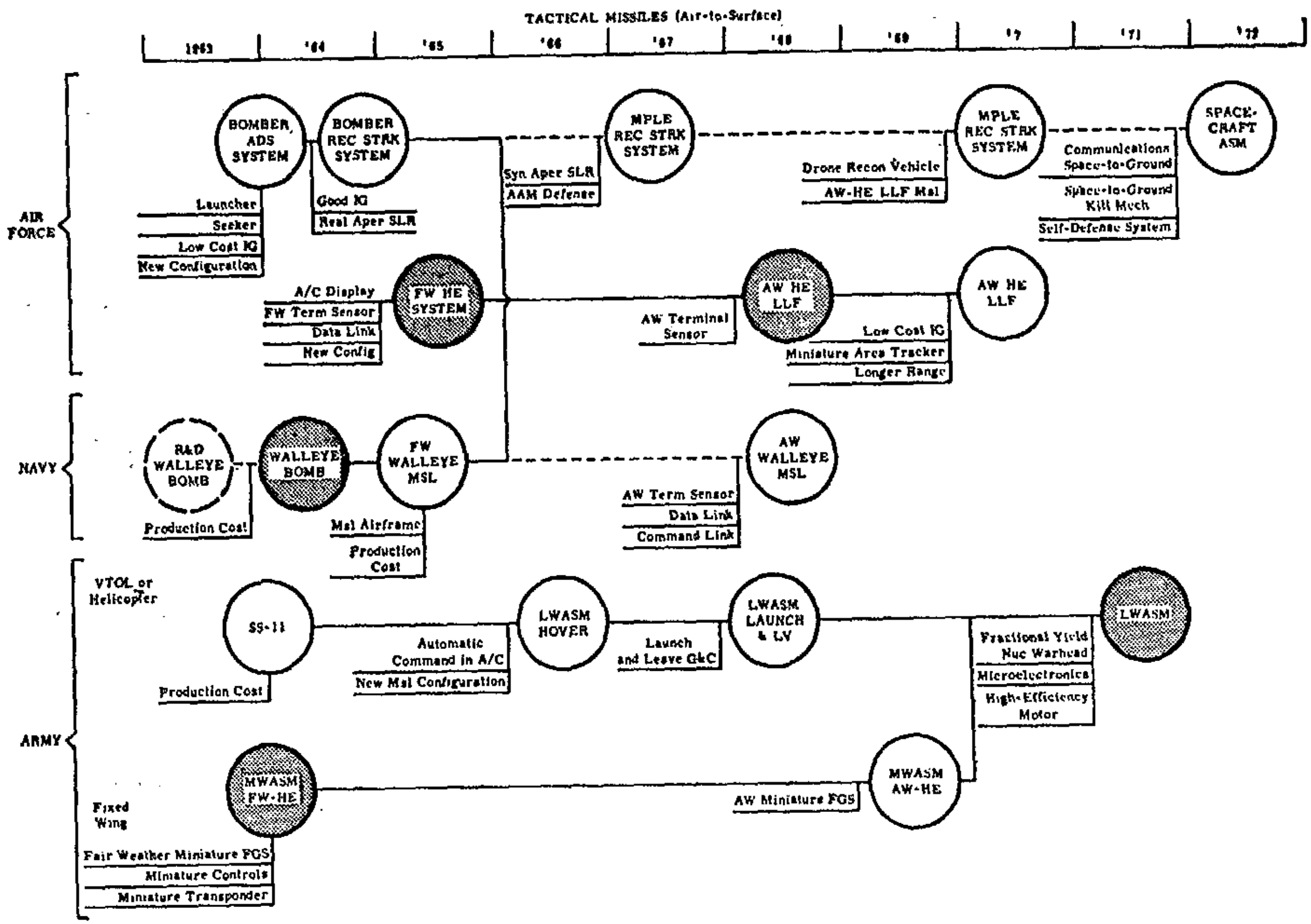
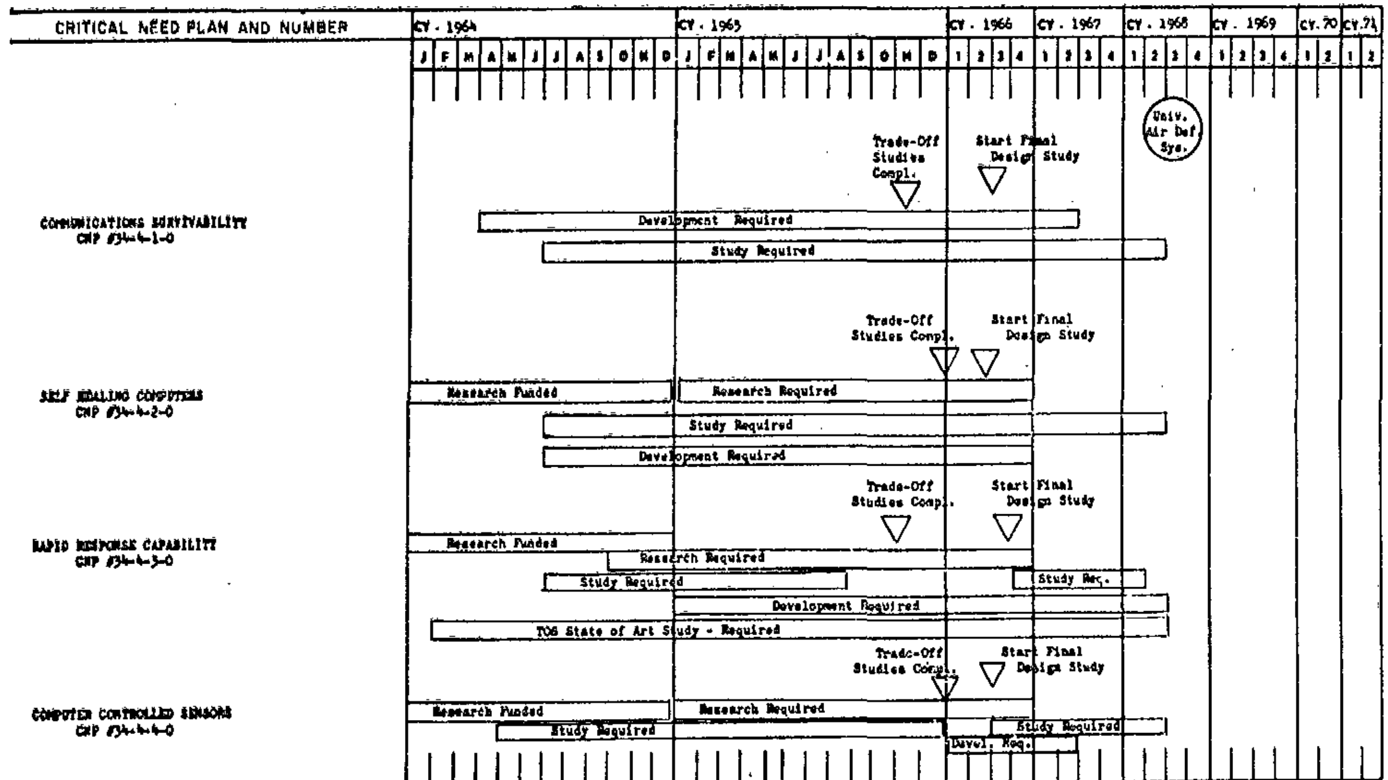



Figure 24. Bubble Chart




| | CY - 1964 | CY - 1965 | CY - 1966 | CY - 1967 | CY - 1968 | CY - 1969 | CY - 1970 | CY - 71 | CY - 72 |
|---|---|---|---|---|---|---|---|---|---|
| TOTAL MAN MONTHS | 212 | 375 | 460 | 125 | 90 | | | | |
| TOTAL COST BY YEAR ($000) | 225.1 | 493.0 | 689.0 | 145.0 | 67.0 | | | | |
| TOTAL CUMULATIVE COST | 225.1 | 718.1 | 1,407.1 | 1,552.1 | 1,619.1 | | | | |

NEW BUSINESS PLANNING

Figure 25. Program Plan

Proposal Title:

Summary of Statement of Work:

Schedule Information

Proposal Review Date ________

Proposal Submittal Date ________

Expected Contract Go-Ahead ________

Length of Contract ________

| | | | | | | |
|---|---|---|---|---|---|---|
| Technical Evaluation | Compatible with Long Range Plan (Critical Needs, Etc.) | Competing Programs | Competing Contractors | Contracts Held By Competition | Orlando Tech Strength vs Competition | Teaming Necessary or Advisable |
| Finance | Proposal Funding Required and Available | Cost Ratios | Type of Contract | Cost Advantages/Disadvantages Peculiar to Orlando | Relationship to Long Range Sales Objectives | Will Win Permit Reallocation of O/H Funds to Other Programs |
| Engineering Manpower | Manpower Skills Required for Proposal | Manpower Skills Available | Manpower Required/Available to Perform Contract | Competition with Other Proposals for Required Skills | Engineering Reputation with Customer | Key Technical People (Name) |
| Sales Intelligence and Market Analyses | Firmness of Requirement | Customer Funds Available Initial Contract/Total Program | Market Analysis Information | Critical Element of System | Orlando Position vs Competition | Other Contracts Awarded to Competition in This Area |
| Facilities and Manufacturing | Additional Facilities Required Contractor Funds/ Capital Funds | Do Facility Requirements Appear in Long Range Facility Plan | Scope of Rearranging to Perform This Program | Manufacturing Capacity Available for Contract | Subcontract Requirements (Baltimore and Others) | Are We Competing in This Area |
| Management Considerations | Probability of Win | Political Environment | Management Interest | Probable Task Leader and Division Assignment | Company Funding Advantage (If Any) | Relationship to Other Martin Divisions |

Figure 26. Bid and Proposal Committee Form