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AEROSPACE PLANNING IN THE 1970'S

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Abstract

The Aerospace Industry has reacted swiftly to the complex management and technological problems created by the mushrooming space requirements. Whereas a quick reaction capability to specific demands of the National Space Program has worked well in the past, a tightening of the Federal purse strings now and in the 1970's will present new management challenges. New techniques for long range planning and management control are evolving. An analysis of the more significant techniques leads to a recommendation for survival and fiscal growth in the future by applying these new techniques to analyze, decide, plan and control aerospace operations.

Introduction

The Aerospace industry has demonstrated a fantastic ability to adapt and to grow during the 1960's. A remarkable conversion of technological capability from military aircraft and electronics systems design into the conceiving, designing, testing and "flying" of sophisticated craft in the hostile space environment has been accomplished. Growth of the industry and its component parts has been explosive, but primarily in response to external geopolitical pressures. The magnitude and direction of these pressures are beginning to change as the geopolitical situation gyrates. New pressures are being created by economic and technological change. The industry cannot maintain an attitude of responding only to the needs as they arrive. Time will no longer permit such a luxury.

Aerospace companies must look far into the future and apply the best of forecasting and management techniques to prepare for a profitable future in the 1970's. In short, aerospace management must be prepared to create and execute more effective Long Range Plans for the difficult but potentially fruitful 1970's.

Management Problems in the 1970's

Management is faced with an unenviable set of problems today. Solutions to the present day problems will not necessarily subtend for the future. The complexity of the situation deriving from rapid changes in the business environment and revolutionary technology developments can be expected to increase drastically and obsolete current solutions. A look into the 1970's to anticipate the new problems which will develop is requisite to further analysis. The more significant problem areas, environmental change, explosive technology development and maturing competition are discussed in the following paragraphs.

Changing Environment

The environment is considered to be controlled by three significant factors - geopolitics, economy and technology. The first two factors are highly interrelated. They are the result of evolutionary developments in systems of large mass not subject to drastic changes. Technology is only indirectly related to the other two factors and it

is subject to revolutionary changes. Because of this, and of the relative importance of technology, it is discussed independently.

Geopolitics. The world political situation of the 1970's will be as difficult to assess as the 1960's have been. A cessation of the Viet Nam War by the mid or late 1970's is a good bet, but there may still be one or more limited wars requiring significant commitments of resources. The "stand-off" or detente between USA and USSR should remain in effect, but the possibility of strong defensive buildups to establish a similar detente with a resurging Red China is very strong. Counterbalancing the military pressures are those arising from the needs to maintain or improve national prestige by space spectaculars and the real or assumed welfare needs. An assessment of the relationship of all of the conflicting geopolitical factors is a basic requirement for planning in the 1970's.

The uncertainties inherent in the political environment make a consideration of diversification imperative. Pressures are already mounting for diversification. Increasing competition, specialized marketing requirements and a leveling off of the total aerospace market are sound reasons for considering moves to the outside world. The projected environment of the 1970's looks equally unpromising. Sound business practices dictate the need for the aerospace industry to broaden its marketing base to become less vulnerable to the geopolitical tides now and in the future.

Economy. Economics are the ultimate constraint upon the magnitude of the military and industrial markets. Other factors such as geopolitics control the distribution within these markets. It seems reasonable to project a stable economy into the 1970's. Although the economy may have "cooled" by this time, a continuing threat of inflation will exist. Taxation can be expected to apply an optimum degree of "braking" without hindering growth. It is expected that Capital Expenditures will be maintained at the highest level that the economy can tolerate. Shortages of manpower and resources should be alleviated and the effectiveness of federal budgeting and control greatly improved by the use of program package techniques. In short, one can plan on effective control by the Federal Government, but the contingencies which may result from inadequate control cannot be neglected.

In previous economic environments, it has been the custom to maintain cash positions adequate to cover all but the direst of contingencies. A recent "tightening" of the money supply has caused second thoughts among the financial managers. Money is no longer easy to obtain. Industry has been forced to get along with much less of a "comfort margin". The effect has not been totally bad. In fact, it has been a revelation to many in proving that they can get by on so little. It should also result in better utilization of capital resources with correspondingly improved returns on investment.

Although money should become "looser" in the 1970's, the lessons learned in astute financial management

in the 1960's will be applied in the 1970's. Management must be prepared to play the game of financial "brinkmanship" in the 1970's, if it is to survive and profit.

Explosive Technology Developments

Although explosive technology developments are expected in all areas, those related to integrated circuit development and application are by far the most significant. These will be revolutionary in nature, requiring astute management to achieve a proper course of action.

Almost universal use of microcircuits in aerospace systems is expected by the early 1970's. The impact of Large Scale Integration (LSI) will be evident by this time and widespread use of LSI is expected by the mid-1970's. This projection is based upon a perfection of the Metal Oxide Semiconductor processes in the interim. The use of LSI will greatly accelerate the current trend toward a systems integration approach by the aerospace industry, with all of the implications of a requirement for capability in depth over a broad scope of scientific and engineering disciplines.

These developments will impose a tremendous burden of critical decisions on aerospace management. Simple survival may depend on decisions with respect to huge investments in microcircuit fabrication facilities with a further difficult choice of techniques between "bipolar" or "unipolar field effect" devices. Other investments in technology, such as Lasers, may require management decisions but these should not be equally hazardous.

Maturing Competition

There is at least one thing certain in the aerospace world - increasingly severe competition. This industry has been quick to adapt to new techniques, including those applied to management. It is expected that by the mid 1970's, at least, the aerospace leaders will be using mathematical approaches and computers to effect better planning and assure reasonable balances between profits and growth. A potentially tighter market, with many organizations of almost equal capability, will force the use of sophisticated techniques as a means for offsetting the competitive pressures. Federal agencies are already adopting such techniques as program packaging and can be expected to impose the use of effective planning and control techniques on major programs. A wise aerospace manager will never allow decisions to be made for him by a computer. The wisest manager will utilize his computer as fully as possible as an aid to his decision making.

Management Techniques for the 1970's

The management problems of the 1970's will be difficult, but the means for solving these problems will be available to the sage administrator. Powerful techniques for analysis, planning and control are just evolving. These new tools for statistical analysis, decision making, long range planning and management control are discussed in the following section.

Sophisticated Analytical Approaches

Many new techniques are evolving. Those considered most significant for future use are: Monte Carlo Methods,

Bayesian Techniques, Regression Analysis and Program Package Budgeting.



Monte Carlo Methods. There is much more to these methods than an intriguing name. Although the general method has been in use for many years, its specific application to management problems is relatively new. It is most useful for simulations. It involves the use of random sampling. This may only be practical with modern high speed computers. An example of its usefulness is the application of random processes to a combination of estimates, each of which has been assigned a range of probabilities. Intuition tells us that for a large number of events we cannot expect that either everything bad or good will occur. A middle of the road situation somewhere in between the addition of the possible extremes is most likely. By applying random sampling, we can determine what this most likely situation will be.

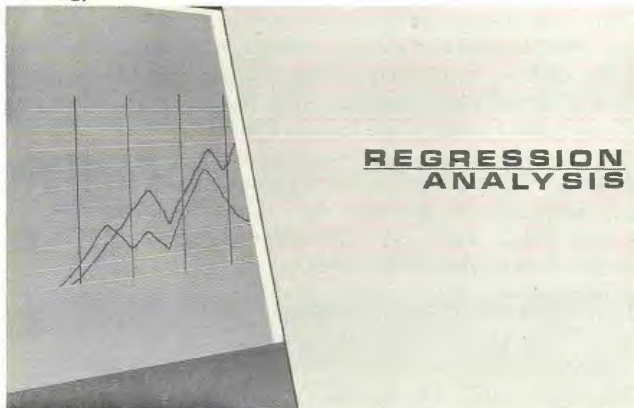
An excellent example of the use of the techniques is given by William A. Clark⁽¹⁾. His simple example illustrates how a Monte Carlo simulation provides an answer to an otherwise baffling problem of optimizing the number of floor polishers to be kept available for rental. If we assume reasonable statistical data are available on demand and breakdowns, we can simulate the actual situation by using a computer to "draw" random numbers and apply these to simulate the actual situation. A good answer means a minimum number of idle machines and profitable operations.

Trivial though this may seem, it can be applied to any business situation where it is not economically sound to provide maximum capability at all times if the demand is known to be random in nature.



Bayesian Techniques. The good Reverend Bayes could scarcely have realized the usefulness of his 18th century concepts in the 20th. This is a powerful tool for re-assessing probabilities in the light of fresh statistical information. A classic example of the use of these techniques is the assignment of election probabilities. Initial sets of probability of vote distribution are modified by the first scattered vote returns. As these are applied to the initially assigned probabilities, the probability of the final outcome becomes more and more certain. In this manner, the eventual outcome can be forecast with a high degree of precision with very little statistical data. The application to surveys and market projections is readily apparent.

An excellent example of a business application is given by Guy Robert Detlefsen⁽²⁾. In this real life example, a marketing strategy was formulated on the estimates of an experienced marketing staff. Key to the strategy was the use of critical decision points which would permit strategy changes as data became available. As limited field data became available, a Bayesian approach was used to improve the original probability estimates. These led to the formulation of an optimal over-all strategy.



Regression Analysis. This fancy sounding technique is simply a method for examining past history as a means for projecting into the future. It is obvious that real-life data is anything but linear. The trick to analyzing historical data is to uncover the meaningful short and long term trends. Regression Analysis is a useful tool for evaluating past data and correctly projecting the trends into the future.

Simple regression analysis may require the use of the linear or curvilinear trend fitting. A least square approach is popular, although the Gompertz or logistic curves (S-shaped) may sometimes be applied.



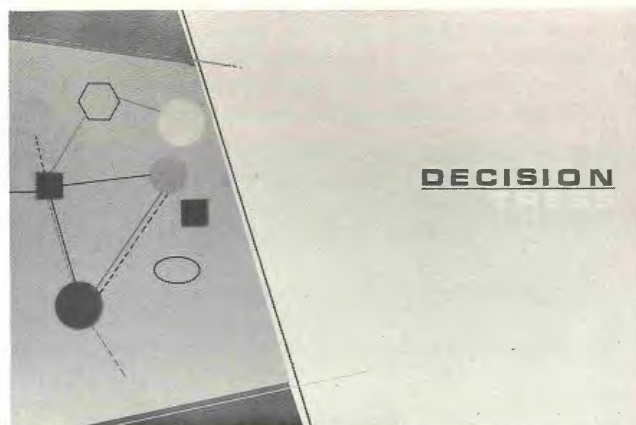
Program Package Budgeting. Program package budgeting got its start with the famous DOD "Hitch" plan. The technique involves the concept of viewing major programs in their entirety as a total program package. Decisions as to whether or not to proceed are based upon comparing the total program returns (benefit) to the total program funding requirements (costs). Competing programs can then be compared on the basis of a cost/benefit ratio. (The famous cost-effectiveness criteria.) This concept applies equally well to commercial and military budgeting.

One of the more interesting applications for the technique is in those areas where the programs have less obvious or intangible benefits. Subjective value assessments are required in order to establish a basis for comparison. Considerable thought is being given to the value assessments of the scientific space programs where the value is obvious to the true scientist but not so obvious to an uninformed public.

The 1970's should see more effective use of the technique for obtaining balanced federal programs where equal justice is given to defense and to purely welfare programs. Experience presently being gained by the Department of Health Education and Welfare in PPBS should ultimately permit the President to fairly choose between guns and butter on a cost-effectiveness basis.

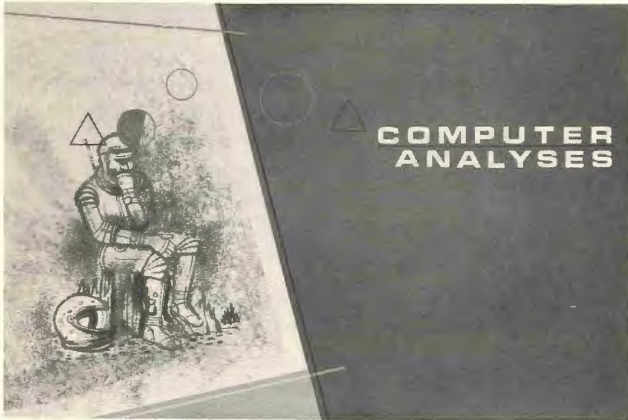
Management Decision Aids

Critical decision making will always remain the province of management. The best decisions are the result of a careful consideration of a number of alternatives. In the modern business world a mental analysis of a host of possible alternatives or trade-offs may become too complex and a less than satisfactory decision is a result. Formalized (structured) approaches, which take advantage of the prodigious capability of computers, can set before the decision maker a digest of only the most promising alternates. Typical management decision aids are decision trees, computer analyses and gaming.



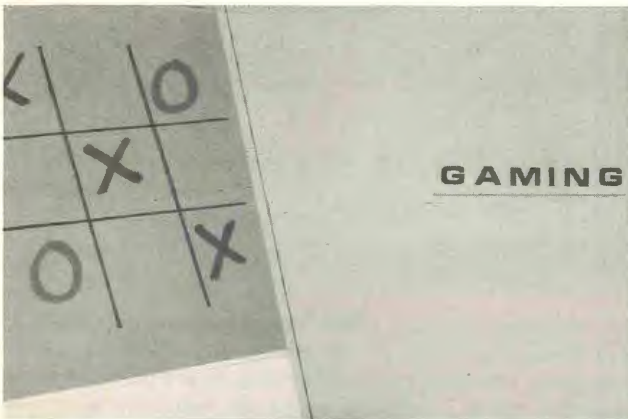
Decision Trees. This is an ordered approach to examining the various alternate paths with their possible branches. Critical path scheduling is a closely related approach often used to examine the sequence of events required to get from point A to point B in a optimum manner. In a decision tree, one examines the potential consequences of a series of possible actions each of which may give rise to a new set of possible actions. The structured approach assures that all possibilities are considered so that the best final decision can be achieved.

A typical example is described by W. J. Dickman⁽³⁾. Although the application of a structured decision making process to the selling of hot dogs appears to be trite, it becomes apparent that even in this homely example the entrepreneur selling hot dogs can either profit moderately or lose his shirt. To the hot dog vendor and to the big business entrepreneur this is important. A properly constructed decision tree can be the difference between good and bad decisions.



Computer Analyses. A high speed computer, when properly used, is the most powerful of management decision aids. It is the computer which makes possible the examination of large databanks, analysis of a multitude of alternative possibilities and the execution of large numbers of iterations. The use of computers as decision aids has only just begun. Software problems are slowly being overcome, and standard programs are becoming available. Time sharing is now possible in most areas, and the services include standard programs available to a large number of users.

A typical example is the use of regression analysis to determine trends for future projections. The standard routines are already programmed, and a "best fit" can be provided within seconds to a remote operator. Other services are rapidly developing, particularly in the field of widely used "data banks" (e. g. Dun and Bradstreet). The availability of these data banks plus standard programs on a time shared basis will make the computer available to all levels of management for decision making.



Gaming. Like the Monte Carlo methods, there is a strong appeal to the name. However, this is by no means the justification of using a gaming approach. As with many other techniques, the military have been the first to adopt gaming as a means for plotting strategy. There

are sound business reasons for utilizing these methods in the aerospace industry where the competitive environment of the 1970's should be fierce. The concept is simple, the implementation more difficult, the results rewarding. A specific example of applying gaming is the determination of an optimum strategy for introducing a new product in an established market. It is known that the share of the market that can be captured increases as a function of advertising and promotion funding. However, one cannot simply spend unlimited funds and capture the entire market. The competition will not be idle. They will be making countermoves to recoup former market shares. They must be assumed to be astute with their finances and attempting to optimize returns. One can construct a gaming matrix which shows the result of each move and countermove. From this, one can determine an optimum region where they maximize returns against an assumed astute competitor. These answers are by no means obvious to even the best intuitive management.

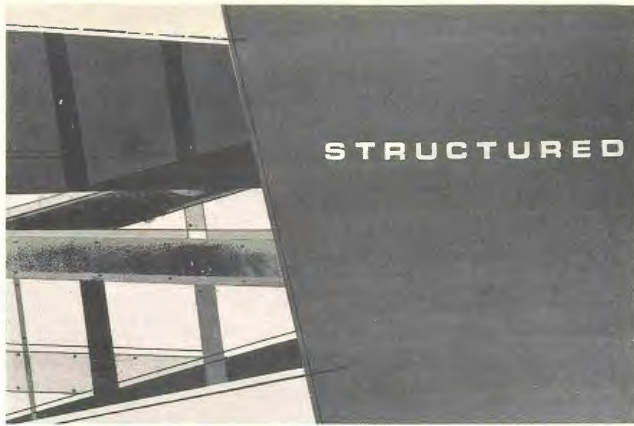
Effective Long and Short Range Planning

Analyses and resulting management decisions should culminate in a series of plans. Short Range Operational Plans are already an accepted way of life in the 1960's. The need to meet profitability criteria will grow stronger in the 1970's. Long Range Planning in the 1960's is still more of an art than a science. The process of long range planning must mature and improve in the 1970's to where it is equally as acceptable as operational short range planning. The trial and error processes applied by 1960's long range planning pioneers have led to the establishment of specific ground rules for effective planning. Long Range Plans of the 1970's must be:



Participative. The old school of authoritarian management is slowly dying. A participative approach will be necessary for the conduct of business in the 1970's. A participative approach will be vital to the creation and execution of a long range plan in a multi-faceted or multi-divisional organization. There is no substitute for individual managers to "plan their work and work to their plan".

The technique is more than the assembly of an ad hoc committee composed of line managers. The real benefits derive from a continuing use of their talent and experience in the development of new technologies or markets. These managers, jointly and severally, are most likely to anticipate potential problems and pitfalls to be avoided. Once a problem can be described, progress toward a solution has been made.



Structured. The science of planning has been well developed. There is no need to re-invent the concepts and techniques. The greatest rewards are obtained from the application of a well conceived plan of attack that has carefully been structured by experts. This assures not only conformity of a family of plans but also avoids lost motion from ineffective self-generated approaches.

Progress in the structuring of the planning process has been good. Relatively standard approaches have been developed by organizations such as the Stanford Research Institute - Long Range Planning Service. By following their orderly process of analysis and documentation, planning managers avoid many of the common mistakes during start-up and are assured of reasonable completeness. By documenting the strategy of the intuitive executives in a structured manner, the true objectives and goals become known to other line managers who may previously have been operating "in the dark".



Accurate. Long range plans can provide accurate guidelines for management control. One should attempt to achieve the highest possible accuracy using all the resources at hand and then apply judgment to assess the true validity of the result. All long range projections are estimates of a sort, and not all of them need to be based on factual or historical data. Completely workable projections can result from probabilistic determinations. These are particularly valid when a number of probabilities from expert and experienced management can be combined.

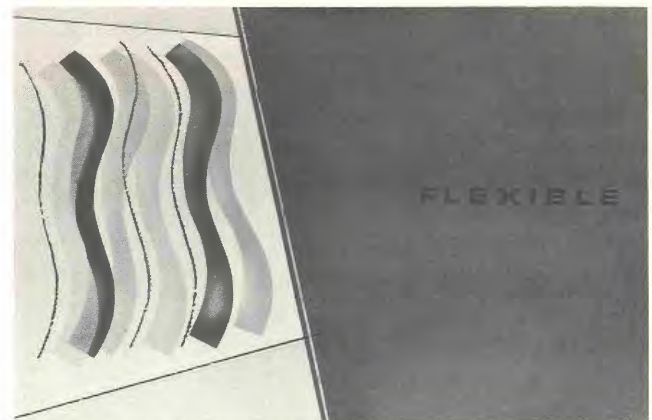
The real problem is to know what accuracies are required. It is easy to analyze a problem to death with only incremental gain as depth of analysis is increased. In many cases a probability assessment may be just as workable as a time consuming market survey and many

times less expensive. We should make better use of probabilistic assessments in achieving adequate but not excessive accuracy.



Inclusive. A narrow plan prepared with blinders on will be of little value. A strong tendency normally exists to remain in a "comfort zone" applying the old technology in old markets. This will be even less appropriate in the 1970's environment than it was in the 1960's. A prime purpose of longer range planning is to closely examine those alternates a little further afield. Considerations of new products and new markets must be as all inclusive as reason permits.

A prime reason for an inclusive approach is the need to examine all potential areas for diversification. Capability of the Aerospace Industry to adapt technology to entirely new market sectors is strong. A particular example is the possible entry of aerospace firms into the Oceanography market⁽⁴⁾. Remote as this may seem, it is worth considering.



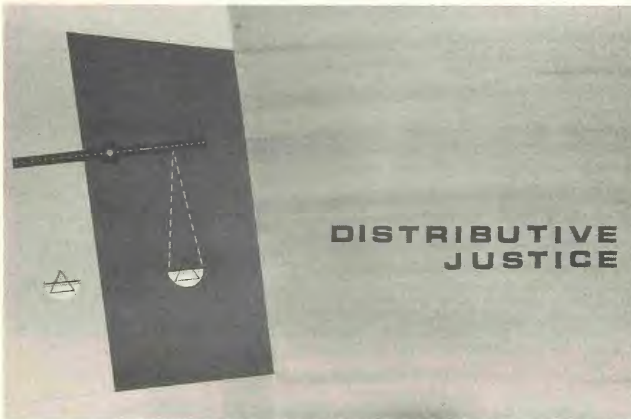
Flexible. The proper degree of elasticity in short and long range plans is difficult to achieve but necessary. The changes in environment which govern the markets and program funding may quickly negate a portion of the best prepared plans. An execution of the "hat trick" may be required to determine the proper frequency with which to modify or update a given plan. Strategic plans stating long term corporate objectives, goals and implementing strategy should not require frequent modification if properly prepared initially. Derivative long range development plans should not require other than an annual updating. Operational plans may require frequent review and modification.

Effective Management Controls

The integration of analyses and decisions into a family of plans does not constitute the final action. Most important of all is the process of monitoring and control. A clearly delineated set of goals should appear in the plans. These must be carefully compared with actual results or progress as time advances. Monitoring of these requires an effective Management Information System. Equitable control demands the proper application of Distributive Justice.



Management Information Systems. The rapid development of the late 1960's should lead to almost universal use of management information systems in the late 1970's. Computers are already producing digested results of detailed analyses. Display techniques are constantly improving. It is the man-machine interface that requires development so that top management can effectively converse with the computer and its data bank. Simple information retrieval will no longer suffice in the 1970's. Managers must be able to "work out" problems jointly with the computer. Related developments in education by computers point toward a realization of the desired Management Information Systems in the 1970's.



Distributive Justice. Management control by brute force authoritarian methods will no longer be effective in the 1970's. Although staff psychiatrists may not be universally acceptable in the 1970's, management will be applying psychology in its exercise of control at all levels. Employee motivation is vital to the success of an innovative aerospace industry. All employees, and managers in particular, are keenly aware of the relative justice implicit in the actions of their supervisors. Management must be keenly aware of the need for distributive justice in its administration.

A Consolidated Approach

The approach required of management to survive and grow in the 1970's is clear. The techniques for analysis, decision making, planning and control are already available or developing rapidly. Management must dedicate its time, effort and resources to:

Analyze

Decide

Plan

Control

The rewards will more than justify the means.

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