PLANNING THE INSTALLATION OF A
DATA BASE MANAGEMENT SYSTEM

by

LUTHER STEVEN GOODIE

B.S., Massachusetts Institute of Technology (1975)

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENT FOR THE
DEGREE OF
MASTER OF SCIENCE

at the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
(May, 1977)

Signature of Author

Alfred P. Sloan School of Management
May 12, 1977

Certified by

Thesis Supervisor

Accepted by

Chairman, Departmental Committee on Graduate Students
ACKNOWLEDGEMENTS

I would like to extend my gratitude, at this time, to the several people who have contributed to the successful completion of this work.

First, I would like to thank Harwell Thrasher who is most responsible for making this thesis possible.

Much thanks is also extended to Peter Briggs and Martin Hatzadourian who have spent much time in sharing their knowledge with myself.

I am also grateful to Abbott Weiss and Bob Grimes both of whom have extended their support to this project.

Finally, I would like to thank my thesis advisor, Professor Stuart Madnick. His criticisms and helpful suggestions have been greatly appreciated.
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER I - Focus and Process</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Focus of Paper</td>
<td>7</td>
</tr>
<tr>
<td>1.2 Systems Development Process</td>
<td>9</td>
</tr>
<tr>
<td>1.3 Planning Phase</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER II - Background</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Case Study Introduction</td>
<td>19</td>
</tr>
<tr>
<td>2.2 Corporate Data Bases</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER III - Stage One of the Planning Phase: Initial Investigation</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Recognition</td>
<td>29</td>
</tr>
<tr>
<td>3.1.1 Request/Commitment System</td>
<td>38</td>
</tr>
<tr>
<td>3.1.2 Performance Evaluation System</td>
<td>43</td>
</tr>
<tr>
<td>3.1.3 CHARTS System</td>
<td>43</td>
</tr>
<tr>
<td>3.1.4 Early Warning System</td>
<td>43</td>
</tr>
<tr>
<td>3.1.5 Resource Capacity Modeling</td>
<td>44</td>
</tr>
<tr>
<td>3.2 Recognition and Generation</td>
<td>44</td>
</tr>
<tr>
<td>3.2.1 Flexibility Problems</td>
<td>45</td>
</tr>
<tr>
<td>3.2.2 Complexity Problems</td>
<td>48</td>
</tr>
<tr>
<td>3.2.3 Control Problems</td>
<td>48</td>
</tr>
<tr>
<td>3.3 Evaluation</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER IV - Stage Two of the Planning Preliminary System Study</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Assessment of DBMS Desirability</td>
<td>54</td>
</tr>
<tr>
<td>4.2 Technical Evaluation</td>
<td>64</td>
</tr>
<tr>
<td>4.3 Operational Evaluation</td>
<td>64</td>
</tr>
<tr>
<td>4.4 Economic Evaluation</td>
<td>66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER V - Stage Three of the Planning Phase: System Planning Study</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Formation of the Project Team</td>
<td>69</td>
</tr>
<tr>
<td>5.2 The Data Base Administrator Function</td>
<td>71</td>
</tr>
<tr>
<td>5.3 DBA Organization</td>
<td>74</td>
</tr>
<tr>
<td>5.4 Determining Information Requirements</td>
<td>75</td>
</tr>
<tr>
<td>5.4.1 Detailed Study and Description of Current System</td>
<td>75</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS (cont.)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4.2 Examination of Future Informational Needs.</td>
<td>76</td>
</tr>
<tr>
<td>5.4.3 Data Analysis</td>
<td>78</td>
</tr>
<tr>
<td>5.5 Evaluation</td>
<td>78</td>
</tr>
<tr>
<td>5.5.1 Technical Feasibility</td>
<td>78</td>
</tr>
<tr>
<td>5.5.2 Operational Feasibility</td>
<td>79</td>
</tr>
<tr>
<td>5.5.3 Economic Feasibility</td>
<td>82</td>
</tr>
<tr>
<td>CHAPTER VI - Conclusion</td>
<td>84</td>
</tr>
<tr>
<td>APPENDIX A - Planning a Corporate-Wide Data Base.</td>
<td>88</td>
</tr>
<tr>
<td>APPENDIX B - Glossary of Terms.</td>
<td>89</td>
</tr>
<tr>
<td>APPENDIC C - Preliminary System Study</td>
<td>91</td>
</tr>
</tbody>
</table>
CHAPTER 1

Focus and Process

The MIS field is undergoing rapid development along three dimensions its name implies: Management, Information and Systems technology. All these factors come into play in determining the evolution of management information systems making it extremely taxing to keep pace with the new developments. Although the technology is at the heart of this rapid evolution, the other two dimensions, management and information, are no less important to the process. Unless the technology can be successfully harnessed, in a cost-effective manner to satisfy the genuine informational needs of an organization, it is of little immediate value to a company.

An excellent illustration of these ideas can be manifested by examining the evolution of one of the more significant ongoing trends in the MIS area: data base management systems (DBMS.) The utilization of data base management systems within organizations has doubled within the last three years and there are expectations that this pace will continue for at least the next three years.
James Martin has called the 1970's, "the decade of the 3 data base", and Richard Nolan has heralded the data base concept as "the next natural milestone in the evolution 4 of EDP applications." With all the literature and fanfare about data base technology these days, it would be easy for a company to jump on the "data base bandwagon" especially when it is being so enthusiastically endorsed and lobbied for by the company's EDP professional staff. The caveat here, is to maintain perspective of the other two dimension of an MIS endeavor: informational needs and effective management processes. One must analyze whether there are bona fide informational needs which economically justify a DBMS and whether such a system can be effectively installed.

1.1 Focus of Paper

This paper is primarily concerned with an depth examination of the planning phase appropriate for a project involving the installation of a data base management system. The planning phase is only the first phase of an entire systems development process; the other two phases being design and implementation. This paper is written from the point of view of someone charged with the responsibility of investigating the desirability and feasibility of adopting a DBMS for use in a particular area of an organization. It
will also be of interest to anyone concerned with the introduction of DBMS's within business organizations and will hopefully provide some valuable insights for analyzing some of the following questions: Is the database approach desirable, feasible and economically justifiable in light of the particular application(s) being considered, the organizational setting and the technology available? What process or approach should be taken to resolve these issues? What are some of the necessary characteristics of such an approach which will lead to a high probability of success? Thus the planning phase begins with the conception of the database project and terminates with a feasibility study. It covers such topics as the investigation of DBMS software capabilities, the justification process for a database project and the formation of a project team. It does not cover detailed database design, system testing or the conversion process as these are part of the design and implementation phases.

For illustrative purposes, examples from a specific database project will be referred to when appropriate. This will be used to show how the approach can be applied to an actual situation. The project involves the installation of a DBMS within a particular area of a large manufacturing organization. Not all facets of the database planning approach will be relevant to the particular project presented, nor is this unusual. Each particular case is unique and will
require custom fitting of the approach.

1.2 The Systems Development Process

The development process suggested for use in the data base project is a general purpose approach for the development of any large computer project. This general approach is presented in a book by John Shaw and William Atkins called Managing Computer Systems Projects. The development process is broken down into three phases and further subdivided into several stages similar to the following.

Planning Phase

- Initial Investigation
- Preliminary System Study
- System Planning Study

Design Phase

- System Requirements
- System Specifications
- Technical Requirements
- Implementation Planning
- Programming
- User Training
- System Test

Implementation Phase

- Conversion
- Post-Implementation Review
- Ongoing Maintenance Requirements

Apart from these specific stages in the development process, there are a number of characteristics associated with the approach which are vital to its successful application. First of all, the process is iterative. In trying to get from a very general conceptual idea to a very detailed
project definition and then to an actual implementation of specific system capabilities, it is essential that an iterative process be utilized. Each stage in the Shaw and Atkins approach attempts to utilize information obtained in the previous step to probe deeper into the problem. The planning stages are concerned with perceiving the problems and coming up with a feasible solution. The design phase is much more technical as the general solution is worked out in detail. During the implementation phase, the specific solution is put into effect.

Another attribute of the process is its multiple evaluation points. Each arrow appearing in the list of development stages represents a decision point where the system is reevaluated for its continued attractiveness. This is a very important feature of the process, what Shaw and Atkins call "creeping commitment." An all or nothing commitment to the project is not required in the early stages of the project before all of the pertinent information is uncovered. Serious ramifications can result from such an approach. For example, a manager may recommend to an important committee that a particular project be funded and supported. The committee may endorse the proposal and authorize the commitment of a substantial amount of company resources to the project. If, at a later time, the manager discovers that for some reason, the project is no longer attractive to the company, he is reluctant (and perhaps
unable) to halt the process once the gears have been set into motion. Shaw and Atkins have tried to alleviate this problem by formulating a phased approach to project development which imbeds a series of evaluation checkpoints within the project management approach. Within their system development process, there are six checkpoints where the project is reevaluated and a decision is made on whether or not to continue. Based on the newest information available, the users examine the evidence and decide whether or not the system is worthy of completion. In this way, the commitment of resources to the project is gradual rather than all at once.

Another benefit of this approach is that it encourages the involvement of users throughout the life of the project. It is of crucial importance to involve the users and get them to shape the form of the system in terms of how it will be used and what its expected benefits will be. Subsequently, users will be involved in reevaluating the project at each of the various checkpoints within the system development process. In this way, the users are kept informed of any changes in the system's design and become more and more aware of what the new system will do and how it will ultimately affect them. To expect the users to totally comprehend the implications of a new system from one consultation during the project's initial stages is clearly
unrealistic. As Michael J. Ginzberg has noted, the implementation of an MIS project can be viewed "as a process of planned change in an organizational setting." As such, it should be a phased, iterative approach enabling and encouraging the users to help shape the change as well as adapt to it. If the system is designed in a vacuum solely by the systems analyst, the users have no chance to mold the system into something which is useful to their needs, nor will they be receptive to the "shocks" of a newly installed system which they know little about. Thus it is important to get inputs from the users and to keep them informed. The importance of this aspect should not be taken lightly. As keen observes, "There is a tendency among computer specialists to design the system, get it up and running and then deal with the 'people' problems, politics and other non-technical issues."

Finally, the Shaw and Atkins approach assumes the existence of a "systems steering committee" which formally reviews the process of a project at each of the evaluation checkpoints. The committee should be composed of top level managers along with the manager in charge of the "user" department for the project under consideration. As Richard Canning points out in EDP Analyzer, this method provides a mechanism through which management can participate
in the planning and control of EDP projects "where it counts." Management should be kept aware of the use of data base management systems within their company and this is one method by which they can get a feel for the benefits and costs associated with a DBMS rather than the technical aspects of such a system.

1.3 The Planning Phase

In many ways, the planning phase is the most crucial phase of the system development process. It is in this phase that the scope of the project is determined and the major improvements over the previous system are decided upon. It is perhaps the most difficult phase in that it requires one to look the farthest into the future to foresee the ultimate implications of the decisions being made. Furthermore, it is at this point that things are the least defined: the capabilities of the technology may still need to be investigated, the information needs of the users, if even known, have yet to be transformed into functional specifications and the organizational resources needed to develop the system have yet to be committed. In addition to all these uncertainties, one is always under the pressure to produce some "hard" results as soon as possible rather than to take the several months or so needed to adequately plan the system. Because of these pressures and uncertainties, it is extremely important that one have a well thought-out
planning process which is adhered to. As Canning points out, "if there is one or more 'fatal flaws' in the planning, it means that much time, effort and money can be lost."

We have seen that Shaw and Atkins' development process has several redeeming features: it is iterative, has multiple evaluation points, encourages user involvement and provides a mechanism by which management can meaningfully and effectively monitor the progress of a project. What their approach seems to lack, however, is an overall view of steps involved in each of the phases and, in particular, within the planning phase. The planning stages: initial investigation, preliminary system study and system planning study, we know are all iterations, but the separate steps to be iterated are never made clear. In this section, we intend to fill that gap with a conceptual process which will encompass the steps to be iterated during each stage of the Planning phase.

The steps in the process are shown in Figure 1. This process itself can be thought of as having three separate sections: recognition, generation and evaluation. These three sections are very similar to Herbert Simon's three steps to problem solving: intelligence, design and choice. The separate steps in the process are somewhat similar to Michael Scott Morton's "predesign cycle" for the development of decision support systems. We feel that the process is
Figure 1: Steps In the Planning Process

PROBE
PROBLEM
AREA

RECOGNIZE
PROBLEMS

ANALYZE
SURROUNDING
PROCESSES

GENERATE
INFORMATIONAL
REQUIREMENTS

FOCUS
PROBLEM
SCOPE

PROPOSE
NORMATIVE
APPROACH

COMPARE
CURRENT
PROCESS
& NORMATIVE
APPROACH

GENERATE
ALTERNATIVE
ACTIONS

ANALYZE
ECONOMIC
FEASIBILITY

ANALYZE
OPERATIONAL
FEASIBILITY

ANALYZE
TECHNICAL
FEASIBILITY

RECOGNITION

GENERATION

EVALUATION
a good template which fits nicely over each stage of Shaw and Atkins' planning phase.

Within the recognition section, one is initially drawn into the process by looking for (or being found by) particular problems. As the problem area is probed, problems are recognized and acknowledged. To put these problems into proper perspective, the surrounding processes must be analyzed. Surrounding processes refer to two different types of processes. First, the process within which a problem occurred should be thoroughly understood. Secondly, one should also be aware of related processes which are a part of the organizational unit's overall role and responsibilities. With this background and understanding one should then try to analyze the underlying informational needs, both present and projected. The next step is to home in on the important problems and thus focus the scope of the project. We now have established the problems we intend to address and have analyzed the existing processes with respect to their contribution to the overall function of the organization unit.

To alleviate these problems implies change. Therefore, we would like to have in our mind some "normative model" towards which to move. This may be some sort of ideal or preferred approach to a problem which one feels should be ultimately adopted. However, it may not be possible or
desirable to move abruptly to this new approach for a number of reasons. In any case, one, hopefully, can move in the direction of this desired approach through a number of alternative actions. After this menu of actions has been generated, these actions must be evaluated for their technical, operational and economic feasibility. Upon final iteration of this process, one of the approaches should be recommended to proceed to the design phase.

This should give one a feel for what is trying to be accomplished during each stage of the planning phase. Of course, the emphasis on the various steps will vary in each of the planning stages. For example, a project's economic feasibility may be only crudely analyzed during the initial investigation while heavy emphasis will be placed upon probing the problem area.

Furthermore, the process just presented need not be followed religiously if one is starting the analysis already armed with some background information. For example; if one is already aware of existing problems and is familiar with surrounding processes, one may already have a prior bias as to what type of normative approach is required. This is certainly the case for anyone considering the installation of a data base management system. One has already assumed or at least suspects that the data base management approach is the desired normative approach. Hopefully, before coming
to this conclusion, one has gone through at least an "implicit" recognition process. Otherwise, one is running the risk of having selected a solution before the problem is known.

In our analysis, it is assumed that past experience has led one to believe that the data base management approach is the normative model to consider. The planning process is then approached from the point of view of verifying the merits of this model. This is felt to be a more realistic approach to the planning process especially from the point of view of someone investigating the desirability and feasibility of converting to a data base management system. One does not have to "pretend," during the recognition stage, that the data base management approach is not being investigated. Since we already have prior indications that a DBMS would be useful, it may be more efficient to, say, compare the existing process with the normative approach (step 7) while analyzing the surrounding processes (step 3.) What is important, is that the steps in the planning process be clearly understood. Their order of execution may vary from project to project for reasons of convenience or circumstance.
CHAPTER II

Background

2.1 Case Study Introduction

Before delving deeper into the planning process appropriate for the data base project, let us provide some background on the organizational setting of the company which will be used as an example throughout this paper.

The company is a rapidly growing manufacturer of computers and computer related equipment. With annual sales growing at well over 25% a year and plant additions and expansions continuing as the normal mode of operating, the company is heavily oriented towards continued growth. The company's organizational structure can be viewed, very simply, as consisting of four separate functions as shown in Figure 2. We will be concerned primarily with the manufacturing organization which is shown in Figure 3. It should be noted that this is the corporate manufacturing organization and does not include the organizational structure of the company's several manufacturing plants (under the Plant Group V.P.'s.) The Manufacturing Systems area, which is also part of the company's MIS organization (see Figure 4), provides EDP support to the various groups within manufacturing. A matrix organization is employed at the company such that
Figure 2: Overall Company Organization
Figure 3: Manufacturing Organizational Chart
Figure 4: Corporate Information Services Organization
each major organizational unit requiring substantial computer resources is assigned their own EDP support group. The dotted lines in Figure 3 show this support relationship between the systems groups and the manufacturing groups.

The data base project under consideration centers around the Manufacturing Planning (MP) group and its associated EDP support group, Manufacturing Planning Systems. Manufacturing Planning's role, according to excerpts from its functional charter, is to "Manage the planning process in manufacturing and provide functional leadership to these people doing the planning... Assure that the necessary plans exist; they are good plans; they are clearly stated; they tie in to other plans (corporate and manufacturing) and that the plans and their implications are understood both by management and by the people who will carry them out... To accomplish [these tasks,] manufacturing planning personnel compile and channel information -- sometimes on a continuing basis, sometimes in special studies of particular problems." To get a better idea of the type of work this entails, we will present a specific example.

Much of the group's efforts centers around the coordination of the interaction between the marketing groups (the Product Lines) and the manufacturing groups (Volume Manufacturing.) In providing this interface, MP has developed and maintains a formal communication system between the
Product Lines and Volume Manufacturing. The Product Lines submit their forecasts or "requests" for products to MP where the data is compiled, exploded, sorted and then routed to the appropriate manufacturing groups. This gives Volume Manufacturing a clear picture of the total demand for each product over the next several months. The manufacturing groups then respond with their "commitments" to deliver finished goods back to the requesting Product Lines. "Due to capacity or material insufficiencies, the volume manufacturing commitment in any period may be less than the corresponding request from the Product Lines. After initial requests and commitments for a period have been processed and disseminated, [Manufacturing] Planning acts as an intermediary in the processing of ongoing changes to both requests and commitments." A more detailed description of how this system impacts the data base project will be presented later.

2.2 Corporate Data Bases

There has been much talk in the literature about the concept of a "corporate" data base or an "integrated" data base. With regard to this concept, it is important to be aware of the scope of the data base project being advocated. It may be a single, all encompassing corporate data base containing all the company's computer data, or it may be an "infrastructure" of many loosely related data bases "which
will allow the corporation's various schemas to grow and interlink over the years..." An even less "corporate" approach may advocate the autonomous assessment by each individual user group of whether or not to adopt a data base approach for their particular applications.

The idea of a single corporate data base, like the idea of a totally "integrated MIS", is a completely unrealistic concept from a practical point of view. Although, one of the benefits of a DBMS is that it facilitates the sharing of data among several users and applications, the notion that the entire company can merge all its data into one common pool satisfying all its informational needs, is carrying things a bit too far. Even if the technical aspects of such a system could be solved, the coordination effort required would be too unwieldy to manage.

A more common approach to corporate data bases is described by James Martin as, "a corporate-wide organizing principal which forms the structure for data-base development." Under this approach, the introduction of data base technology into the corporation is done via a centrally planned infrastructure of separate DBMS installations. A common DBMS package is selected for use throughout the corporation so as to ensure compatibility and allow for the eventual interlinking of separate data bases as the systems continue to grow. Next, a long-range growth plan is developed
which spells out the sequence of applications to be brought under control of a DBMS. For more detailed information on how to select an appropriate DBMS, see references [21] and [18]. For a description of the procedures for setting up a corporate-wide data base plan see references [2], [15] and [18]. Appendix A shows a brief summary of one of these procedures.

The advisability of developing a corporate-wide DBMS "infrastructure" is not at all clear cut at the present time. For one thing, there currently exists no standard data base "language" such as exists for the higher level programming languages (COBOL, FORTRAN, ALGOL, etc.) The diversify of current approaches to data base management (hierachical, network, relational, etc) gives an indication of the lack of agreement on a standard approach much less a standard specification. (For a good description of these approaches and some specific DBMS implementations, see references [7], [14] and [18]. For some thoughts on DBMS standardization and capatibility between the approaches see [4].) Although the CODASYL approach is a plausible candidate for eventual standardization, data base technology is still in its infancy and it may be too soon to justify corporate-wide commitment to a single DBMS implementation. Another problem with the corporate-wide approach may be the diversity of hardware throughout the company. A common
DBMS may not be feasible because of lack of commercially available software for some of their computer systems. Also, it is not entirely clear what is meant by the eventual interlinking of separate data bases that Martin speaks about. The concept of distributed data bases is still very new and the technology for its practical and cost-effective implementation has yet to be developed. Thus although the idea of interlinking data bases sounds reasonable, the uncertainties concerning the future direction of data base management systems as well as the direction of distributed systems, make it difficult to anticipate the eventual merging of the two concepts.

This paper does not cover topic of corporate-wide data bases but instead concentrates on the planning aspects of a single DBMS installation. This single project could be viewed as part of a larger process of developing a corporate-wide system or it could be looked at as an independent project initiated at a local level with little or no relation to other data base projects within the company.
CHAPTER III

Stage One of the Planning Phase: Initial Investigation

As stated previously, the planning phase covers all activities from project initiation through the feasibility study and decision to continue into the design phase. Shaw and Atkins say the planning phase can be further subdivided into three stages: initial investigation, preliminary system study and system planning study. Our goal is to fit the data base project into this framework. Some of the steps involved in planning for the installation of a data base management system do not fit nicely into a single stage of the planning process. For example, the analysis of users' informational needs should be conducted in all three stages and should continue on into the design phase. An examination of capabilities of the DBMS package(s) under consideration is not a one-shot affair either. Nor is the economic analysis of the project. Many of these tasks are interrelated and require an iterative approach for the successful resolution of interdependencies. Thus in each stage, the project is analyzed in more depth than before, building on the information uncovered in the previous stage. Crucial to this process is the management review at the end of each stage confirming the project's continuing
economic viability. This review will monitor the project's progress and will hopefully uncover any problems as soon as they arise.

3.1 Recognition

The initial investigation begins with a request by someone that a data base management system be considered for a particular application. A systems analyst should then be assigned to look into the matter. At the outset, the exact procedure for analyzing this request is very dependent on the circumstances involved. Any number of factors could cause the data base approach to be inappropriate for a particular application at a particular time. This is one of the reasons why factor studies analyzing the reasons for MIS failures never seem to agree conclusively. What is needed is not a list of factors to consider, but a "clinical" approach to the problem. This means that one does not assume that a data base management system is the best solution to whatever implicit problem the initial requestor may be dealing with. The system analyst handling the request should begin by analyzing the problem area and then consider a DBMS as one of several alternative approaches to the problem. It would not be wise to narrow one's view too early on in the project.

Analyzing the problem area means close and constant contact with the user group. In order to evaluate and
compare alternative solutions, one must be cognizant of the priorities of the users' informational needs. There will always be tradeoffs to consider which will have to be evaluated in light of these priorities. The users must be consulted to verify the accuracy of the evaluations. This is true not only during the planning phase but throughout the duration of the project. The issue of user involvement probably can't be stressed enough. As was stated in *EDP Analyzer*, "It has been too often the case that user departments have stayed aloof of a new application system until conversion was almost upon them. This is not a safe procedure in any case, and particularly when first installing a data base system."

In a data base environment, there are really two classes of users: end users and support personnel. End users would include those who are directly concerned with the validity and meaning of the data. They are not members of the EDP support groups but are interested in interpreting the data to assist them in their primary functions. Support personnel, however, are from the EDP area and include application programmers and the data base administrator(s). This distinction is quite important. Both groups will be affected by the conversion to a data base management system yet they may have altogether different needs. Support personnel will be the most directly impacted
by the changeover. They will have to understand the whole concept behind DBMS. New techniques will have to be learned and accepted. The whole process of user education is an important part of installing a DBMS. This training should start early in the project and not be rushed over just prior to conversion. Users must be given adequate time to adjust to the changes caused by a new technique or that technique will not be well received.

End users will be less affected by the conversion because, to a large extent, they only see the outputs from application programs which access the data base. They are not concerned with the internal mechanisms of how the data is stored or retrieved. Presumably, though, there will be long-term benefits from a DBMS which will affect the end users, otherwise, the system probably can not be justified. End users should be consulted to make sure that these benefits can be realized and that they are relevant.

Thus during the initial investigation we want to begin looking into the following questions: Why is a DBMS being considered and what benefits are hoped to be gained by its use? What is the problem area which precipitated the request for a data base system? Who are the users? What resources are necessary to implement the system and are they available? The initial investigation is only the first pass at some of these questions and is purposely a very brief
investigation. If the system warrants further consideration it will be analyzed in greater depth in the preliminary system study. If not, then relatively little company resources have been invested in the project.

As stated before, the data base project for our example is being considered for installation in support of Manufacturing Planning but will be developed and maintained by their EDP support group: Manufacturing Planning Systems. The overall picture of MP Systems' operations is shown in Figure 5. Manufacturing Planning's "data base" is really a collection of four sets of indexed sequential (ISAM) files and a number of "organizer" files and tables. The largest and most active file is the Where-Are-We (WAW) file. It contains historical information such as bookings, cancellations, shipments, backlog, inventory and internal requests, commitments, deliveries and backorder for all major parts sold by the company. (See Appendix B for a glossary of terms.) This information is collected periodically from various other groups within the company and updated into the WAW file. The second set of files is the CHARTS files, of which there are three. These are essentially summary files of the WAW data. The dimensions along which the data are summarized will be discussed at a later point. The Worldwide (WW) CHARTS file contains summary information concerning total worldwide operations
Figure 5: Manufacturing Planning's Data Files & Systems
while the Domestic (DOM) CHARTS contains only data for U.S. operations and the Irish (IRE) CHARTS pertains to overseas operations. The Early Warning (EW) file is yet another derivative of the WAW information. Almost identical to the WW CHARTS file, it too contains summary information but is used solely in support of a graphics application. The last major file in the system, the Bill of Material (BOM) file, contains the product structure, down to the level of sellable options, of most of the companies products. This file also contains product attributes for each part such as manufacturing cost, retail price, etc.

The data stored in the WAW, CHARTS and EW files are categorized along several dimensions as shown in Figure 6. For example, within the WAW file, data is stored as the number of units of a particular part, made by a particular Vol. Mfg. stockroom, for a particular business stockroom, in a specific month. The data type, whether it be bookings, requests, inventories or whatever, is also indicated (see Figure 7a). The CHARTS and EW files contain essentially the same information only summarized along the product dimension and the market dimensions. (See Figures 6 and 7b) The BOM file contains the product relationships necessary to summarize along the product dimensions while several of the "organizer" files allow one to summarize along the market dimensions. Yet another table is used for summarization.
Figure 6: Data Dimensions
Figure 6 (Cont.): Data Dimensions
Figure 7.a: WAW Record Format

Figure 7.b: CHARTS Record Format
along the manufacturing dimension. The interaction between the WAW, CHARTS and EW files is shown in Figure 8. The figure illustrates the multitude of possible update paths as new information propagates through all the files. The problem is magnified by the fact that information concerning each of the data types arrive at Manufacturing Planning at different times of the month. Thus, there is not one big update at the end of the month but several partial updates throughout the month.

The application systems, of which there are approximately five, interact with the data files in several ways. Within each system, separate jobs are run to update a file, access information, manipulate data or produce reports. Each application system consists of approximately ten to twenty separate jobs each of which contains on the order of five to fifteen steps. All the systems are primarily batch oriented, however, portions of the Early Warning Graphics System do involve a certain amount of interaction.

A brief description of each of the systems will be presented below.

Request/Commitment (R/C) System:

This system was referred to earlier in this paper as an example of the type of work carried out by Manufacturing Planning. As was mentioned, this system coordinates
Figure 8: Data File Interactions
the communication between the marketing groups and the manufacturing groups. To get a clearer picture of this interface, refer to Figures 9a and 9b. Volume Manufacturing does not deal directly with the Product Lines but instead deals with an FA&T (Final Assembly and Test) Business Stockroom which represents one or more Product Line groups. The Product Lines submit their requests (called ship forecasts) to their FA&T Business Stockroom (BUS). The BUS stockrooms then communicate, via the Request/Commit system, with Volume Source stockrooms. The Volume Source stockrooms then respond back to the Business stockrooms with their commitments. The sequence of events for a single month are shown below:

<table>
<thead>
<tr>
<th>Week</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A: Publish end-of-month reports Distribute pre-printed commitment forms to Vol. Mfg.</td>
</tr>
<tr>
<td>2</td>
<td>B: Collect commitment forms from Vol. Mfg.</td>
</tr>
<tr>
<td>3</td>
<td>C: Publish new commitment reports and distribute along with pre-printed request forms to FA&amp;T.</td>
</tr>
<tr>
<td>4</td>
<td>D: Collect request forms from FA&amp;T Business stockrooms.</td>
</tr>
<tr>
<td>5</td>
<td>E: Process forms and begin new cycle.</td>
</tr>
</tbody>
</table>

Besides these monthly updates, the Request/Commitment system also processes minor updates three times a week.
Figure 9.a: Marketing / Manufacturing Interface
Figure 9.b: Interfaces
Performance Evaluation (PE) System:

This system has two main functions. First, it collects and updates the data files with the following data types: backorders, deliveries, inventories and returns. Secondly, and most importantly, it monitors the delivery performance of the Vol. Mfg. Source stockrooms. The system produces a number of monthly management reports showing how well each Manufacturing group is delivering what it committed to the Marketing groups.

CHARTS System:

This system updates the CHARTS files and generates some 70 reports each month. The level of the CHARTS data is at the major product group level of which there are some 200. The information is also stored by market group (16) rather than by Business stockroom (approximately 170.) (See Figure 7b.) The CHARTS management reports basically show historical information concerning all data types for each CHART part: requests, commitments, backorder, inventory, etc.

Early Warning System:

All of the reports mentioned so far exhibit data in tabular form. Such data is often difficult to interpret. Historical trends are not readily apparent nor are anomalies in the data. For rapid interpretation, a pictorial representation of the data is what is needed. The Early Warning
Graphics system provides this capability. For any CHART part or combination of CHART parts, and for any market, a graph may be produced which exhibits the historical behavior of one or more data types. For example, one may want to view the projected requests and commitments for a particular part over the next year. Manufacturing commitments which are way below requests for a particular month will show up much more vividly on a graph of this type than it would in tabular form. The Early Warning graphs help tremendously in the area of product analysis. The EW System is the only interactive system within Manufacturing Planning although the interaction is slow and clumsy.

Resource/Capacity Modeling:

These models take the projected build schedule for, say, the next 12 months and do the following: project labor and space requirements by plant; determine aggregate budget data by plant group including interplant transfers, value added expenses and raw material expenses; and project inventory levels. Requests or commitments may be used as the projected build schedule.

3.2 Recognition and Generation

With this background, we can begin to examine some of the problems with the current system and some of the reasons why a DBMS might prove useful in such an environment. Some of the problems and constraints associated with the present
system have arisen and become more noticeable as a result of several factors:

1. The system's piecemeal growth over time
2. Manufacturing Planning's changing informational needs
3. The growing acceptance and refinement of new technologies

These problems can be grouped under three broad headings:

1. System's lack of flexibility
2. System's growing complexity
3. Need for better control

3.2.1 Flexibility Problems:

An example from each of these categories will be given. The system's lack of flexibility can be illustrated by the existence of the Early Warning file. As mentioned before, it is very similar to the Worldwide CHARTS file and contains essentially the same information. At the time the Early Warning file was created, the CHARTS file contained only a few of the data types required for the Early Warning system. Although these data types were eventually added to the CHARTS files as well, it was easier to create a whole new data base with the advent of a new system rather than to make additions to the CHARTS file and have to modify all the existing programs which accessed them. Thus we have applications which "lock onto" existing data files thereby freezing their structure. If the data is needed in
a slightly different form for another application, the data either has to be restructured into another file or the old applications also have to be modified. Frequently, it is less painful in the short run to create and maintain a new data file. However, this introduces complexity, redundancy and the potential for inconsistency into the system. One of the chief advantages to a DBMS is the increase of independence between applications and data. This concept of data independence is illustrated in Figure 10. Under the conventional approach, application systems tend to "own" their private data files. The sharing of data is a difficult and tricky process. If either application B or C required a change to data file IV, the other application would also have to be changed in order to be compatible with file IV's new format. Under a data base management system, DBMS acts as an interface between the physical data storage and the logical view of the data as seen by the application systems. Two applications may be accessing the same data in two different manners. DBMS restructures the data to suit the needs of the individual application systems. Of course, the degree of data independence achieved varies for different DBMS implementations and is never total. A certain amount of overhead is involved with the introduction of this new "intermediary." Also, any restructuring of the data base
Figure 10: Data Independence
can still be a lengthy process. However, this is a much less severe problem than that of modifying all the programs in one or more application systems.

3.2.2 Complexity Problems

The system is becoming more and more complex as more data files, organizer files and tables are added. Not only is there redundant data in the system but, as a result, there may also be inconsistencies. As an example of a "time" inconsistency, the CHARTS file may contain bookings information through the month of June but inventory only up until May. The Early Warning file, on the other hand, may have June's inventory but no bookings past May. Just keeping track of the status of all the data files can be a confusing task. If a DBMS could reduce the amount of data redundancy, the problem of inconsistency would also be reduced.

Lack of Control:

Although people have been assigned responsibility to run, maintain and improve the various application systems, no one has been assigned direct responsibility for maintaining the individual data files. Some of the files are shared between two or more application systems and therefore, no one person has overall responsibility for those files. Because of this, the data files tend to become cluttered and
out of date. Until very recently, fully one-third of the records within the WAW file were obsolete. The installation of a DBMS will not, in and of itself, result in more effective control of the data and yet this is very definitely at the heart of a lot of the problems with the existing system. As the size and number of applications systems grow, so will the amount of shared data, either through the creation of redundant files or the actual physical sharing of files. It is essential that someone or some group be assigned the responsibility for monitoring and controlling this data base as a whole. This group, which we will call the Data Base Administration (DBA) group, should not be associated with any particular application system but instead should have an overall view of the needs of all the application areas. The DBA function will be discussed in greater depth at a later point. Thus we can see that a DBMS is not necessarily the best cure for all of the system's present problems. This points out the importance of investigating the problem area before investigating the "solution." A data base management system, in this case, should really be viewed as a tool to be utilized by the DBA group to help them achieve their objectives. As the CODASYL Systems Committee advocates, effective data management begins "first [with] the establishment of a data base administration function and second, [with] the acquisition
of a data base management system," Creation of the DBA function, thus, becomes part of our normative approach.

3.3 Evaluation

Support personnel in our example would be the application programmer/analysts in charge of the various application systems. (The DBA group, if and when formed, would also be considered support personnel.) The end users would be the analysts in Manufacturing Planning. Most of the information concerning the existing system can be acquired through interviews with the application programmers while ideas concerning new informational needs and possible extensions to the system should also be elicited from the end user group.

Although the potential benefits associated with the installation of a DBMS look promising, one must also consider the availability of resources, the long-range plans of the organization, and the mood or atmosphere dominant within the group. These aspects will be touched upon briefly to give one a flavor of their relevance. Palmer points out some of the broad categories of resources which must be considered when installing a DBMS: funds, manpower, expertise, software and hardware. The first two are fairly obvious. Expertise refers to the knowledge and understanding of data base concepts and the implementation skills which are prerequisites to the successful realization of a data base project.
DBMS software packages are also an important factor in considering a "data base approach." The process of selecting a DBMS package is often a very long and involved process, (see references [21] and [18].) In our case study, the choice was fairly limited. Only two DBMS's were commercially available for the computer being used. One of these packages was a CODASYL implementation developed and marketed by the company itself. The other package was not a CODASYL approach nor was it a widely used system. Thus, by default, there was only one package seriously considered. This could be obtained at no cost to the group and was continually being maintained and upgraded by the company. Development of an "in-house" DBMS was also never seriously considered due to a multitude of problems with this approach. (Besides, the only DBMS package considered was, in fact, an in-house development!) Still, the capabilities of the DBMS must be carefully analyzed to verify that the informational requirements of the project being considered can be adequately satisfied.

The overhead associated with a DBMS may necessitate hardware additions to the existing computer system in the form of more core or on-line storage. If system capacity is already a problem, the effects of a DBMS and the possibility of new hardware additions should be seriously studied.
In planning the development of any large computer system which will have a lifetime of several years, it only makes common sense to verify that the system's objectives are consistent with the organization's long-range goals. This is particularly important with a data base system since it will form the foundation for all the application systems developed over the next few years. If one can anticipate some of the new applications likely to be needed in the near future, the data base can be designed ahead of time to accommodate them. In converting to a DBMS, one is not simply redesigning capabilities which already exist. Extensions and additions now possible with a DBMS should also be evaluated. Knowing the future plans for applications development may also shed light on the advisability of installing a DBMS at the present time. If little new development is planned and existing applications are felt to be adequate to satisfy users' informational needs for the next few years then, a decision to convert to a DBMS is probably an unwise and costly effort. Conversely, if existing applications are going to be overhauled in the near future, then the incremental cost in going to DBMS will be a lot less than it would in the static environment described previously. As for Manufacturing Planning's future system plans, the Request/Commitment System is already undergoing extensive revisions and both the PE
and CHARTS systems will probably be completely redone during the next two years. Thus the timing seems right for such a conversion assuming most of the other pre-conditions for a DBMS are favorable.

Consideration of the technical issues is clearly a crucial aspect of the data base project. However, the implementor must be aware of the non-technical aspects as well. The mood of all the groups involved: systems analysts, users, management and the project team itself, are important considerations which should not be ignored. Is the atmosphere right for a change? Is management behind the project? Are the systems analysts eager to learn new techniques? Although all these types of questions do not have to be answered positively before starting a data base project, it is important to bear in mind where problems may crop up and perhaps do a little "preventive maintenance" beforehand.

The initial investigation is now relatively complete. Enough information has been gathered and analyzed to warrant further study into the data base project. As an indication of how long the initial investigation should last, Shaw and Atkins feel that typically it will take a single systems analyst one to three days. Of course, this assumes that the analyst is already familiar with the organization's existing system and with data base concepts.
CHAPTER IV

Stage Two of the Planning Phase: Preliminary System Study

The preliminary system study encompasses the next pass or iteration in analyzing the advisability of installing a data base management system. Because it is another "iteration" within the planning phase, many of the issues examined during the initial investigation will be re-examined in more depth during the preliminary system study. Tasks are purposely meant to span several steps of the development process. What does change in going from one step to the next is the level of analysis and degree of detail. During this stage, which will take in the vicinity of two to four man-weeks, a major portion of the effort will be expended on information gathering activities: interviewing users, examining the existing systems, analyzing the capabilities of the DBMS package, etc. Hopefully, this information will allow us to further define the scope of the new system and get a better handle on the benefits which can be realized and the resources to be expended.

4.1 Assessment of DBMS Desirability

Again, it is best to begin by examining the present system for problems and inadequacies. It is tempting, and
probably very common, to begin by examining all the possible benefits of a DBMS (of which there are many.) Such a procedure is a very valuable exercise to make oneself aware of the potential of a data base management system. However, it may be a dangerous place to begin a project evaluation because these advantages are only important to the degree that they contribute to the alleviation of the real problems of the existing system. It is all to easy for the EDP professional to look primarily at the alleged benefits of the data base management approach without thoroughly investigating whether these benefits are merely frills or whether they represent viable solutions to real informational needs. For this reason, we will not explicitly list all the advantages of a DBMS but, instead, will raise them when they are relevant to the data base project under consideration.

The organizational chart for the Manufacturing Planning Systems group is show in Figure 11. These "support personnel" users should all be interviewed in an effort to ascertain how their particular application systems interact with the existing data files and how their applications might be impacted by a conversion to DBMS. During these interviews, one should be on the alert for the following types of information:

1. any and all problems/opportunities associated with the existing system
2. potential benefits of a DBMS.

A complete summary of the information uncovered during these interviews for Manufacturing Planning can be found in sections b and c of Appendix C. This Appendix is a facsimile of the report produced at the end of the preliminary system study and will be referred to throughout this section. For background, some of the major problems, aside from those already mentioned, are outlined below.

Flexibility Problems:

Because the data files are indexed sequential, data can only be accessed in one of two ways, either sequentially or directly via a record "key". In the WAW file, this key is the concatenation of three fields: part number, business stockroom and data type. (Refer to Figure 7a.) Each record contains 36 months worth of data. The type of data, i.e, requests, commitments, inventory, backlog, or whatever, is specified by the data type. Part number identifies the product or "sellable option", and FA&T Business stockroom refers to the marketing "interface" group to which the data pertains. Thus, the data file cannot easily accommodate selective inquiries unless all three fields are specified. A sequential scan of the entire data base may be required. For example, suppose one wants to know all the inventory for part A, summed up over
Figure 11: Manufacturing Planning Systems Organization
all business stockrooms. There is no way, under the current system, that only the relevant records be directly accessed since the record key includes a field for Business stockroom which is variable for this inquiry. Thus the entire data file will have to be read sequentially until the first record pertaining to part A is encountered. All records for part A will be contiguous since the file is sorted first by part number, then by business stockroom and then by data type. Therefore one must sequentially read through the section pertaining to part A, while maintaining a running total of the inventory records. For batch processes, where this kind of analysis is done for every part, this procedure is the most efficient method. For a single inquiry, however, it is very inefficient. On the average, at least half the file will have to be read to answer this kind of inquiry.

With a DBMS, multiple access points into the data base will greatly enhance the efficiency of a single inquiry. On the other hand, the performance of a batch inquiry will be somewhat degraded because of increased overhead. The real question is whether or not a selective inquiry capability is a real informational need or just a luxury. Presently, most of Manufacturing Planning's application systems are batch oriented, however, even some of these may benefit to some extent from multiple entry points into
the database. Most applications do not access the WAW file directly. Instead, they sequentially read an "extract" file containing records of a single data type. This extract file would previously be generated by performing a complete scan of the WAW file, copying into the extract file all those records of a particular data type. Under a data base structure, all the records of the same data type could be linked together so that an extract procedure would no longer be needed. Each application system could efficiently access directly from the database those records of a single data type.

The selective inquiry capability would be beneficial to the Quick Response function (see Figure 10.) Part of the role of the Quick Response function is to handle any special informational requests from the users. Typically these require the retrieval and analysis of only a small portion of the data. Under the present system, this usually involves accessing much more data than is really needed simply because there is only a single entry point for accessing the data directly.

Another major restriction inherent in original design of the system is the limited time frame of the data files (WAW, CHARTS and EW.) Only three years worth of data can be handled. In practice, only a year and half's worth of historical data can be maintained since 18 months of the
three year window is devoted to forecasted requests and commitments which refer to future time periods. A year and half is simply not long enough to analyze certain trends such as product life cycle. Although older information is available on archive tapes, the difficulty in accessing it makes it virtually unavailable. Hopefully, under a new scheme, the time frame of the data would be longer (either indefinite or of a fixed length which is longer than the life of the system.) One alternative would be to let each record of data hold twelve months of information. All related records could then be linked together in chronological order. Thus one record from the present data files would appear as three linked records under the new scheme. Of course, more than three or less than three could also occur.

Complexity Problems:

Besides the four basic data files, WAW, CHARTS, EW and BOM, there are a number of tables maintained for various different reasons. These tables are used for formatting reports, for maintaining data relationships and for storing explanatory or "title" information. The Business Table, for instance, contains a record for each valid FA&T Business Stockroom. This record contains the stockroom number, business name and associated market code. Thus, this table can be used to summarize data along the market dimension
(see Figure 5) through the mapping of Business Stockrooms onto Markets. The Business Report Table, on the other hand, contains formatting information for a report ordered by Business Stockroom. The problem with all these tables is the lack of standardization among them and their tendency to obscure information. Most of the tables were designed for a specialized use for a particular application. The information contained in these files, however, is potentially useful for other applications as well. Because of the lack of control over this data, it is difficult to obtain and maintain awareness of the existence of these tables much less all their specific formats.

DBMS provides a standard mechanism for storing data relationships: a SET. Basically a SET is used to show the relationship between two types of entities, say, between Markets and Business Stockrooms. Associated with each Market would be all of its member Business Stockrooms. In this way, the relationship become a part of the data base where they are much more readily apparent. The information conveyed in these relationships should, therefore, become more meaningful and more fully utilized.

Control Problems:

As the company evolves and reorganizes itself to better deal with changes in the environment, so must the data base. Because much of the data is associated with
specific organizational units, problems will occur when these units are combined, split up, renamed, reorganized or disbanded. The implications with respect to the database can be far-reaching. In a dynamic, swiftly growing company like the one in our case study, these issues are especially important. As an example of this, consider the market dimension of the WAW and CHARTS data. In the WAW file, information is stored by FA&T Business stockroom and by Market in the CHARTS file. To get to "CHARTS" format, both the product dimension and market dimension of the data were translated to the next highest level. (see Figure 6) Focusing on the market dimension, FA&T Business stockrooms are translated, via the Business Table, to their associated Market. Thus the CHARTS files contain historical, summary information by market groups. But, what happens when market groupings change, say, for example, when Business stockroom 2 moves from Market E to Market A? Should the CHARTS history be changed to reflect the reorganization or should the new market grouping affect only future data? Someone within the systems group should be charged with the responsibility of resolving these kinds of issues, undoubtedly through careful investigation of users' needs. In the past, a reorganization of the type described was dealt with on an ad hoc basis in the most expeditious manner. First of all, with the current
system, it would be a very long and involved process to recompute all the CHARTS data. On the other hand, if the historical data was left to reflect the old groupings, then any kind of analysis using this data could be potentially misleading. Besides, one of the application groups within Manufacturing Planning was quite adamant about their need for recomputing at least some of the data according to the new market groupings. As a compromise, only past bookings data up to a year old was recomputed while all the other data types were left as it. Thus the immediate problem was solved but at the expense of jeopardizing the validity of the data. In any future analyses using this data, one must be aware of the inconsistencies in the data file: parts of the data reflect old market groupings and parts reflect the new grouping. Over a three year period, it is very likely that these organizations will be forgotten and, thus, any future analyses could be potentially misleading. Because application analysts tend to have a parochial view of the data and because data base reorganization is not really part of their domain, it is important that a separate person or group, with an overall view of all application systems, be made responsible to deal with issues having far-reaching effects on the data base. This is the Data Base Administrator (DBA) group.
4.2 Technical Evaluation

The decision to move to a DBMS cannot be made without regard to the specific DBMS implementation to be employed. There is a wide variation of "DBMS's" available in terms of performance and capabilities. During the preliminary system one, wants to begin evaluating the technical feasibility of the project under consideration. For a DBMS project, most of this evaluation will center around the DBMS package. At this early stage it is wise to begin by simply reviewing the stated capabilities of the package as specified in the manuals. Careful questioning of previous users of the package can also be a valuable and enlightening method of evaluation. One must be cognizant, however, of differences in informational needs among users.

Finally, a preliminary design of the data base should be attempted utilizing only those capabilities known to exist in the specific DBMS package. This is something which should be done anyways, just to get started on the data analysis and data base design steps. Section f of Appendix C shows a rough data block diagram for the Manufacturing Planning Data Base.

4.3 Operational Evaluation:

In investigating the operational feasibility of converting to a DBMS, one examines the procedures necessary
to successfully change over to the new system. For the
data base project, this involves an examination of the
interfaces between the application systems and the
present file system. With several tens of programs as
part of each application system, the implications of this
interface could be extremely important. As it turns out,
only a small number of programs directly access the WAW
file. Most analysis programs use an extract file which
is a copy of a portion of the WAW file. This will make
the initial conversion of the WAW file a relatively
simple task since only a few programs will have to be
redesigned. The BOM file, on the other hand, is referenced
by a large number of programs. Rewriting of all these
programs could be a very time consuming process. To ease
this problem, it is suggested that a subroutine be
written to simulate an access to the old BOM file. All
existing accesses to the BOM file would then have to be
replaced with a call to this subroutine.

The CHARTS file could probably not be done away with
altogether. It would still be much cheaper to keep this
summary (and, therefore, redundant) file around rather
than always doing the summarization "on the fly." However,
to solve the reorganization problem referred to earlier,
the system should be redesigned to generate the entire
CHARTS file every month rather than updating just the
latest month as is done now. The processing time is not
expected to increase substantially because most of the time is consumed by the translation process which would be done once for each record in either case. The extra time to then process 36 buckets instead of nine buckets (as is done now) would be relatively insignificant. Presumably, the Early Warning system could be modified to read the CHARTS data rather than the Early Warning file. This would lead to a considerable reduction in redundancy.

4.4 Economic Evaluation:

The process of evaluating the economic feasibility of computer systems is a very interesting area. A variety of methods have been used, ranging from a full blown cost/benefit analysis to almost no formal justification process whatsoever. The important point is that no one method is appropriate for all projects and circumstances. A computer system which is simply replacing an existing manual system may be very well-suited to a cost/benefit approach since most of the benefits will be "hard" benefits. On the other hand, a system which is felt to be vital to the continued operation of the company may require no formal economic evaluation simply because there is no real choice involved.

A strict cost/benefit approach for a data base project, in most cases, would not be appropriate. There are too many soft benefits which could not be meaningfully
translated into dollar values. Richard L. Nolan and K. Eric Knutsen, in their article, "On Cost/Benefit of Computer-Based Systems," address the issue as follows:

The effects of computer-based systems... usually do not lend themselves to a neat quantitative analysis of costs and savings, which can be pushed through ROI or similar evaluation mechanisms. To attempts to do so is not only overly time-consuming, but tends to obscure the real issue. Excessive quantification of qualitative factors engenders debate on assumptions to the detriment of the real trade-offs involved.26

Because of these difficulties, cost/benefit analyses tend to concentrate on the hard benefits of a new system and the soft, qualitative benefits are "either treated as a side issue or ignored." If one insists that a project be justified on the basis of its hand payoffs alone, thereby ignoring any qualitative benefits, one runs the risk of overlooking a number of worthwhile projects. As Keen states, such an approach is "too conservative to be desirable except in the short run."

A more appropriate approach is to quantify as many of the costs and benefits as are reasonable and leave the soft benefits in descriptive form. Management can then subjectively assess the value of these qualitative factors. As for the evaluation of costs, this is usually more quantifiable then the benefits but the degree of accuracy in the estimates will depend on the stage the project is
in. As Nolan and Knutsen state, "For most computer-based projects, it is almost impossible to accurately estimate the costs at the outset. The erratic prediction of costs in the past bears out this observation.... For typical system development efforts, it may take 20-30 per cent of overall project dollars to reach the stage where the development group and its clientele can agree with some precision on what is to be done and at what cost."

Thus, at this stage of the project, an accurate estimate for cost of developing the data base project is not reasonably possible. One should, however, begin to think about the tasks involved in such a project and the resources need to accomplish them. A rough estimate in terms of man-years of development time would give management at least some idea of the costs involved. Without this estimate, it would be difficult to evaluate the advisability of continuing the project into the next phase.
CHAPTER V
Stage Three of the Planning Phase: System Planning Study

Once the preliminary system study has been reviewed and approved by management, the project moves into the final stage of the Planning process: the System Planning Study. In this stage, the project team is formed and a complete, more traditional feasibility study is conducted: a detailed analysis of the present system is performed, extensions and alternatives to the system are examined, the scope of the new system is further defined, and the technical and economic feasibility of the new system are reevaluated in greater detail. In this section, we will again apply this process to the data base project and will refer occasionally to the case study when appropriate. The project involved in the case study, however, is still in the "feasibility" stage and therefore will be referred to less frequently in this stage.

5.1 Formation of the Project Team

For a data base project, the issue of the project team formation has special implications. It is very closely related to the establishment of the Data Base Administrator function mentioned earlier. In fact, most sources agree
that the DBA function should be set up prior to or as a first step towards the planning of a data base project. The CODASYL Systems Committee has stated that the creation of the DBA function is the initial step "towards establishing effective control of the data base..." Even if the question of installing a DBMS is not being considered, "most of the functions [of a DBA group] are relevant whether or not such a system is employed." Basically, what is being stressed is that the early establishment of a DBA group is a vital prerequisite to the installation of a DBMS and will provide a useful function even if a DBMS is not adopted. It is the DBA group which should plan and control the data base project, i.e., the project team is really under the control of or a part of the DBA. Because of the importance of the DBA function to the data base project, an entire section will be devoted to it shortly.

Another important consideration concerning the formation of the project team is that of user involvement. It is strongly recommended that a member of the user group be included as part of the project team. Furthermore, that person, "should be intimately familiar with the workings of the user organization... he should be among the best, highest-qualified members of the user organization." This kind of commitment to the data base project, by the user
organization, is crucial to the project's success. In designing a new system, the users' current as well as future needs must be taken into consideration. It cannot be assumed that the systems group will be aware of these needs without considerable contact and involvement with user activities. By placing a well-qualified user member on the project team, it is assured that user needs will be voiced and dealt with. The many advantages and rewards of heavy user involvement were expounded upon earlier and will not be repeated here.

5.2 The Date Base Administration Function

As the size and number of application systems grow, the need to share data across applications becomes more and more prevalent. This overlapping use of the data files has become increasingly apparent with the Manufacturing Planning systems. This interaction has necessitated the establishment of an overseeing function to control and coordinates data base activities. This is the DBA group. The establishment of this group is actually more important than the installation of the DBMS itself. The data base management system is really just a tool utilized by the DBA group to help them accomplish their objectives. The DBMS is only a part of the solution.

The actual roles and responsibilities of the DBA group is still a fuzzy and evolving issue. It is clear,
however, that the Data Base Administrator, whether or not he be one person, must wear many hats. He plays an interdisciplinary role involving management, users and systems analysts (application programmer/analysts.) The DBA's functions may be grouped under four broad headings:

1. Business and organizational comprehension
2. Technical aspects
3. Control functions
4. User interface

Business and organizational comprehension:

The initial responsibility of the DBA is to design and maintain an adequate data base structure. To do this, he must translate organizational relationships and abstract user needs into a technically feasible data base design. The DBA should be very familiar with the users' business. He must thoroughly understand the nature of the data relationships involved so he can accurately evaluate the tradeoffs involved when structuring the data base. Continued awareness of user activities and needs is necessary in monitoring the adequacy of the data base.

Technical Aspects:

The Data Base Administrator is also responsible for selecting, evaluating and acquiring the data base software package. He must develop and utilize software tools to maintain and restructure the data base. Monitoring
performance and tuning the system is also part of his
domain.

Control Functions:

As custodian of the data, the DBA must ensure its
security by providing adequate backup and recovery pro-
cedures and by controlling the accessing and updating of
the data base. He is also responsible for the data's
integrity and availability. The DBA also must deal with
the problem of data migration or retirement so the data
base will not become cluttered.

User Interface:

The creation of the DBA function has further separated
out the tasks involved in EDP activities. There will now
be three distinct groups all responsible for different
aspects of a computer system. Operations is responsible
for running the computer facility, application programmers
develop and maintain specific application systems and, now,
the DBA controls and maintains the common data base shared
by the various application systems. As such, the DBA will
be looked upon by the users as the primary source of in-
formation regarding the data. A data base dictionary
indicating the meaning and format of all the data available
should be maintained by the DBA. The DBA must act as a
consultant, informing users of efficient access techniques
and providing technical assistance in the development of
of any new applications. The DBA must also monitor user needs and provide appropriate data base tools such as a data base query language. With a broad perspective of all user needs, it is the DBA's responsibility to resolve conflicting user requests concerning the data base.

5.3 **DBA Organization**

With all these multi-faceted responsibilities to perform, the question arises as to who should (or who can) be the DBA. In reality, it is more helpful to think of the DBA as a role rather than as a single person. Because the DBA function encompasses so many varying tasks, it is unlikely that any one person could adequately fulfill all the necessary qualifications. This is especially true when one is talking about a corporate-wide collection of data base systems. In such a case, the DBA function is really a collection of separate roles. For example, the ANSI Study Group makes the following distinctions between DBA roles:

- **Enterprise Administrator** - understands the operations of the company and the meaning of its information. Has over responsibility for the data base.

- **Data Administrator** - responsible for the physical structure of the data base.

- **Application Administrator** - responsible for a particular application system and as such is only concerned with a limited view of the data base.
James Martin makes a similar distinction when he talks about the data administrator as the individual responsible for all the company's data and the data-base administrator as the person involved with the more technical installation and control of a single data base system.

With regard to the company in our case study, these ideas could probably best be applied in modified form. For example the "data administrator" should probably be a staff group within the Manufacturing Systems organization rather than at the higher "corporate" level. This group would then loosely plan and coordinate data base activities among the various EDP support groups, Manufacturing Planning System being one of them. The "data-base administrator" would have primary responsibility for the particular DBMS installation in Manufacturing Planning and there may be other "data-base administrators" within the other groups. For our purposes, the DBA group will refer to the DBA in charge of a single data base installation such as the one being planned for Manufacturing Planning. At the initiation of the data base project, the DBA group and the project team are very nearly synonymous.

5.4 Determining Informational Requirements
5.4.1 Detailed Study and Description of Current System

In an effort to better understand the specifics of what is entailed in the conversion to a data base management system, it is necessary to thoroughly investigate the
current system especially with respect to the interfaces to the data files and tables. This will give the project team the necessary background in understanding the informational requirements of the current system. Most of these, along with some additional ones, will have to be satisfied under the new system as well. The level of detail at which this study is done is fairly important. Certainly one wants to investigate each application system down to the level of jobs and programs. Specifically, one will want to determine which files are accessed by each program. The manner in which the data is processed in terms of sorting, filtering, etc. will also shed light onto the underlying informational requirements of the various application systems. One should carefully document and keep track of all pertinent findings. Data flow diagrams showing interactions between jobs and data files and tables should also be prepared. This study will undoubtedly involve close communication with the support personnel users in charge of the application systems.

5.4.2 Examination of Future Informational Needs

In the redesign of any existing system, it is essential that one attempt to assess the future informational requirements of the organization as well. If any of these can be predicted, they too should be addressed by the new system. This will ensure the system's longevity and,
hopefully, avoid any significant oversights. To investigate these possible future requirements, one should interview managers, users and systems support personnel to ascertain what new systems are being planned for the near future and what new business-related activities may lead to changing informational requirements. The difficulty in this procedure is that one is likely to obtain widely varying responses as to what might occur over the next few years. It is a good idea to document carefully what each person said and then to reexamine and compare all the predictions. Second interviews should then be conducted to try and reach a consensus as to the most likely and most important new developments seen in the near future.

For an example of a change in business activity which could alter the informational requirements placed upon the data base, let us refer back to the case study. In the past and for the most part, even now, individual products or parts at this company have been single sourced, i.e., there is usually only one Volume Manufacturing Source stockroom which produces a given part. In this way, if one knew the part number, one could also determine the Source stockroom. This is why Source stockroom is not part of the key for the WAW file (see Figure 7.) However, with more and more plants being built, multiple sourcing of parts is becoming more commonplace. The impact this
will have on Manufacturing Planning's information systems will have to be well thought-out. Undoubtedly the data base itself will be impacted. Information may need to be stored by [part/business stockroom/manufacturing stockroom] combination rather than by just [part/business stockroom] combination as is done presently.

Data Analysis:

Using the information gathered in the last two steps just described and building upon the effort begun during the preliminary data base design, one should now begin to analyze the data in an effort to determine which data and data relationships should be included in the data base design. The inclusion of too many relationships will result in poor performance in terms of update and deletion times. During the Planning phase, one does not want to develop a complete data base design but simply begin analyzing the data from a business point of view.

5.5 Evaluation

5.5.1 Technical Feasibility

Investigation of the capabilities of the DBMS software should continue during the systems planning study. The package is evaluated in terms of the information requirements uncovered thus far. An important aspect of the systems planning study is to certify the ability of the DBMS to meet these requirements. Certainly the vendor's
documentation and literature concerning the system should be thoroughly studied. Previous users should also be carefully interviewed. There is no sense in making the same mistakes someone else has already made. If possible, candidate systems should also be tested out or "bench-marked." Knowing how well the system performs each of its stated capabilities will help tremendously when planning the actual database design.

5.5.2 Operational Feasibility

Besides the technical feasibility of the new system, the operational feasibility must also be certified. As Shaw and Atkins warn:

> Any major new system will create an impact on the user department. To a large extent, this is unavoidable. The important thing rather, is that management of the user department understand what is going to happen and accept both the consequences of change and the responsibility for implementation of the new techniques. 36

From the viewpoint of corporate-wide database development approach, much emphasis is placed on the selection of the first DBMS installation. Careful selection of this first application can greatly enhance the operational feasibility of the database approach. This first project should be simple, clearly cost-justifiable, and have full management and user support. Richard Canning in his EDP Analyzer advocates that the plan for a corporate-wide database should
be broken down into a series of short projects. In this way, uncertainties over the data base approach can be resolved evenly over time.

The same principles can apply to the installation of a single data base management system. The plan should include a series of separate phases whereby each phase involves the conversion of only a subset of the existing system. This phased approach will:

1. make the data base project more manageable
2. allow one to make mistakes and learn from them
3. increase the project's overall success

For the Manufacturing Planning data base project, a three phase process is suggested:

1. Conversion of WAW data
2. Conversion of BOM
3. Conversion of CHARTS and Early Warning Systems.

The WAW data is really at the heart of Manufacturing Planning systems. Most of the monthly data resides there and a good deal of Manufacturing Planning's total analyses is performed using this data. Because of the extract file concept, the number of interfaces between the application systems and the WAW file is relatively low. This would be an excellent place to begin because it would
enable the project team to produce worthwhile results fairly quickly, would keep the data base relatively simple to begin with and, finally, provide an opportunity to gain experience with the DBMS before the entire system is completely designed.

The second phase would involve the conversion of the BOM file to its inclusion into the data base design. This step is a little bit more complicated than the WAW conversion because of the widespread referencing of the BOM file. Delaying this part of the project will also allow more time to be spent analyzing the desirability of adding extended features to the existing BOM.

The third phase would center around the CHARTS system and the Early Warning system. As mentioned before the CHARTS data base should probably be regenerated every month so as to be sure to reflect the latest CHART part groupings and market groupings. This CHARTS data, it should be remembered, is very similar the data contained in the EW file and there seems to be no reason to maintain both of them. Therefore, the EW Graphics system would be redesigned during this phase to access the new CHARTS data. If the CHARTS data is maintained under a DBMS, there is the possibility that the EW system can become a more interactive system than at present. Currently, one must go through three steps to produce an EW graph:
1. specify graphs desired
2. extract data
3. produce graphs

This cycle is too drawn out to allow for effective interaction.

Redesign of the CHARTS application system is being planned for sometime in the next two years, so it is probably wise to wait awhile on the conversion of the CHARTS file. Being the third phase of the project, this redesign will hopefully coincide with the planning for the new CHARTS system.

5.5.3 Economic Feasibility

At this stage, it should be possible to start getting some rough cost estimates for the development activities and the ongoing EDP requirements. The supposed benefits should also be clearly stated and quantified to the extent possible (reasonable.) Specifically, for a data base project, it would be appropriate to analyzed the costs and benefits associated with each phase of the project. One might also want to differentiate the costs and benefits associated with the creation of the DBA function as opposed to the installation of a data base management system. Management could then properly review the various alternatives involved.
Although costs are, in general, easier to quantify than the benefits, they too can be difficult to analyze. For example, some of the "costs" associated with a conversion to DBMS are less obvious than others. Since the use of database management systems within business organizations is still relatively new, it is difficult to attract and maintain qualified personnel proficient in database skills. All new systems analysts will have to be trained in the use and understanding of database techniques. If the DBMS is being installed in a dynamic environment where new application systems are also being developed then it may be that some of the costs, which otherwise might have been allocated to the database project, might be better thought of as costs associated with the application projects. For example, if a change in business activities precipitated changes to be made in the existing data files anyways, then the incremental costs associated with converting to a DBMS would be less the the conversion under a more static situation. Basically, one is assuming a certain level of maintenance, redesign and development work which will occur over the next few years regardless of whether a DBMS is adopted. The database project should then be analyzed as one more incremental project to be developed as well.
CHAPTER VI

Conclusion

In this paper, we have attempted to adapt the planning phase of a system development process to a project involving the installation of a data base management system. In this section, we will examine the applicability of such an approach to a data base project.

In developing any large scale computer-based system, it is essential that the implementation have some kind of process to follow. The complexity of the project is such that the steps involved cannot be learned "on-the-job" while the system is being developed. A complete and clearly understood process appropriately applied to the project under consideration will substantially increase the chance for a successful outcome. A successful outcome need not imply the ultimate implementation and installation of the system. It could refer to an early recognition of the system's infeasibility or undesirability. The project could be successful in the sense that the system was accurately evaluated and deservedly rejected before substantial resources were committed to its completion.

The systems development process described does provide steps for ensuring that the system is, in fact, desirable.
Existing problems are evaluated, current and projected processes are examined and a set of informational requirements are derived. System alternatives are then evaluated with respect to these requirements. Next, the system's technical, operational and economic feasibility are analyzed.

The development process also provides at least a general road map to follow and is helpful in allowing the implementor to control the progress of the project. Such questions as "What stage are we at now?" and "What do we do next?" can readily be answered. The process is also iterative allowing successively intensive analyses to be interspersed among multiple evaluation checkpoints. These checkpoints provide the control to redirect the project if it is off course or to kill the project if it is no longer felt to be attractive. These checkpoints can also be thought of as a mechanism to get top management involved in the project and to keep them abreast of and committed to the project.

The development process was selected for the data base project because of its beneficial characteristics mentioned above. However, its appropriateness for a data base project is not wholly complete. The data base project is distinct from other system development projects in that it provides a foundation for most other applications. It is highly interrelated and inseparable from these other
systems. For these reasons, the systems development process must be modified to emphasize this pervasive importance of a data base project. Other systems must be analyzed in light of the dualistic impact of a conversion to a data base management system. The data base project and the applications systems will be mutually effected by each other.

The systems development process also does not deal adequately with the issue of two separate classes of users in a data base project. Each group has a very different perspective on the new system and each will be impacted in a different manner. Again, the process must be extended to differentiate between these users and deal with them separately in terms of their involvement in the project, education, training, etc.

Thirdly, a data base project is so closely related to a Data Base Administration function that it, too, must be considered in the project. The systems development process suggests that the project team be formed during the final stage of the planning process. For a data base project, the DBA function should be created as early as possible. The existence of this "role" is really a prerequisite to the consideration of installing a DBMS. There must be someone with an overall view of all the application systems to control the data base project. Again, this is because
of the pervasiveness of such a project. The DBA function may be created as a result of the data base project but should ideally be created beforehand.

Finally, the systems development process neglects the broader, company-wide aspects of data base systems. A separate process must be utilized to plan and control a "corporate-wide" data base project. Such a project should at least be investigated to take maximum advantage of the potential benefits of data base management systems.

In conclusion, then, the systems development process does provide a useful approach for the planning of a data base project. However, it should be augmented with additional steps to adequately deal with the special issues unique to a data base project.
APPENDIX A

Tasks involved in planning the implementation of a corporate-wide data base. (Summarized from Data Base Systems: A Practical Reference by Ian Palmer, Wellesley, Mass.: Q.E.D. Information Sciences, Inc., 1975.)

1. Feasibility to justify the need for such a system.
2. Management decision to proceed subject to regular reviews of project's economic viability.
3. Define responsibilities for project activities.
4. Define the scope of the project.
5. Determine hardware and software requirements.
6. Select appropriate DBMS software in light of users' informational needs.
7. Perform cost analysis and economic justification of project.
8. Outline plan for phased development.
9. Select initial application(s) to be supported.
10. Approval of plans by management.
## APPENDIX B

### Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backlog</td>
<td>customer orders (bookings) which have yet to be shipped.</td>
</tr>
<tr>
<td>Backorder</td>
<td>a statement of the differences between Volume Manufacturing's commitment of a specific product in a particular time period and its actual delivery to the Marketing groups. Thus, backorder shows Vol. Mfg.'s failure to deliver what it promised.</td>
</tr>
<tr>
<td>Bookings</td>
<td>customer orders for a specific product, booked against a particular Marketing group.</td>
</tr>
<tr>
<td>Cancellation</td>
<td>a cancelled customer order. Negates a previous booking.</td>
</tr>
<tr>
<td>Commitment</td>
<td>Volume Manufacturing's promise to deliver a specific product in a specific time period to one of the Marketing groups.</td>
</tr>
<tr>
<td>Delivery</td>
<td>refers to the internal delivery of a specific product from Volume Manufacturing to one of the Marketing groups.</td>
</tr>
<tr>
<td>Inventory</td>
<td>on-hand stock of a particular product. Is associated with a Marketing group.</td>
</tr>
<tr>
<td>Request</td>
<td>an internal order for a specific product by one of the Marketing groups.</td>
</tr>
<tr>
<td>Return</td>
<td>refers to a product being sent back to Volume Manufacturing from the Marketing groups usually because it is defective. Negates a previous delivery.</td>
</tr>
</tbody>
</table>
APPENDIX B (cont.)

Shipment - delivery of a specific product to the customer.
APPENDIX C

PRELIMINARY SYSTEM STUDY

A DATA BASE MANAGEMENT SYSTEM FOR MANUFACTURING PLANNING
SECTION A: RECOMMENDATIONS

This document is the result of a preliminary system study conducted in an effort to investigate the feasibility and desirability of installing a data base management system for the storage of Manufacturing Planning's (MP) manufacturing related information. The results of this study suggest that such a system is indeed desirable and that further, a new group be formed, the Data Base Administration (DBA) group, within the Manufacturing Planning Systems organization to not only continue the investigation of adopting the data base management approach but also to assume control and responsibility of the various MP data bases. It is recommended that this new group be created regardless of the decision of whether or not to install a data base management system. During the early development stages of MP's EDP systems, the natural emphasis was placed on individual applications and their associated data requirements rather than on a data base as a whole. Individuals or groups have been assigned EDP responsibility for the various MP applications (Request/Commit, Charts, Performance Evaluation, Early Warning, etc.) but no one has been assigned real authority over the data bases and charged with the responsibility of controlling and maintaining them. Because of this, a number of problems
have arisen, including a rapid cluttering of the data bases (fully one-third of the records in the Where-Are-We data base contain no useful information), duplication of effort in the design of data bases and a growing complexity of all the systems. These problems have tended to inhibit the development of new applications.

It is now time to organizationally separate the responsibilities of EDP applications from those of data base control. This is merely an extension of the separation of EDP activities which already exist. Instead of just an applications group (Manufacturing Planning Systems) and an operations group (IPC), there will now also be a data base group (the DBA group). This centralization of control over the data base is essential for the installation of a data base management system but is also highly recommended for Manufacturing Planning Systems in an effort to ensure the data base's integrity, validity, security and ease of use. A data base management system can be viewed as a tool which can be utilized by the DBA group to help them achieve these objectives. It is doubtful that without such a tool, the group could successfully manage all these tasks.

The rest of this document provides an in depth analysis of the current system and the proposed data base management system. It should be emphasized that this is
not a full scale feasibility study (it is poorly lacking in terms of an economic justification), but instead is meant as a first-cut investigative study.
SECTION B: PROBLEMS WITH THE CURRENT SYSTEM

Several problems and constraints associated with the present system have arisen and become more noticeable as a result of several factors:

1. The system's piecemeal growth over time
2. Manufacturing Planning's changing informational needs
3. The growing acceptance and refinement of new technologies

These problems can be grouped under three broad headings:

1. The system's lack of flexibility
2. The system's growing complexity
3. The need for better control

I. Lack of Flexibility

A. In adding new applications:

Because of the inter-relationships of the various subsystems with the present data bases, it is very difficult to modify a data base for one application without affecting the other subsystems. This usually means that when a new application is developed, a new data base must also be created which may be very similar to an existing one. This is precisely what occurred when the Early Warning System was developed. This proliferation of data bases has resulted in several "complexity" repercussions (see next section).
B. In adding and deleting fields in the data base:

Because existing applications are "locked" into the data bases, adding or modifying fields within the data base become a difficult task. For example, Manufacturing Planning would like to extend the time dimension of the data base to cover an indefinite period of historical information. With the present system, it would be extremely cumbersome to accommodate such a change.

C. In altering or adding data relationships:

There have been numerous occasions when Manufacturing Planning has wished to alter certain data relationships. Some examples have been: redefining the composition of Chart parts (and having the change reflected in historical data), regrouping and extending market groups, adding new relationships such as product groupings, etc. Some of these changes and extensions are more easily accommodated than others. The important point, however, is that the user's needs for expressing data relationships is changing over time as they gain more familiarity and insight as to the best way to look at the data. Thus it is extremely important to remain as flexible as possible in our ability to restructure and redefine data relationships.
II. Growing complexity

A. Redundancy:

1. Between major data bases:

The Charts data base and the Early Warning data base are basically just condensed versions of the Where-Are-We data base and are almost identical to each other.

2. Within the Charts data base:

The Charts data base is really three distinct data bases: one containing world-wide information and the other split out into domestic information and Irish information. The world-wide Charts base is simply a summary of the other two.

3. The existence of multiple copies of some data bases:

There are times when two copies of a particular data base are kept on-line, each containing a different time frame of data. This frequently occurs just after a data base has shifted in order to make room for more recent information. The older data which is not included in the new data base may still be relevant for certain applications and this accounts for the need to have two versions of the same data base.

4. Of information within records:

Price and cost information for a part is stored in every WAW data record. Ideally, this information need
only be stored in one place, i.e., in the BOM record for that part.

As a result of these redundancies, any additions or changes to one of the data bases must eventually propagate through the rest of the data bases. Several avenues for updating the data bases have been programmed to suit the particular circumstances. For example, the Early Warning data base may be updated from the Charts data base all at once, or individual data types (requests, commits, bookings, etc.) may be updated selectively from the original input. Much people time is spent initiating and monitoring these various update procedures.

B. Inconsistency:

The use of multiple updating procedures often renders the data bases inconsistent with one another. For example, the Charts data base may contain June bookings but inventory only up until May while the Early Warning data base may have the latest inventory but not bookings for June. Just keeping track of the status of the various data bases can be a confusing task.

C. Proliferation of information outside the data bases:

Relationships are not easily stored in the present data bases and as a result, several non-standard tables exist which embody these relationships. Some of these
tables are the product line table, the business table and the stockroom table. Storing these relationships in a number of non-standard and widely dispersed tables only tends to obscure their visibility and discourage their use. If incorporated as part of the data base, these relationships would be more readily discernible by application programmers.

III. Need for Better Control

A. Responsibility for the data bases:

Although people have been assigned responsibility to run, maintain and improve the various MP sub-systems, no one is responsible for the individual data bases which often span several sub-systems. Because of this, the data bases tend to be cluttered and out of date. Someone should have the responsibility of purging the data bases of obsolete records.

B. Documentation of data bases:

The data bases themselves (apart from the applications which access them) are not well documented. In many cases, the people who designed the data bases and associated sub-systems have since left the Planning Systems Group, leaving these systems in the hands of newcomers. Because the data bases are inadequately documented, they are confusing and slow to be comprehended by new people joining the group. That documentation which does exist is poor and sometimes even misleading.
For example, in the record description for the Where-Are-We data base, there is a data field called PRODUCT-LINE. In reality, this refers to a business stockroom, not a product line. Also, special data codes are often left unexplained.
SECTION C: BENEFITS OF A DATA BASE MANAGEMENT SYSTEM FOR USE IN MANUFACTURING PLANNING

The prospective benefits of the new system will also be discussed in terms of three categories: flexibility, reduction of complexity and better control over the data.

I. Flexibility

A. In changing existing data relationships such as:
   1. groupings of businesses within markets
   2. groupings of parts under Chart parts
   3. groupings of product lines (P/L's) within businesses

   These types of modifications could be easily accommodated under a DBMS system. The DBA would be responsible for making any of these changes so as to ensure the data base's integrity.

B. In adding new data relationships such as:
   1. Product groupings of parts
   2. "Is-used-on" relationships for the Bill of Materials (BOM). This would allow one to quickly determine all those parts which a particular part is used in.

   Adding new relationships may or may not affect existing applications. If the new relationship involved a part of the data base which was not referenced by the application, then the application would not have to be changed.
C. In adding new data types such as:

1. Ship forecast information

2. Names and places information (plant mgrs., business mgrs., locations, extensions, etc.).

Additions of these types will probably not affect existing applications which will not use the new data types. The DBA will have to reorganize part of the database to accommodate the new data types. However, the change should be invisible to application programmers.

D. In developing new applications:

1. The data base may be modified to adapt to new applications without affecting existing ones
   a) New fields may be added to records without affecting applications which use those records. This is because the mapping of data fields to the user's work area is done at run time.
   b) "New" records from the existing data base may be designed to suit the particular needs of the new application.

2. New applications may be designed and brought up more easily and quickly because:
   a) the application programmer need not be concerned with design and creation of a new data base, unique to his application.
   b) the DBA will be responsible for any required modifications of the data base.

E. In the maintenance of historical data:

1. An indefinitely long "time" dimension may be incorporated into the data base. Additional space will be obtained semi-automatically as time passes.
2. Historical requests, commits and backlog could be maintained in the data base.

3. Historical price information may be kept.

4. Historical relationships such as old market groupings may need to be kept on-line.

II. Reduction of complexity

A. Consolidation of data files would:
   1. Reduce the amount of redundancy.
   2. Eliminate time-related inconsistencies.
   3. Cut down on updating activities and thereby
      a) Reduce programmer time for these activities
      b) Reduce the number of updating runs
   4. Enforce naming standards. This would help eliminate confusion over a number of manufacturing--and company--related terms such as P/L's, businesses, markets, backlog, backorder, etc.

B. Incorporation of relationships within the data base:
   1. Fewer "hidden" tables such as BUSNES.FIL, 5460FC.TBL, etc. Making these relationships as part of the data base standardizes their formats. The formats of the existing tables are not standard and are difficult to interpret by those not familiar with them.
   2. Relationships will become more visible if they are made a part of the data base. The information conveyed in these relationships should, therefore, become more meaningful.

III. Better Control of the Data

A. Creation of a Data Base Administrator (DBA) function:
   1. Has responsibility for managing the data base
a. ensures the data base's integrity. The DBA should monitor any structural changes to the data base.

b. controls access to the data base.

c. develops and executes backup procedures.

2. With the creation of the DBA function, EDP activities are separated into three distinct functions:

   a. computer operations (IPC)
   b. applications (R/C, Charts, PE...)
   c. data bases (the DBA)

   A DBMS is the tool which allows this kind of separation of tasks.

B. Documentation of the data base:

   1. Maintenance of a Data Base Dictionary which explains all the records and relationships embodied in the data base.

   2. Available information is made clearly visible.
SECTION D: SYSTEM OBJECTIVES

As the various manufacturing systems at Manufacturing Planning have developed and grown over time, it is becoming increasingly apparent that the data base area should be viewed as a separate area apart from the various applications on systems which utilize the data bases. Because the data bases support multiple applications, it is essential that issues concerning the data base be resolved by a separate group which is not associated with any particular application, but instead has an overall view of the needs of all the application areas. We will call this group the Data Base Administration (DBA) group.

The objective of this group will be:

A. To assume responsibility for the data bases in terms of the data base's:

1. Integrity - the information in the data base is of crucial importance to the company at the corporate level. The group will be responsible for providing backup and recovery procedures for the data base.

2. Consistency - much of the data within the data base is highly inter-related. The DBA group must ensure that the data base is internally consistent.

3. Security - because the data is highly confidential, another DBA responsibility is to control the access to the data base.

4. Reorganization - any changes or restructuring of the data base will be monitored by the DBA group.
5. **Currency** - the DBA group is responsible for ensuring that the data base reflects the latest available information. They should also work in conjunction with application groups and Manufacturing Planning users to develop mechanisms to identify and remove, or somehow indicate the status of obsolete information.

**B. To provide flexibility in the system to adapt to changing informational needs:**

1. DBA group will be assigned specific responsibility to modify the data base when a change is required. Very often, a user (Manufacturing Planning) requested change will involve the modification of one or more applications and a change to one of the data bases. This type of request should be easier to accommodate with the existence of the DBA group. They will be responsible for any restructuring of the data base and ensuring that all other affected application areas are informed of the change.

2. The Data Base Management System provides several features designed to facilitate change.

**C. To integrate and standardize the data. Specific functions will be to:**

1. Define standard names for all pieces of information which are consistent with the proper manufacturing terminology.

2. Document the data base, i.e., maintain a data base dictionary.

3. Determine the types of data and data relationships to store in the data base.

**D. To accommodate the needs of the various application groups:**

1. Relieve them of the burden of maintaining the data bases.

2. Arbitrate conflicting requests.

3. Act as a source of information concerning the data base.
4. Assist in the data base design for new or modified applications.

In the context of this discussion, a data base management system can be viewed a tool to be utilized by the DBA group to assist them in achieving their objectives. The DBA group could be, and probably should be, formed even if the decision to convert to a DBMS was rejected. However, it is of utmost importance that the DBA function be created if, in fact, a DBMS is decided upon. It is essential that one group be assigned responsibility to manage the data base. It is also highly doubtful that the DBA group could effectively perform all the responsibilities outlined above without the assistance of a DBMS to provide the necessary facilities needed to modify the data base.
SECTION E: SYSTEM FEASIBILITY

The conversion to a data base management system must not be sudden and disruptive change-over simultaneously redefining the functions of all Manufacturing Planning systems. The conversion must be a gradual and orderly process which successfully enables each system to take advantage of the new design concepts without interrupting the current flow of reports and analysis required by Manufacturing Planning users. A phased approach which limits the impact of the new data base design to one or two systems at a time would be ideal. One alternative would be to start with the Bill of Material (BOM) file and the Where-Are-We (WAW) data base. The information in these two files is highly interrelated and could be integrated into a single data base structure. The data base would include information associated with various data entities (plants, stockrooms, parts, markets, businesses, etc.), information associated with part-business combinations (requests, commits, bookings, inventory, etc.) and information concerning data relationships (source stockrooms by plant, business stockrooms by market, part structure, part grouping by CHART part, etc.). Thus, much of the information currently kept in tables would also be incorporated into the data base.
An examination of the various Manufacturing Planning systems (R/C, CHARTS, PE, EW, Ship Forecast and Resource/Capacity) shows that very few programs access the WAW data base directly. Most analysis programs utilizing the data in the WAW data base were designed to use extract files from the WAW data base rather than access the data base itself. The system was originally designed in this manner to lessen the impact of a restructuring of the data base. Only those programs which directly access the WAW data base will have to be rewritten. The BOM file, on the other hand, is referenced by several programs. To avoid extensive recoding of all these programs, it is suggested that a subroutine be written to simulate an access to the old (the existing) BOM file. All READ statements referencing the BOM file would have to be replaced with a call to this subroutine. Organizer files or tables will still be maintained for use by these programs until a total conversion to the new system can be affected. This will require a more extensive revision of these programs and will have to be conducted over a longer period of time. The CHARTS system and Performance Evaluation systems would be relatively unaffected by the reorganization since these systems work primarily with extract files. In order for these systems to take advantage of the flexibility of the Data Base Management System (DBMS), a second development stage should
be planned to complete the change over process. This stage should be carefully planned prior to carrying out the first stage so as not to overlook design considerations required by the second stage.

A number of preparatory steps must precede the actual conversion to a DBMS. First, a Data Base Administration (DBA) group should be formed to plan, design and develop the new system. Part of their task will be to work closely with MP users in performing an exhaustive analysis of the data and data relationships to determine the types of information to be included in the new data base. (A preliminary data description which portrays some possible data relationships appears in a subsequent diagram.) In conjunction with this data analysis step, a detailed familiarization with the capabilities and limitations of the DBMS package should begin. The knowledge gained from these two studies can then be used to transform the desired conceptual data base into an actual DBMS data base design. Any system requirements not provided by DBMS will have to be identified and provided for through the development of utility programs designed to meet these needs. Finally, before converting to the new data base, considerable effort should be placed on verifying the validity of the current data, resolving any conflicting information and purging the data bases of any obsolete or
misleading information. Procedures to maintain the data base in such a state should also be developed.

To accomplish the design and development of the new data base, a project management team should be formed to coordinate the activities. The conversion to a DBMS will require a substantial effort on the part of the individuals in Manufacturing Planning and Manufacturing Planning EDP support as well as those on the project team. For the project to be successful, the users of the system (MP EDP support and MP) must be consulted frequently in order to determine their informational needs and to keep them informed of how the new system will affect them. To facilitate this interaction between the project team and the users, it is important that the members of the project team be as familiar as possible with the present systems, with MP's informational needs and with the current trends of concern to MP such as decentralization to the plants, changes in Manufacturing organization, etc. At the same time, it is highly desirable that the members of the project team be conversant with data base concepts if not with the specific DBMS itself. The capabilities of the DBMS will be a major force in shaping the ultimate form of the new data base. Because it is highly unlikely that many (if any) individuals will meet both qualifications, it is important that the group consist of a mixture of personnel,
some strong in one area and some strong in the other. For example, the project team might consist of a project manager, hopefully, familiar with both areas, at least two individuals who are primarily DBMS programmers and one or two people whose primary strength would be their knowledge of MP operations. At the completion of the project, some of the members of the project team may become part of the DBA group.
One plant group record exists for each of the three major divisions of plants.

These records represent the new organizational level between the major plant groups and the individual plants.

Each record contains information related to a particular plant.

One record for each of the 16 market designations.

Contain information about each of the individual stockrooms.

A record for each Product Line. Note that PL's are organized by Businesses.

A classification of parts into 12 major categories.

120 to 140 option groupings representing some 80% of the dollar value of all options.

Parts as they might appear on the existing MP BOM file. Note that parts are grouped by source stockroom, by product group and by Chart part.

A record for every part/business combination where that particular business is in some way (through a Request, Commit, Booking, etc.) concerned with a particular part.

Component records represent the structure of the Bill of Materials. The record contains the quantity of the component.
part required. The owner portion represents a backwards link from the component structure.

**TYPE**

One record for each valid data type: Request, Commit, Bookings, Deliveries...

**PART/BUS/TYPER**

Represents a specific data type (Request, Commit, Bookings...) for a particular business concerning a particular part. This is the level of individual records in the Where-Are-We data base.

**TIME**

One record for each contiguous unit of time--most likely one fiscal year.

**PART/BUS/TYPER/TIME**

This record would contain the actual monthly data--probably one fiscal year's worth. Thus, one of these records would contain a slice of the monthly data contained in a single record of the WAW data to be kept for an indefinite time span.
SECTION G: SYSTEM PLANNING WORK PLAN
(The next stage in the planning process)

Analysis and Examination of Present System - Information gathering task on the current systems: interviews, analysis of documents.

Present System Summary - Data flow diagrams of present system.

Proposed System Preliminary Requirements - Information gathering on proposed system: DBMS capabilities, interview DBMS users.

Proposed System Summary - Preliminary data description diagram; identification of systems and programs affected.

Project Requirements - Staffing requirements for project development and subsequent system operation and an estimate of their associated costs.

Preliminary Computer System Design - Preliminary data description diagrams, identification of systems, jobs and programs affected by new system. Identification of new programs required.

Computer Development and Costs Schedule - List of development activities and an estimate of their cost.

Compute EDP Recurring Costs - Identification of operating costs of new system.

Economic Evaluation Summary - Summary of costs, measurable benefits and intangible benefits of proposed system.


Recommendations/Management Summary
SECTION H: OVERALL PROJECT OUTLINE

I. Examination and Analysis of Current Systems
   A. In-depth interviews with users
      1. Current use of the data base
      2. Problems encountered concerning the data base
      3. Information needs and expected data usage
         a. Present
         b. Future
   B. Data flow diagrams of systems
   C. Analysis of MP Programs
      1. Identify affected programs
      2. Determine degree of modification required

II. Data Analysis
   A. Useful data types or entities (parts, plants, markets, etc.)
      1. Associated information
      2. Interactions with other data types
   B. Examination of data relationships
      1. Degree of usage by the various systems
      2. Complexity
   C. Historical data

III. Data Base Design
   A. Record design
      1. Related information
      2. Method of storage (Location mode)
B. Data relationships (Set design)
   1. Linkages (Set mode)
   2. Ordering (Set mode)
   3. Membership (Set membership)
   4. Selection process (Set selection)

C. Backup and recovery procedures

D. Protection and access control mechanisms

IV. Systems Work and Extentions to DBMS
A. Reorganization procedures
B. Backup extentions
C. Other

V. Conversion of Existing Programs
A. Recoding of programs
B. Simulated calls to old data base

VI. Creation of a Test Data Base
A. Test DBMS
B. Test DBMS extentions
C. Test program conversions

VII. Development of Data Base Maintenance Procedures
A. To alter existing data relationships
B. To alter existing record types
C. To add new record types or relationships

VIII. Data Clean-up and Conversion
A. Develop methods to identify obsolete information
B. Develop methods to resolve conflicting information
C. Purge the data base
D. Conversion

IX. User Education
A. New data relationships
B. DBMS
C. System flexibilities

X. System Test and Parallel Running
BIBLIOGRAPHY


FOOTNOTES


2. Ibid.


6. Ibid., p. 27.

7. Ibid., p. 16.


10. Shaw and Atkins, pp. 16-17.


15. Ibid., p. 6-14.

16. From an internal company document.


19. Ibid.


22. Ibid, p. 3.

23. Shaw and Atkins, p. 57.

24. Ibid.


27. Keen, p. 17.

28. Ibid., p. 18.


32. Ibid.

33. Shaw and Atkins, p. 71.


35. Martin, p. 7.

