ENGINEERING INTERNSHIP AT BROWN & ROOT, INCORPORATED

A Report

by

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Submitted to the College of Engineering
Texas A&M University
in partial fulfillment of the requirement for the degree of

DOCTOR OF ENGINEERING

December 1977

Major Subject: Industrial Engineering

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ABSTRACT

A Report on an Engineering Internship
at Brown & Root, Incorporated. (December 1977)
Randall Joe Gannaway, B.S., Texas A&M University;
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Co-Chairmen of Advisory Committee: Dr. Donald T. Phillips
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An engineering internship at Brown & Root, Incorporated was completed over a period slightly in excess of one year. During his internship, the industrial engineer was assigned tasks related to the organization of a manufacturing department and the pursuit and completion of its projects. Many of his contributions were system-related and involved sales, engineering proposals, engineering economy, contract negotiations, employee merit evaluation, design, and general groundwork. He was also assigned to two engineering projects concerning the design and construction of manufacturing facilities. One of the project assignments required international travel to England and Nigeria, and almost all of the assignments involved some aspect of engineering management.

ACKNOWLEDGMENTS

Many individuals assisted me in the completion of the Doctor of Engineering program. Without their help, the obstacles that I faced in attaining this degree would have been much greater, if not insurmountable.

I especially thank three key individuals who gave much of themselves to my cause. They were my advisory committee co-chairmen, Dr. Donald T. Phillips and Dr. Milden J. Fox, and my intern supervisor, Mr. Keith Sandefer.

Dr. Phillips assumed the responsibility for processing the enormous amount of paperwork that accompanied me through my courses, internship and graduation. He was my closest advisor and the first one to whom I went with a problem.

Dr. Fox called upon his vast knowledge of academic affairs to guide me on my degree plan and related activities. He also took the time to explain to my understanding what was required of me, and he was the primary editor of my intern report.

Mr. Sandefer went well out of his way many times to assist me. He made me feel comfortable during my internship, and he took time away from his busy schedule to meet with me and to fulfill both the academic and job-related requirements of his position. I thank him for his cooperation and his open door.

I also thank my two other committee members, Dr. James K. Hennigan and Dr. August W. Smith, and Dean Richard E.

Thomas for their cooperation and the answers they gave to my many questions. They offered their wisdom and various points of view to my problems.

My parents encouraged me from the beginning of the program and helped me financially when I needed it. I thank them for their faith.

Lastly, but not by any means least important, I thank my fiancée for her support through the last semester and her cheerful disposition that lifted my spirits when I was depressed.

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INTRODUCTION

I entered the Doctor of Engineering program of Texas A & M University in the summer of 1975, after having received in May two Bachelor of Science degrees in Computing Science and Industrial Engineering. After completing the required course work and passing the written and oral exams, I received a Master of Engineering degree in Industrial Engineering in August, 1976. At this point, I had taken enough courses toward the Doctor of Engineering degree, that I could immediately proceed to the internship. I accepted employment at Brown & Root, Inc. (hereafter referred to as Brown & Root), in the Solids Processing Department under the supervision of the Department Manager, Mr. Keith Sandefer, a professional engineer. I completed a year of internship with Brown & Root and plan to continue working with the company after I receive my degree.

The objectives of the internship program are 1) to enable the student to demonstrate his ability to apply his knowledge and technical training by making an identifiable engineering contribution in an area of practical concern to the organization or industry in which the internship is served, and 2) to enable the student to function in a non-academic environment in a position where, in addition to traditional design or analysis he will become aware of the organizational approach to problems such as management, labor relations, public relations, environmental protection, and economics. I want to

call special attention to these internship objectives and the problem areas mentioned, because a primary purpose of this report is to reveal how these goals were indeed met. While many internships might address just one or two of the cited problem areas, my internship involved all of them and more, and while many internships involve a single project given to an engineer to work on his own, my internship stressed the organizational approach mentioned in the objectives.

I also want to emphasize my particular branch of engineering. I am an industrial engineer. Industrial engineering is concerned with the design, improvement, and installation of integrated systems of men, materials, and equipment. It draws upon specialized knowledge and skill in the mathematical, physical and social sciences, together with the principles and methods of engineering analysis and design, to specify, predict, and evaluate the results to be obtained from such systems. The key word in the definition is systems. An industrial engineer would probably not be called upon to design and construct a dam, but he would be called upon to design and implement the supporting (infrastructure) systems that achieve the desired objectives, such as material handling systems, scheduling systems, and cost control systems. Likewise, an industrial engineer would probably not design a computer, but he could be responsible for integrating a computer system into a manufacturing process. When I use the word "design," I am referring to "engineering design" as found on page 75 of the 43rd Annual Report, Year Ending September 30,

1975 Engineers Council for Professional Development, New York, New York, "Criteria for Accrediting Programs in Engineering in the United States Including Objectives and Procedures 1975/76" which defines engineering design to be "the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective."

The primary activities in industrial engineering, as categorized by the American Institute of Industrial Engineers, appear in the following list:

* 1. Selection of processes and assembling methods.
* 2. Selection and design of tools and equipment.
* 3. Design of facilities, including layout of buildings, machines, and equipment; material handling equipment; raw materials and product storage facilities.
* 4. Design and/or improvement of planning and control systems for distribution of goods and services, production, inventory, quality, plant maintenance and engineering, or any other function.
* 5. Development of cost control systems such as budgetary controls, cost analysis, and standard cost systems.
6. Product development.

7. Design and installation of value engineering and analysis systems.

* 8. Design and installation of management information systems.

9. Development and installation of wage incentive systems.

*10. Development of performance measures and standards (including work measurement and evaluation systems).

11. Development and installation of job evaluation systems.

12. Evaluation of reliability and performance.

*13. Operations research, including such items as mathematical analyses, systems simulation, linear programming, and decision theory.

14. Design and installation of data processing systems.

*15. Office systems, procedures, and policies.

*16. Organizational planning.

*17. Plant location surveys which consider potential market for plant, raw material sources, labor supply, financing, taxes.

Those activities marked with an asterisk are the primary activities of industrial engineering in which I had at least some experience during my internship. As can be seen, I have spanned much of the spectrum of industrial engineering already, during the short one-year period of internship at Brown & Root.

OVERVIEW

When I accepted employment at Brown & Root, I did so as would any other employee. I was given no special considerations, because I was a doctoral intern, and I was exposed to the same industrial environment that I would have experienced had I been employed through standard methods. The department I entered was the Solids Processing Department, and I was assigned the skill level 050, which translates to the title of Engineer.

The general practice of Brown & Root's Engineering Division is for an engineering department to be either an industry department or a service department. Industry departments are those in which engineers and technicians, experienced in particular fields, cross discipline lines to perform the work of a project involving the industry around which their department is based. The Marine Industries and Petro-Chemical Departments are examples of industry departments. Service departments are those which are generally of one discipline and which assign engineers and technicians to work on projects sponsored by industry departments. The Electrical and Structural Departments are examples of service departments.

Prior to its replacement, the Solids Processing Department was primarily a service department and therefore supplied engineers and technicians as they were required by projects sponsored by industry departments. Related to mineral industries, the Solids Processing Department had personnel

experienced in geology, thermal and pyro processing, material size modification, solid wastes treatment, and mining and mineral processing. The Department also had a section involved in air pollution emission control, industrial hygiene, and noise control. Containing a large number of mechanical engineers, the Department was capable of supplying personnel experienced in machinery specification and selection, special machine design, and mechanical works. The material handling section had a broad and diversified history of projects involving the movement of materials pertaining to industrial, manufacturing, and process plants, but the materials involved were mainly bulk in form. Closely related to the material handling section was the industrial engineering section which supplied personnel experienced in the efficient utilization of people, materials, equipment, space, time and money.

At the beginning of my employment, there were approximately 100 engineers and technicians involved in the above areas. Most of them were assigned to various industry department projects, such as projects in the Pulp and Paper, Marine Industries, and Metals Industries Departments. The Chahbahar Project, a multimillion dollar Iranian industrial complex, had begun near the end of 1974, but entered the doldrums in the middle of 1976, due to internal Iranian political scandals. Rumors of Chahbahar picking up were ever circulating through the Department, but the project continued to flounder until just before the end of my internship. The Hockley Salt Mine

Project, a small project for United Salt Corporation, was also beginning about the same time as my internship, and it concerned aspects of a mill above ground and a mine over 1500 feet below.

At Brown & Root, the Engineering and Construction Divisions operate almost as separate companies, each seeking their own projects. Of course, they interact constantly, working together to obtain both the engineering and construction for a project where possible. The Department gets a lead on a project from Business and Development, from a direct referral by a client or from within the Company such as from the other Division or another Department. If the Department obtains permission to pursue the project, it sends the prospective client a proposal at the appropriate level - qualification, project, or combination. If a positive response is received on the proposal, then Brown & Root, and the prospective client enter contract negotiations. If both engineering and construction are involved in the project, then both the Engineering and Construction Divisions must have opportunities to make input along the way.

Once an engineering project has been obtained, it is organized on a task force basis. The task force approach is implemented by the assignment of a Project Engineer or Project Engineering Manager and other required industry support personnel by the management of the industry department which is sponsoring the project. The Project Engineer or Project

Engineering Manager, along with representatives of discipline departments and technical support services, will assemble the balance of the team. The Project Engineering Manager and Project Engineers will remain with the project through its completion.

The advantages of the task force approach are many, of which the most prominent ones are 1) the continuity of management and engineering design for a given project, 2) the feeling of personal responsibility, involvement, and job satisfaction that each member of the task force can and should experience, and 3) the range of talent and experience that can effectively be applied to each project. A further advantage, concerning my internship, is that the task force concept enabled me to become involved in an organizational approach to a project at the same time I was applying my engineering skills.

The procedures followed to obtain and develop a project are relevant to this report, because in December of 1976, the Solids Processing Department was replaced by the Manufacturing and Processing Industries Engineering Department, called MAPI for obvious reasons. Where the Solids Processing Department was primarily a service department, the MAPI Department is an industry department. As its name implies, the MAPI Department operates within the manufacturing industry which includes almost everything that the previous industry departments did not handle. The development of MAPI was an expansion by Brown & Root into an area that it had not previously been involved on a sustained basis.

THE MAPI PROPOSAL

Shortly before my employment in August of 1976 by the Solids Processing Department, several engineers, including Mr. Keith Sandefer, the Senior Department Manager and my intern supervisor, submitted to Brown & Root a proposal advocating the development of a department devoted to the manufacturing and processing industries. The proposal recommended that initial attention be given to the Food, Drug, and Personal Care Products Industries, and presented the industry study which led to the recommendation. Included in the presentation were charts and tables concerning U. S. industry performance, industry comparisons, and industry capital expenditures.

The original idea concerning a manufacturing department at Brown & Root had occurred many years before, but had never been accepted by the corporate management. Therefore, the impression that this proposal was the first suggestion for such a department and that it was quickly approved and put into motion is not valid. To those who had worked for the development of a manufacturing department and thought it to be a good idea with obvious benefits for the Company, getting the new department approved was a long and painful process. Even though this proposal was prepared with optimism, it was submitted with full knowledge that another rejection was quite possible.

The proposal was delivered a matter of days before I began my employment; therefore, I did not help in its

preparation. I include this brief comment on the proposal report to provide continuity and to aid the understanding of some of the events that took place during my internship.

SEMCO/BROWN & ROOT LITIGATION

TASK SPECIFICS

In November of 1976, Mr. Keith Sandefer assigned me to gather and organize evidence concerning the SEMCO/Brown & Root litigation. My Department was not directly involved in the litigation, but provided this service to a project sponsored by another department. Due to Southwestern Engineering and Machining Corporation's (SEMCO) repeated failure to meet contract dates for conveyor shipments, Brown & Root had cancelled portions of two purchase orders. Claiming over $400,000 in damages, SEMCO had filed suit against Brown & Root. Brown & Root responded with a countersuit claiming over one million dollars in damages resulting from SEMCO's negligent ordering and handling procedures.

My assignment entailed searching through three years of files to gather information pertinent to the case and then to analyze the information and to organize it in a systematic manner. The objectives of the task were:

1. To represent the technical facts of the case in a manner easily followed by non-technical people.
2. To centralize into one file the pertinent information that was spread over all of the project files.
3. To obtain a rational indication of what company was at fault and where.

TASK PLANNING

I was given three weeks to complete the task and had at my disposal all of the project files, including those of the

Project Manager and several Project Engineers. A major portion of the assignment involved research. By referencing the project record, I had to piece together what had happened concerning material handling during the project's life of three years. This task required the reconstruction of the existences of the conveyors and feeders that were to be delivered by SEMCO. My plan of execution was to sift through the Project Manager's files and to create a chronological file which hopefully would give some order to the otherwise confusing records. Once the information was organized, I could then pull out what I needed to complete the task.

TASK PERFORMANCE

Not long after I began sifting into the Project Manager's records, I could see that much of the needed information was missing; therefore, I had to expand my search to other Project Engineers' files. I gathered the purchase order, invoices, letters, memos, and anything that referred to SEMCO or Brown & Root's relation with SEMCO and organized them both chronologically and by kind of document. From the information gathered, I created a master drawing list, drawing reference file, and a file containing the purchase order, releases, and transmittals. The end product was a set of reference charts one could follow through the drawings and their revisions for each piece of equipment and then proceed to fabrication and delivery dates to easily see where unusually long delays occurred.

The only real engineering skills employed in the completion of this assignment were the knowledge of the engineering vocabulary and a knowledge of material handling equipment. Some business knowledge was also required to understand the more business-like end of the project involving purchase orders, releases and invoices. The most valuable skill I employed, however, was the ability to systematize the scattered information into a well-documented form.

This assignment was my first involvement in how Brown & Root operates its engineering and construction projects; therefore, I learned much about the Brown & Root system. The most valuable outlook I acquired concerned the importance of orderly and well-maintained documentation. The study of this past project showed me what not to do. The primary peripheral activity I employed was the involvement with people. To complete the task, I had to interact with both engineering personnel associated with the project and with the lawyers who were handling the litigation. They do not very often speak the same language. Through the course of the assignment, very little actual supervision was given me outside of weekly meetings and periodic phone calls to discuss progress and problems.

ASSIGNMENT RESULTS

I attained the goals originally established. I synthesized and analyzed the project records; the resulting charts gave an indication of who was at fault where; and with the

help of the lawyers, I presented the information in a manner understandable to non-technical people. In addition to representing the information which was available, I was also able to list the information that was missing from Brown & Root's records. Knowledge of the missing information let the lawyer know what information he would have to obtain from SEMCO's records or from verbal statements.

I used the entire three weeks to complete the task. The results were then given to the lawyers involved in the litigation and to my supervisor. Very little follow-up was required of me outside of periodically answering a few questions. A technician was used to restructure the charts as desired by the lawyers. I regret that I was unable to include the charts as an exhibit in this report, but they may be found in the corporate file.

POST-TASK ANALYSIS

Taking into consideration the amount of money involved in the litigation, one can see the importance of organizing the project records and developing clear, accurate exhibits stating Brown & Root's position. Though the task was not technically demanding, it was invaluable to the development of my skills as a future Project Manager. The assignment was a valuable introduction to the Brown & Root approach to engineering and construction projects. Even more valuable, it left a vivid impression of the importance of maintaining good documentation, for one never knows when a lawsuit such as this one will occur.

My plans and procedures were as good as could be expected, considering the poor shape of the data with which I was working. The amount of information gathered in the short time available speaks for both my performance and the procedure I followed. The work did not just have volume; it also had quality. The lawyer received what he wanted. However, if the records had been in better condition, I could probably have taken a more systematic approach. As stated earlier, the supervision was not ever-present, but there was no need for it to be so. By giving me a free hand except for the periodic reports, I was left free to get the task done on time. There was not a lack of supervisory assistance. Whenever I needed help in getting information from Project Engineers or in dealing with the lawyers, the assistance was always there.

SUMMARY COMMENTS

The goals of the internship are to enable the student to make an identifiable contribution in an area of practical concern to his organization and to enable the student to function in a non-academic environment where he will become aware of the organizational approach. This task meets those goals. A million dollar lawsuit is unquestionably a matter of practical concern to Brown & Root, and being involved in such litigation and having to work with both Project Engineers and lawyers is operating in a non-academic environment in a situation which I was previously not experienced. The legal

aspects of engineering are very valuable to an engineer's training.

There was very little in my educational background that prepared me for working with a complex project organization, such as that maintained by Brown & Root, or with lawyers. It would be of great benefit if the engineering universities devoted more time in their programs to interaction with people and other practical engineering problems. Concerning industry's approach, it is said that hindsight is always twenty-twenty, but perhaps something can be learned in this instance. Once the mistake had been made, the Company did the only thing it could - sent someone to clean up the mess. But if proper expediting had been performed throughout the project, the litigation may have been avoidable. In any case, if the project records had been maintained properly, the cost of preparing for the litigation would have been substantially less and the Company's position much more secure.

The only recommendation that I have concerning this problem, I have since seen in operation. The Project Manager should maintain both a chronological file and an engineering discipline file (a file containing all information related to each of the engineering disciplines) and should receive a copy of every document concerning the project, including all reports, correspondences, etc., to be included in each of the two files.

THE MANUFACTURING ENGINEERING DEPARTMENT

As stated earlier, a proposal was presented shortly before my employment which advocated the development of a manufacturing engineering department. The proposal was given the acronym MAPI which stood for Manufacturing and Processing Industries. In December of 1976, this Manufacturing and Processing Industries Engineering Department replaced the Solids Processing Department, and all but a nucleus of engineers and technicians were transferred to other departments. The mechanical engineers and technicians, including the environmental group, went to the Mechanical Department; other disciplines went elsewhere; and the Department, which once had approximately ninety members, was left with only about ten.

Before the official birth of the MAPI Department, I was assigned to write a report discussing the development of an Industrial Engineering Department at Brown & Root, which would procure and manage jobs for industrial plants. The report advocated the addition of such a department and made recommendations as to the functions, staff, and operating procedures within it. Written some two months before the MAPI Department came into being, the report took a very simplified and theoretical approach. To arrive at the form that I proposed an Industrial Engineering Department would take at Brown & Root, I took the skills offered by an industrial engineer and attempted to mesh them into the type organization and philosophy I had seen during my short

employment with the Company. I am not going into great detail on the report, because it was not a major project. I am including it as an exhibit in this section, along with the official scope, simply because of its similarity to what actually came into being.

Though the scope of the department I devised was a very simplified version of the scope of the MAPI Department that was formed, the organization of the department I proposed was in close agreement with that of the Industrial Engineering Section in the MAPI Department. The Plant Layout Section in my report corresponds to the Venture Planning Division of the Industrial Engineering Section, as does the Materials Handling Section to the Physical Distribution Division and the Methods Engineering Section to the Manufacturing Processes Division. Of course, the MAPI Department also included other necessary sections such as the Project Management Section, the Business Development Section, and the Home Office Support Section. The Industrial Environmental Engineering Section was later transferred to Mechanical, but the then floundering Chahbahar Industrial Complex remained.

Since the basic philosophy of the Department had changed to that of an industry department and since the industries in question were very new to Brown & Root, a large amount of basic groundwork was necessary to make firm the foundation of the MAPI Department. This groundwork took the form of a series of systems which had the dual purpose of giving organization to the Department's activities and supplying information

where needed. In other words, the systems were designed to aid the Department in acquiring projects and then to aid in the engineering of the projects. Much of my internship was directed toward the development of the following systems:

Sales System

Proposal System

Venture Planning System

Contract System

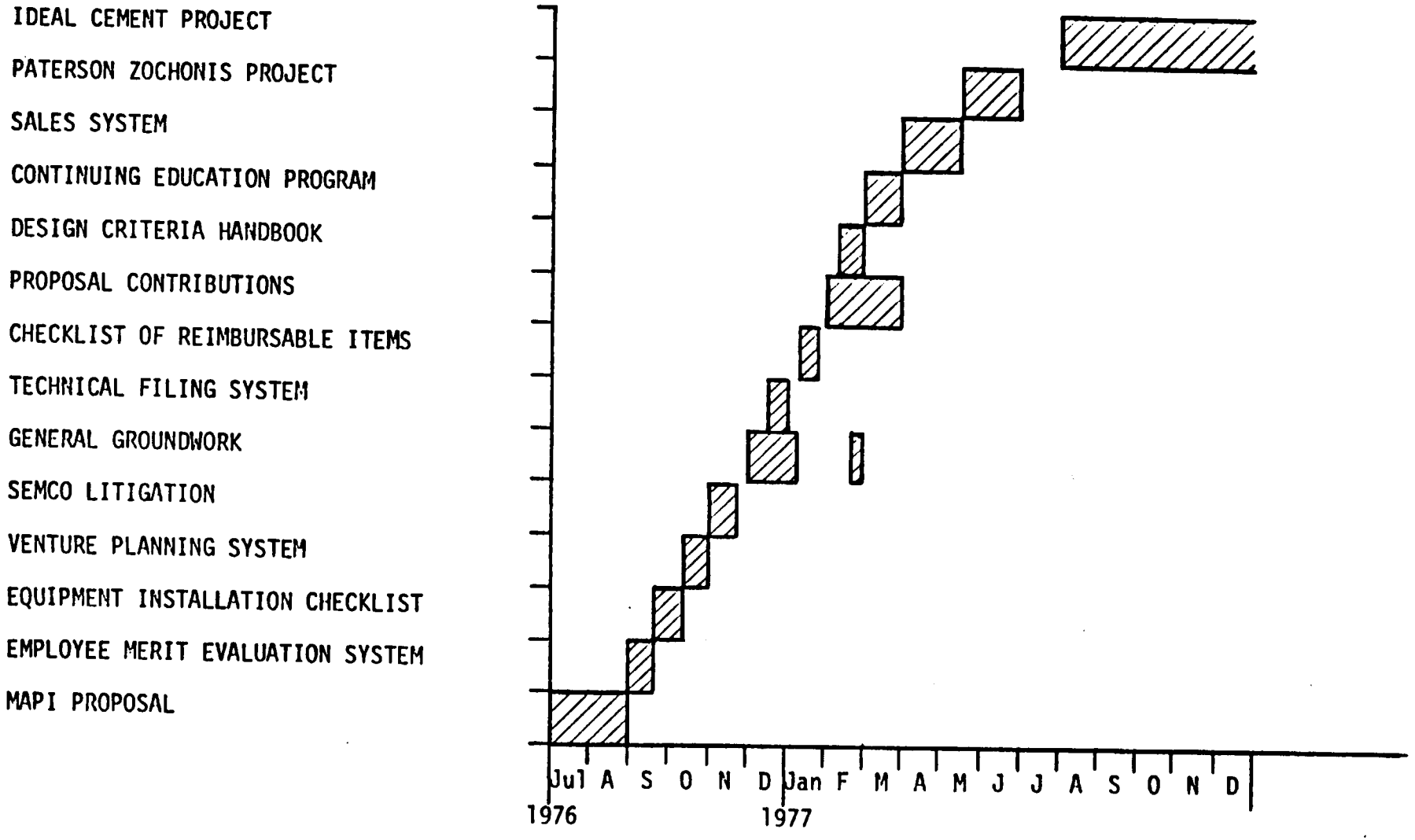
Filing System

Design Criteria

Merit Evaluation System

I will discuss these systems in this report according to the above order of application to a project rather than in the chronological order of their development. A Gant chart that represents the time I worked on these systems and my other projects is included in Appendix I which follows this section. Each of the projects is discussed in its own section followed by an appendix which contains related exhibits.

APPENDIX I


IDEAL CEMENT PROJECT
PATERSON ZOCHONIS PROJECT
SALES SYSTEM
CONTINUING EDUCATION PROGRAM
DESIGN CRITERIA HANDBOOK
PROPOSAL CONTRIBUTIONS
CHECKLIST OF REIMBURSABLE ITEMS
TECHNICAL FILING SYSTEM
GENERAL GROUNDWORK
SEMCO LITIGATION
VENTURE PLANNING SYSTEM
EQUIPMENT INSTALLATION CHECKLIST
EMPLOYEE MERIT EVALUATION SYSTEM
MAPI PROPOSAL
Jul A S O N D Jan F M A M J J A S O N D
1976
1977

BROWN & ROOT, INC.
SOLIDS PROCESSING DEPARTMENT
OFFICE MEMO

TO: Mr. Keith Sandefer DATE: October 7, 1976

FROM: Randall J. Gaunaway FILE NO.: 105.00-000

SUBJECT: INDUSTRIAL ENGINEERING DEPARTMENT

The addition of an Industrial Engineering Department to Brown and Root would result in several benefits. First, it would allow expansion in an area previously untouched by Brown and Root. The purpose of this new department would be to procure and manage jobs for industrial plants. While serving as an additional source of income, the Industrial Engineering Department would also result in centralization of industrial engineering services. This department would give Brown and Root the capability to compete with the few engineering and construction companies and independent consulting firms that do this type of work and with the departments that large industrial firms must maintain and financially support to engineer and build their own industrial plants.

Industrial Engineering Functions

The industrial engineer is one of the most versatile of engineers. His function in an organization could be a combination of any of the following tasks:

- Plant Layout
- Materials Handling
- Methods Engineering
- Production Control
- Inventory Control
- Time Study
- Job Evaluation
- Operations Research
- Data Processing
- Quality Control
- Cost Analysis
- Tool Engineering
- Human Factors
- Safety Engineering

The industrial engineer, therefore, can be responsible for the layout of buildings and equipment, the design and improvement of control systems, the development of financial management systems, the study of the work place, and/or many other things.

Functions Within the Department

The tasks performed within the Industrial Engineering Department must be compatible both with its purpose to procure and manage jobs for industrial plants and with the type work performed by Brown and Root. The general areas within the Industrial Engineering Department should be plant layout, materials handling, and methods engineering. These areas of industrial engineering lend themselves more easily to the engineering and construction environment of Brown and Root and also allow expansion into the work for industrial plants. Once the department is operating and experienced, further expansion could be possible into other areas of industrial engineering such as production and inventory control, quality control, time studies, problem solving through operations research techniques, information and data processing systems design, and others. These latter areas, however, are out of the realm of the Industrial Engineering Department when it first begins.

Plant Layout Section

The Plant Layout Section will deal with the arrangement of the physical facilities and manpower required to produce a product. This arrangement may include any or all of the areas of the production process including receiving and shipping activities, service operations, inspection areas, and storage. Examples of the types of problems that this section could handle are the planning of an entire new plant, the enlargement or reduction of an existing department, and the moving or addition of a department. Some of the duties of this section are to plan the materials flow pattern, the planning and layout of the plant areas and facilities, the construction of the master layout, and the supervision of the construction and installation of the layout plan.

Materials Handling Section

Working closely with the Plant Layout Section is the Materials Handling Section. It enables the static flow pattern to become a dynamic flow of material. The objective of this section is to transport materials from point to point and to deliver them to their appropriate work places or productive centers in a manner which avoids congestion, backtracking, delay, and unnecessary handling. The Materials Handling Section is responsible for choosing the material handling equipment. This duty covers all areas of the plant where material handling equipment is used including getting material to the plant, unloading and loading, receiving and shipping, storage activities, in-plant distribution, in-process handling, and packaging. Like the Plant Layout Section, this section need not work on an entire plant. It could handle the material handling for a specific department or even the individual work place. Both the Materials Handling Section and the Plant Layout Section are responsible for the merging of the materials handling equipment with the plant layout.

Methods Engineering Section

The third major section in the Industrial Engineering Department is the Methods Engineering Section. This section is responsible for designing and selecting

the best methods, processes, tools, equipment, and skills necessary to produce a product. This responsibility includes the design and development of the various work centers where the product is produced. This section must work closely with the other two sections in order to interface the work center design with the overall layout and the work center equipment with the material handling equipment. Also under the responsibilities of this department is safety engineering including the fulfillment of OSHA Standards.

Outside Help

Of course much more goes into the building of an industrial plant than just the type of tasks handled by these three industrial engineering sections. These tasks would be performed by people assigned to the project from outside the Industrial Engineering Department. Help can be obtained in disciplines such as electricity, instrumentation, mechanics, heating, air conditioning, ventilation, plumbing, and structural design. Help can also be obtained from industry departments such as petro-chemical, power, pulp and paper, and public works.

Department Head

The Industrial Engineering Department in its beginning should be staffed with a small nucleus of competent engineers. At the head of the department should be a senior industrial engineer with at least fifteen years experience and who is a registered professional engineer. He should be skilled in industrial engineering operations which involve maximum client participation, and experience in consulting would be helpful. The duties of the Department Head are to make the initial client contacts, to appraise projects, to make the department's major plans, to assign priorities, and to perform some of the administrative activities.

Department Staff Engineer

Directly below the Department Head is the Department Staff Engineer. He should have a broad background in industrial engineering. His responsibilities are to make project assignments, to coordinate the work, to make follow-up correspondence, and to help with the administrative activities.

Project Engineers

One Project Engineer should exist for each of the three sections. They should be registered professional engineers with the capability of being assigned to a variety of projects involving different activities and different clients. Advanced degrees in areas such as operations research, systems analysis, and/or management science would also be helpful. Each Project Engineer should be given responsibility for the particular technical speciality in his section. He should also be responsible for seeing that safety standards are met. Safety

information may be received from his own experience, from the aid of an engineer within the department whose responsibility it is to keep up with safety regulations, or from a safety engineer from outside the department. Specific responsibilities of the Project Engineer are the following:

1. Project definition
2. Control of tasks and funds allocated to the project
3. Coordination of all disciplines on the project
4. Development of a master project schedule
5. Establishment of a status-reporting system
6. Identification of problems significant to the project's success and initiation of immediate action to resolve them
7. Control over all project changes
8. Primary contact to the client

Others

Below the Project Engineers should be from three to five engineers with a broad industrial engineering background who will be assigned to the various projects as need requires. These engineers need not be registered professional engineers, but they should be encouraged to become registered, because they will probably form the basis of further expansion of the department. Also required, of course, are draftsmen and secretarial help.

Recruiting

Some of the engineers required may be obtained from other departments within Brown and Root due to the centralization of the industrial engineering functions. However, most of the engineers will have to be recruited through techniques such as advertisements in technical journals and the larger newspapers around the country.

Beginning of Operation

The first projects worked on by the Industrial Engineering Department should be small and simple, designed to give the department experience while it is showing its capabilities and potential. The department should be given at least a three-month period in which to organize, make contacts, expand knowledge, and locate potential initial projects.

Locating the Client

Of primary importance to the Industrial Engineering Department is locating clients. The initial sources of potential clients may be contacts in the

industry or names in the news media. Another means of acquiring clients is the distribution of up to date and complete brochures that specify the department's capabilities. Once a potential client is found, he should be approached by the Department Head. Clients prefer to deal with the man at the top, because they feel that they are receiving the personal interest, attention, and expertise of the Department Head. After the initial meetings, an organized follow up should be launched.

Project Operation

Once a project is approved and assigned to a Project Engineer, the Project Engineer will put together a project team which consists of the necessary industrial engineers and professionals from outside the department. The project will be in the hands of the Project Engineer and his project team, and the Project Engineer should attempt to obtain maximum client involvement by having the client or his representative available for immediate decisions.

Conclusion

The Industrial Engineering Department would fit very well into the Brown and Root framework of project assignments and manpower pools. It would also allow expansion into the industrial plant area which promises to be a sizeable new source of income for Brown and Root. In the outset the department need only be a nucleus of well trained and experienced industrial engineers around which the department can grow and expand its capabilities. The potential of such a department should not be hastily overlooked.

Randall J. Gannaway

RJG:jfk

MANUFACTURING AND PROCESSING INDUSTRIES ENGINEERING DEPARTMENT

SCOPE OF OPERATIONS

This Department was formed so that Brown and Root could diversify its Engineering-Construction activities into fields where no sustained effort was being expended. The fields in which Brown and Root was active at that time were: Power Generation; Pulp and Paper; Heavy Civil Works; Mining and Metals; Petroleum and Chemicals; Pipelines and Terminals; Oil and Gas Production Systems; Marine Technology and Naval Architecture; and Offshore Structures. By subtraction, the industries available to this Department constitutes a very large segment of U.S. business activity.

Without considering the limitations on engineering-construction inherent in some industries, the following generic industrial groups are potential markets for this Department:

Aerospace

Appliances

Automotive

Beverages

Building Materials

Conglomerates (selected activities)

Containers

Drugs

Electrical/Electronic Equipment

Food

Machinery, except Electrical

Instruments

Leisure Time Products

Miscellaneous Manufacturing (some activities)

Office Equipment/Computers

Personal Care Products

Publishing

Service Industries

Textiles, Apparel

Tires and Rubber

Tobacco

Telecommunications

Since it would be impossible to approach all of those industries simultaneously, three were selected for the initial penetration effort. The Food, Drugs and Personal Care industries are all profitable, expanding and inextricably interdependent. So these are the primary targets.

Additionally Brown and Root had occasionally done work for specific subindustries which did not fall into the jurisdiction of any other of the existing Departments. It was felt that this Department should also attempt to obtain work in these industries since some experience could be shown:

Abattoirs, Meat Packing Plants

Air Pollution Control Facilities

Animal Feed and Feed Supplement Plants

Asbestos-cement Building Materials Manufacturing

Barge Transfer Terminals

Cement Terminals and Storage

Cement Plants

Clay Products Plants

Coal Handling Systems (except Power Plants)

Concrete Products Plants

Dredges and Dredging Projects

Feedlots

Fertilizer Formulation Plants

Food Packaging Plants

Foundries

Grain Elevators and Terminals

Lime Plants

Maintenance Shops

Noise Abatement

Pipe Coating Plants

Plastic Extruding Plants

Plastic Masterbatch Plants

Roofing Plants

Salt Works

Sand/Gravel Plants

Seed Oil Extraction Plants

Shops, General Manufacturing

Special Machines

Stone Quarries

Synthetic Aggregate Plants

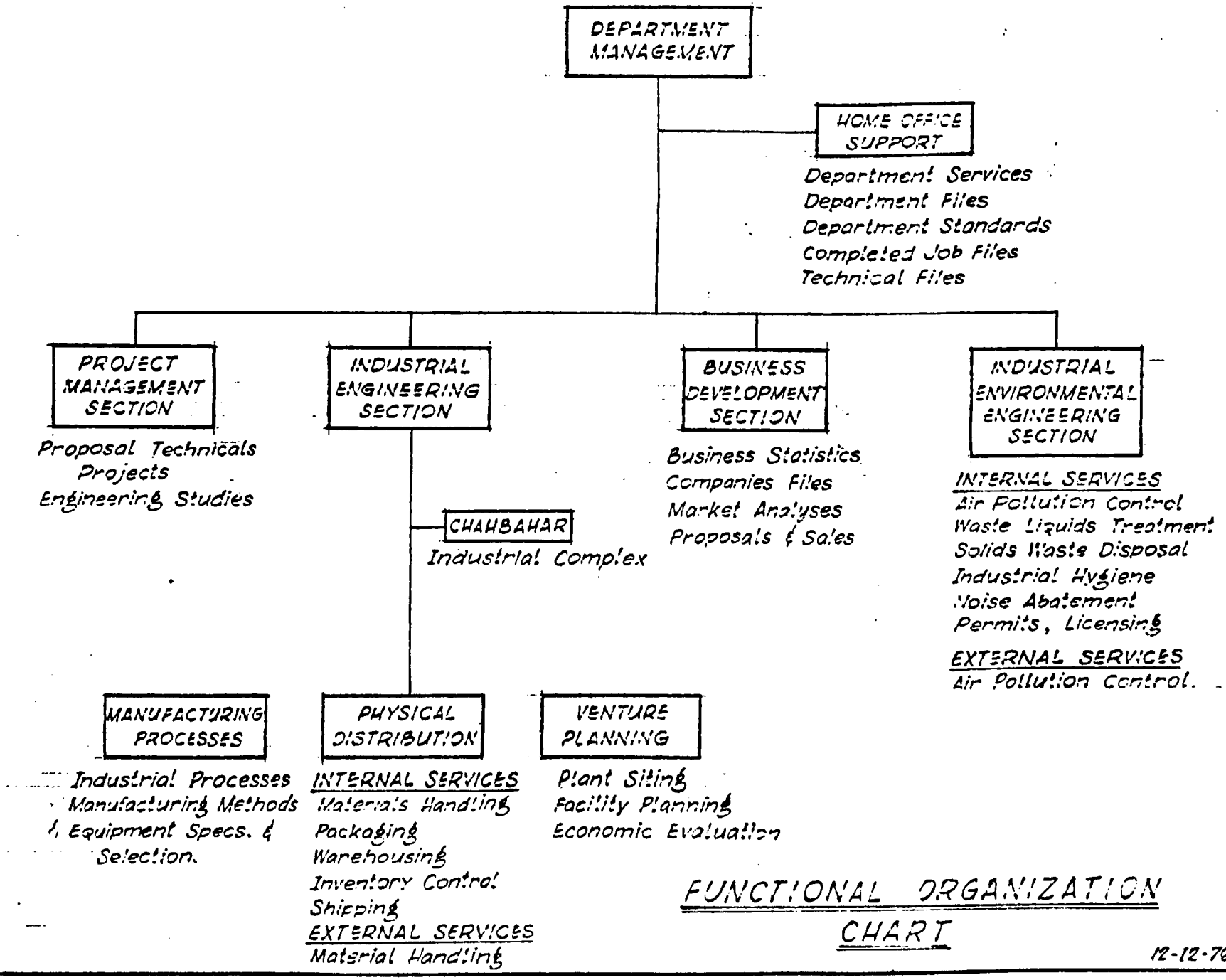
Truck Terminals

Warehouse, Distribution

Waste Classification and Recovery Plants

Wood Chemicals Extraction Plants

It is readily apparent that the activities of the Department could (and probably will) be very widely diversified. The organization, personnel and procedures of the Department have to be geared for the handling of almost any type of work.



FUNCTIONAL ORGANIZATION CHART

12-12-76

BROWN & ROOT Inc. HOUSTON, TEXAS

MANUFACTURING AND PROCESSING INDUSTRIES ENGINEERING DEPARTMENT

DRAWN BY JABLIK CHECKED APPROVED DATE PAGE OF DWG. NO. CONT. NO.

SALES SYSTEM

TASK SPECIFICS

In April of 1977, Mr. Keith Sandefer assigned me to develop a system that would keep the MAPI Department and its salesmen informed on engineering-construction developments and prospective work within the scope of MAPI Department operations. The MAPI Department was only three months old, and Business and Development had just hired a new salesman who was to be devoted to the Department. His past experience had primarily involved the food industry; therefore, the sales system was to expand his contacts in not only the food industry, but all of the industries under the scope of the MAPI Department.

The task entailed obtaining the names of companies within the manufacturing engineering scope, data and contacts associated with the companies, and sources of industry information and then developing a sales system around the information gathered. The goals of the resulting sales system were:

1. To obtain a representative, if not complete, list of companies and their related data that are within the scope of the MAPI Department.
2. To find the names of contacts within the companies.
3. To develop a mailing list.
4. To provide for the recording of sales communications.
5. To provide a means of keeping current on developments within the manufacturing industries.

TASK PLANNING

I was supplied a Standard & Poor's Stock Guide, listings from Fortune Magazine of companies and positions, and lists of companies and contacts collected by the newly hired salesman. Also combined with this data were the annual reports of manufacturing companies that had been solicited shortly after the formation of the MAPI Department. In the early stages research was also necessary into various financial publications, such as those published by Standard & Poor's and Dun and Bradstreet, to obtain the list of manufacturing companies and the names of contacts within the companies. The time allocated for the task was not fixed, but was estimated to be between one and two months.

My plan of execution was to first make a list of the companies to be included in the system because their operations were within the scope of the MAPI Department and to find the name of at least one contact within each company. If no contact was known through a salesman, then annual reports would be used. A file folder was to be set up for each company to hold annual reports, forms designed to record company information, and any other items of interest concerning the Company.

TASK PERFORMANCE

Once I began the task and was working with over one thousand companies and their subsidiaries within the scope of MAPI, I quickly saw the need for subdividing the load and establishing priorities. I divided the companies into two groups: 1) those companies involved in food, pharmaceutical,

and personal care industries, and 2) those companies involved in everything else. I emphasized the first group, because the Department's salesman had experience and knowledge in that area, and it was to the Department's benefit to get the salesman on the road as quickly as possible. I further subdivided the companies into geographical zones and volume of sales according to the following codes:

CODE	GEOGRAPHICAL AREA
1	Maine, New Hampshire, Vermont, New York, Massachusetts, Rhode Island, Delaware, Connecticut, New Jersey, Pennsylvania, Maryland, West Virginia.
2	Virginia, North Carolina, South Carolina, Georgia, Florida.
3	Ohio, Michigan, Wisconsin, Illinois, Indiana, Kentucky.
4	Tennessee, Alabama, Mississippi, Louisiana.
5	North Dakota, South Dakota, Minnesota, Iowa, Missouri.
6	Montana, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Oklahoma, Arkansas.
7	Texas.
8	Washington, Oregon, Idaho, California, Nevada, Utah, Arizona, Alaska, Hawaii.

CODE	ANNUAL SALES ($ MILLIONS)
A	500+
B	100-499
C	50- 99
D	25- 49
E	Below 25

Thus if a company is classified as "1A", then it is a 500+ million dollar company located in geographical zone one. These codes were placed in sales books and on Company Data Master Cards, forms that I designed in conjunction with my supervisor and the salesman. I used the Master Cards to record company related data such as the address, phone number, contacts within the company, and the company's subsidiaries which were, in turn, also placed on a Master Card of their own. After arranging the Master Cards in alphabetical order, a company mailing list could be extracted. The sales books correspond to the geographical zones and accompany the salesman on his trips. The form used in the books separates into four copies, one copy for each of four sales books, and lists the company, its address, phone number, sales volume, and the names and titles of contacts within the firm.

To record mailings, sales calls, and visits, I used still a third form called the Master Contact Record. There is a Master Contact Record for each company, and on it is recorded the date and type of contact, plant contacted, and person contacted. This record is kept in a file folder, one folder for each company, along with the company's Master Card, annual report, and items of current company events clipped from the Wall Street Journal and other financial publications. The clippings are glued to standard size sheets of paper. I specified the procedures for maintenance of these files, and then the details were worked out between the salesman and the

clerks who were responsible for completing the forms, searching for current events, and maintenance.

The skills I employed in the completion of this task were not so much educational as they were by-products of education - research methods and efficient recording of information gathered. Through this assignment, I became much more familiar with how Brown & Root attracts and seeks jobs. I also became more familiar with how the manufacturing industry is dispersed throughout the country and with the names of companies and influential people within the industry. In this task, I worked with non-technical personnel such as the salesman and later took part in the supervision of clerks until they had learned the system. Close supervision was given me throughout the assignment by my intern supervisor, who constantly reviewed the progress of the system, suggested modifications and made inputs.

ASSIGNMENT RESULTS

The result was a sales system established around a company related filing system that references over one thousand companies and their subsidiaries and maintains files of 1) annual reports, 2) Master Cards, 3) Master Contact Cards and 4) clippings of company current events. Copies of the forms are included as exhibits in this section. Also part of the system are a company mailing list and the geographical zone sales books. This system fulfills the goals originally defined.

A major undefined objective that I reached was the creation of two subsystems within the larger system. Since the initial thrust of the MAPI Department was to be toward the food, pharmaceutical, and personal care industries, I kept separate the company information related to companies in those industries. This separation resulted in two mailing lists and two sets of geographical zone contacts books and turned out to be very useful to the Department in its initial efforts.

My part in the development of the sales system required six weeks, and it is now kept in file cabinets in the Department file room for use by anyone who needs it. In the early stages of the system, I had to answer questions of the clerks who were and are maintaining the system, but from this time forward there will probably be little need of any follow-up by me.

POST-TASK ANALYSIS

If one engineering project results from the sales system, then the cost of developing and maintaining the system will be reimbursed many times over. The sales system is a valuable aid to the attainment of projects and could therefore be very profitable both to the MAPI Department and to Brown & Root. Concerning value to myself, the task was beneficial as part of my management training. It broadened my knowledge of both the manufacturing industry as a whole and of the Brown & Root approach to obtaining jobs.

If volume is the judgement criteria, then my performance was excellent. On the other hand, if usefulness of the

information is the criteria, then I question the usefulness of some of the information in the system. The names of contacts, for instance, were sometimes chosen with a guess from a long list of officers due to the lack of familiarity with the company. Though the information gathered is a helpful beginning, if time had permitted, more accurate information could have been gathered. Due to the sheer numbers of companies and contacts involved and the straight forward approach I took, the task sometimes appeared to be unending. Perhaps I could have divided the companies even more or could have gathered the information in stages such that results could have been seen and used earlier. There were times when, though the goals were defined, the means of attaining those goals were somewhat shaky. An example is the different viewpoints held by everyone concerned on how to handle the innumerable subsidiaries of companies. In such cases answers to questions put to my supervisor came slowly, or too quickly, only to be changed later.

SUMMARY COMMENTS

The value of this task to my internship stems from two points. First, the task was a fairly complex system involving the efficient handling of information related to over one thousand companies and their subsidiaries. Second, the task involved the organizational approach to a problem, namely sales. It required input from personnel involved in sales, management, engineering, and clerical work and had to conform to the larger Brown & Root method. The development of the

sales system is within the fifteenth primary activity of industrial engineering as described in the Introduction to include the development of office systems and procedures.

Previous to this assignment, my background had included very little contact with company names within the manufacturing industry as a whole across the country. I also had been involved little with the selling function. Such business activities are usually, and wrongfully so, left out of an engineer's education. A shortcoming of industry's approach was that the task was approached from the viewpoint of "get everything in a hurry now." The result of that approach was that the quickly needed information was delayed by the magnitude of obtaining all of the information necessary to complete the task. I recommend that tasks of this nature and magnitude should be divided into subproblems, even more so than was done, and then completed according to a pre-established priority ranking.

APPENDIX II

MASTER CARD: COMPANY DATA

40

SUBSIDIARY COMPANIES

COMPANY NAME

UBSIDIARY OF

HOME OFFICE STREET ADDRESS

HOME OFFICE MAILING ADDRESS

CITY STATE ZIP

ALES AREA

CONTACT EXECUTIVE

TITLE A/C PHONE NO EXT

OPERATING DIVISIONS/PLANTS

SALES AREA

DIVISION/PLANT NAME MAILING ADDRESS

STREET ADDRESS CITY STATE ZIP

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

SALES AREA

DIVISION/PLANT NAME MAILING ADDRESS

STREET ADDRESS CITY STATE ZIP

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

SALES AREA

DIVISION/PLANT NAME MAILING ADDRESS

STREET ADDRESS CITY STATE ZIP

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

CONTACT TITLE A/C PHONE NO EXT

CONTINUED ON BACK

MASTER CONTACT RECORD

COMPANY NAME

HOME OFFICE ADDRESS

DATE OF CONTACT	CONTACT MADE BY	TYPE *	PLANT/DIVISION CONTACTED	PERSON CONTACTED	REMARKS

Sales Vol. | SalesZone

COMPANY ______

CONT. EXEC. ______ TITLE 42

ST. ADD. ______ MAIL TO ______

CITY ______ ST. ______ ZIP ______ A/C ______ TEL ______

CONT. ______ TITLE ______ TEL ______ EXT. ______
CONT. ______ TITLE ______ TEL ______ EXT. ______
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Sales Vol. | SalesZone

COMPANY ______

CONT. EXEC. ______ TITLE ______

ST. ADD. ______ MAIL TO ______

CITY ______ ST. ______ ZIP ______ A/C ______ TEL ______

CONT. ______ TITLE ______ TEL ______ EXT. ______
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Sales Vol. | SalesZone

COMPANY ______

CONT. EXEC. ______ TITLE ______

ST. ADD. ______ MAIL TO ______

CITY ______ ST. ______ ZIP ______ A/C ______ TEL ______

CONT. ______ TITLE ______ TEL ______ EXT. ______
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Sales Vol. | SalesZone

COMPANY ______

CONT. EXEC. ______ TITLE ______

ST. ADD. ______ MAIL TO ______

CITY ______ ST. ______ ZIP ______ A/C ______ TEL ______

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BM Introduces Computer Line For Small Firms

4-15-77

ystem 34 Can Handle Up to 8 Operators and Is Aimed Also at First-Time Users

By a WALL STREET JOURNAL *Staff Reporter*

ATLANTA—International Business Ma-ines Corp. expanded its line of computers small businesses and first-time users by roducing the System 34, which can ac-mmodate up to eight operators.

IBM's General Systems division here also nounced enhancements for the recently roduced Series 1 minicomputers, which e aimed mainly at sophisticated custom-s who want to disperse their data-process-functions among many locations.

IBM made a major effort to lower the st of computers for first-time users when introduced the System 32 in January 1975. nce then, it has shipped more than 10,000 its to small bussinesses, the overall mar-has swelled, and many new competi-s—large and small—have appeared.

When Sperry Rand Corp.'s Sperry Univac vision entered the field last January with BC-7, it estimated there were more than manufacturers in it. Among the other ma-concerns are Burroughs Corp., NCR rp., Digital Equipment Corp., and Data neral Corp.

IBM's System 32 is designed for a single erator and does one job at a time. The allest model can be purchased for $33,560 d comes in a single unit with 16,000 char-ters of main data storage, 3.2 million aracters of supplemental disk storage, d a printer that runs at 40 characters a cond. The largest model, with more stor-e and a faster printer, costs $50,410.

The new System 34 comes with up to ght "work stations" that can be installed gether or distributed up to 5,000 feet from e central unit in the offices of a small mpany. The stations can run different s simultaneously and even interrupt them additional tasks without interfering with ch other. IBM said that makes the com-ter useful as well for large companies th data-processing expertise.

First deliveries of the new computer will gin next January.

The basic System 34 comprises a central ocessor with 32,768 characters of main rage; 8.6 million characters of disk stor-ge; a so-called diskette unit for additional, ick storage and retrieval; a controller for taching peripheral devices; one operator's deo-display console, and one 40-charac-s-a-second printer. Such a system may be ught for $34,700 or leased for three years $850 a month. The largest systems could st well over twice as much.

Various combinations of main storage, disk storage, and diskette storage make 18 models of the System 84 available, IBM said. The maximums are 65,536 characters of main storage, 27.1 million characters of disk storage, and 9,472 records of 128 characters each in diskette units.

A Model 5251 display station, with a typewriter-like keyboard may be bought for $3,200 or leased for $85 a month. Several printers are available, as well as a new two-sided, "double-density" diskette unit.

The basic operating programs are available for monthly fees. IBM said System 32 programs "with minor modifications" can be used with the System 34. It also said that specialized application programs are available for 10 industries, including manufacturing, construction, hospitals, and schools.

IBM said the System 34 is able to communicate with a broad range of other IBM computers.

The enhancements for Series 1 computers involve both programming and equipment. The programs include a "real-time" operating system and two "high-level" programming languages known as Fortran and PL/1. IBM also announced lower-cost, electronic memory cards that can store 32,768 characters each, a printer that can run at up to 414 lines a minute and a video-display station.

Charles T. Casale, a Boston analyst specializing in small computers for the securities firm of Bache Halsey Stuart Inc., said the System 34 "rounds out" IBM's product line in a market that should continue to expand rapidly. Mr. Casale said he didn't expect an adverse effect on IBM's competitors in the near term.

He also said that IBM's broadening of the capabilities of the Series 1 minicomputers, which were introduced last fall, was expected. In the next several years, he said, he expects IBM to increase its share of the minicomputer market at the expense of small competitors, while established leaders in the field, including Digital Equipment, Data General, and Hewlett-Packard Co., also increase their market shares.

In New York Stock Exchange composite trading yesterday, IBM closed at $272 a share, down $1.375 from the prior day. Burroughs closed at $61.75, down $1.125; and Digital Equipment, at $40.375, and Data General, at $40, were each down $1. Sperry Rand rose 12.5 cents to close at $34.875, and NCR also rose 12.5 cents to $35.375.

IBM was ordered to pay $2.7 million damages to Forro Precision in a finding that it intentionally interfered with Forro's prospective business relations. But the jury couldn't decide on charges of antitrust monopolistic practices by IBM. 9-19-77

(Story on Page 16)

Forro Receives Damage Award In Its IBM Suit

9-19-77

IBM Will Appeal Case That Involves $2.7 Million, but Gets $260,777 Cross Claim

Special to THE WALL STREET JOURNAL

SAN FRANCISCO—A federal jury has awarded Forro Precision Inc. $2.7 million general damages from International Business Machines Corp. for intentionally interfering with Forro's prospective business relations.

The jury, however, was unable to decide whether Forro, a Woodland Hills, Calif., computer parts manufacturer, had been the victim of alleged antitrust monopolistic practices of IBM. Forro's attorney, Joseph M. Alioto, son of the former San Francisco mayor, said he will ask for a retrial of the antitrust allegations.

Frank I. Cary, chairman of IBM, said: "We are obviously disappointed that the jury didn't reach a decision on the antitrust charges, since we are confident of our position. It s difficult to understand the award to Forro since the 'interference' was related to a search of Forro's premises by the police with respect to IBM trade secrets. We intend to appeal."

The five-women, one-man jury in Judge Ray McNichols's court also gave IBM $260,777 on its cross-claim against Forro that charged misappropriation of trade secrets.

Mr. Alioto said he would ask that the award to IBM be thrown out by Judge McNichols on the ground that evidence failed to support such a verdict.

Forro had charged in its 1974 suit that IBM conspired since at least 1954 to unlawfully restrain trade and monopolize the electronic data-processing idustry. Forro had asked for up to $24 million in treble damages on the antitrust accusations.

The $2.7 million award was based on a Forro claim that in June 1973 IBM, "acting together with others, seized plaintiff's business records, including confidential pricing information and blueprints."

This was done, according to the complaint, "for the purpose and with the intent of destroying plaintiff's business and impeding and eliminating competition in peripheral devices and computer components."

Out of court, Mr. Alioto said the 1973 incident involved "IBM giving false information and withholding pertinent facts to the San Jose (Calif.) Police Department which resulted in search warrants being issued against Forro." According to Mr. Alioto, this "resulted in Forro being placed in the position of looking like a criminal when it wasn't."

The Forro case is the second of several multidistrict antitrust cases against IBM to go to trial. The first, brought by California Computer Inc., resulted in a directed verdict in favor of IBM by Judge McNichols after a 2½ month trial in Los Angeles earlier this year.

PROPOSAL SYSTEM

The next step from a sales system in attaining projects is the proposal system. After information concerning a prospective project reaches the Department, a proposal is prepared and sent to the prospective client. I made my contributions to proposals after the proposal system had already been developed by other engineers, but I am including a brief discussion of the system to give continuity to the Department's systems and to introduce the contributions I did make.

The proposal system was designed to provide an organized and efficient method of preparing and distributing proposals. The MAPI Department uses three types of proposals: 1) qualification, 2) project, and 3) combination. Qualification proposals are Brown & Root's response to the general solicitation by a prospective client for Engineers and/or Constructors who have an interest in providing services for a barely-defined venture. A project proposal is Brown & Root's presentation to a prospective client of the exact services to be used in performing the project. It details the goals to be met, the methods to be employed, the resources available to the project, the time-frame and initial schedule, and the costs to be anticipated. In the situation requiring a combination proposal, the prospective client has established much of the requirements, goals, and guidelines of the project but has not developed a list of qualified engineers and/or constructors. Thus, the

principle features of both the qualification proposal and the project proposal must be combined.

The contents of each type of proposal and their descriptions have been outlined to the point that a standard form is followed (see the exhibits in this section.) Even the paper, type, and tab colors have been specified. A file numbering system was devised to give each proposal a unique number, and to aid maintenance, an update schedule was developed and inventory details supplied for quantities and reorder points of contents.

TASK SPECIFICS

On several occasions in February and March of 1977, Mr. Keith Sandefer assigned me to make inputs concerning industrial processes and manufacturing methods to MAPI Department engineering proposals. Since the MAPI Department was a new department, the sections in the qualification proposal did not exist and had to be written. In relation to some of the project proposals, the prospective client knew little or nothing about the manufacturing process he desired, and since the process was usually new to the Department, a quick study of a general process was required for inclusion in the project proposal.

For a qualification proposal exhibit my assignment involved delving back into Brown & Root's records for the necessary information, organizing the information found and then representing the information in a manner suitable to the proposal. For a project proposal, the task entailed contacting

vendors and researching the technical library. The objectives of the task were:

1. To organize information relative to the proposal in a succinct, informative manner.
2. To educate the client concerning some aspect of Brown & Root.
3. To present Brown & Root's capability to do the project by exhibiting its technical competence.
4. To acquaint the Department with new manufacturing processes as the demand for them arose.

TASK PLANNING

At my access I had all of the past proposals from other Brown & Root departments, a listing of all of Brown & Root's past projects, the Department's technical files, and the Brown & Root technical library. I used the proposals and list of past projects to research information for my qualification proposal exhibits and I referenced the technical files as well as the books and microfiche in the technical library to obtain a better understanding of the manufacturing process in question. The time given me to complete the tasks varied from two days to two weeks.

My plan of execution for a qualification proposal was to exhaustively enumerate every project appropriate to the exhibit and then select from that list the project and information to be included. For a project proposal, my plan was to contact a number of vendors in the area of interest

and to research technical articles and books. The information gathered was then merged to represent a general manufacturing process or method.

TASK PERFORMANCE

Two exhibits that I prepared for qualification proposals involved innovative designs and work experience. Researching Brown & Root's history, via past proposals and brochures, I selected those projects which were the most unusual, the largest, or the best of their kind and then described them in paragraph form as an exhibit for those proposals which request innovative designs. While involved with Brown & Root's work experience, I began gathering all of the past proposal exhibits from other department proposals that dealt with work experience. These exhibits I combined and augmented with additional information such that the end result was a series of work experience exhibits in a standard tabular form that listed almost all of Brown & Root's past work experience both by industry and geographical area. Thus, when a proposal was being sent to a prospective client, a work experience exhibit could be included which listed past experience related to that industry and/or its geographical area.

An example of the type input I made to a project proposal was the research I did for the proposal to Clayton Import-Export, Inc., of the Republic of Ghana, who was considering the manufacture of pistons and piston rings. I contacted several vendors and requested information, which I received.

To support and expand this information, I referenced many technical articles and examined microfiche cassettes. The result was a very preliminary process flow sheet which was insufficient to present to a client as a proposed process but which gave a general, knowledgeable basis.

Outside of writing skills and a general engineering background, little educational skill was required for the qualification proposal exhibits. The project proposal inputs, however, required a familiarity with manufacturing methods and a knowledge of industrial process designs. Besides the increase in my knowledge concerning Brown & Root's past, this assignment broadened my knowledge of manufacturing processes and introduced me to many manufacturing industries that were new to me. Also, this task was my first to involve the use of vendors to any extent. As could be expected, the supervision was constant when a deadline was close and the task was in need, and it was not so strong when the need for the exhibit was not critical.

ASSIGNMENT RESULTS

For the qualification proposals, I produced a series of exhibits that present a large amount of information concerning Brown & Root's capabilities in a very succinct, systematic manner. For project proposals, I obtained technical information concerning a number of manufacturing processes new to the MAPI Department. This information included equipment selection, materials, and process flow sheets. Whenever possible, I attempted to represent the information in more

than one manner so that it could be used in different situations depending on the need. For instance, the work experience exhibits were organized both by industry and geographical area. The exhibits I prepared were placed with other proposal exhibits in the proposal files and can be used for future proposals. Since I have progressed to other assignments and since the tasks were of a fashion not to be changed, little or no follow up will be required of me.

POST-TASK ANALYSIS

The exhibits I developed were not new material, but old material adapted to the needs of the MAPI Department. They may not have been very critical to the message communicated by the proposal in which they were used, but they were required sections of the proposal, without which the prospective client would not have accepted the proposal. For me, the task increased my familiarity with a number of manufacturing processes and broadened my knowledge concerning Brown & Root's past endeavors, but my time might possibly have been better spent on an engineering project, had such a project been available.

In every effort, I produced information that was helpful and in many cases more so than was necessary. My lack of knowledge concerning many industrial processes in combination with the shortness of time available limited my effectiveness in preparing descriptions of some processes. The procedure I used to obtain project proposal information was quick and effective, but in many cases my results still lacked

enough detail to be of great use. Concerning qualification proposals, the representation of the information obtained was done in a uniform, systematic manner, but the method of gathering that information required a lot of unnecessary duplication. I could have produced exhibits not quite as complete, but just as informative, if I had known to examine fewer records and past exhibits. I had almost no assistance, and the supervision was more in an expediting fashion, but considering the nature of the task, little more was necessary.

SUMMARY COMMENTS

The value of this assignment to my internship lies in two facts. First, it gave me an opportunity to apply my engineering abilities to manufacturing methods and industrial processes. Second, it involved me in an organizational approach to proposals which resulted in a functional system that relieved many of the problems related to proposal preparation. The proposal system is within the fifteenth primary activity of industrial engineering as described in the Introduction to include office systems, procedures, and policies, and my inputs to the project proposals were also within the first, second, and third activities which concern the design and selection of processes, equipment, and facilities.

A shortcoming in my background was that due to the general nature of my engineering education and my limited experience, I was not familiar with many specific processes. To prevent this shortcoming in future engineering graduates, I recommend a course that examined the manufacturing industry

from a specific process point of view. A shortcoming in industry's approach to the assignment was that in most of the proposal requirements, nothing was done until it was absolutely necessary and then the task was rushed to an extent that the production of truly professional exhibits was hampered.

APPENDIX III

QUALIFICATION PROPOSALS

Outline and Table of Contents

		Dividers
I.	Title Sheet (1 page) (Special centering if standard window cover used)	None
II.	LETTER OF TRANSMITTAL (1-2 pages)	Brown 4-cut tab Pos 1
III.	TABLE OF CONTENTS (1-2 pages)	Brown 4-cut tab Pos 2
IV.	INTRODUCTION (1 page)	Brown 4-cut tab Pos 3
*V.	QUALIFICATIONS (1 page intro)	Brown 4-cut tab Pos 4
*A.	CORPORATE HISTORY (2 pages)	Yellow 4-cut tab Pos 1
*B.	VOLUME OF BUSINESS (1 page)	Yellow 4-cut tab Pos 2
*C.	NUMBER OF EMPLOYEES (1 page)	Yellow 4-cut tab Pos 3
*D.	CONSTRUCTION EQUIPMENT (1 page)	Yellow 4-cut tab Pos 4
*VI.	CONSOLIDATED BALANCE SHEET (1 page)	Brown 4-cut tab Pos 1
*VII.	OFFICERS AND DIRECTORS (2 pages)	Brown 4-cut tab Pos 2
*VIII.	PARENT, AFFILIATED, SUBSIDIARY COMPANIES (3 pages)	Brown 4-cut tab Pos 3
*IX.	ENGINEERING OFFICERS, DEPARTMENT HEADS (2 pages)	Brown 4-cut tab Pos 4
*X.	ENGINEERING BRANCH OFFICES (1 page)	Brown 4-cut tab Pos 1
*XI.	ENGINEERING METHODOLOGY (3 pages)	Brown 4-cut tab Pos 2
*XII.	PROCUREMENT (1 page)	Brown 4-cut tab Pos 3
*XIII.	BROWN & ROOT EXPERIENCE (3 pages)	Brown 4-cut tab Pos 4
*XIV.	EXHIBITS (varies)	Brown 4-cut tab Pos 1
*XV.	ENGINEER/ARCHITECT QUESTIONNAIRES (see note) (Use only when required)	Brown 4-cut tab Pos 2

Note: USGSA Form 254 - 4 pages
USGSA Form 255 - 11 pages
USAID Form
ADB Form
XIMB Form

PROJECT PROPOSALS

Outline and Table of Contents

	Dividers
I. Title Sheet (1 page) (Special centering if standard window cover used)	None
II. LETTER OF TRANSMITTAL (1-2 pages)	Brown 4-cut tab Pos 1
III. TABLE OF CONTENTS (1-2 pages)	Brown 4-cut tab Pos 2
IV. INTRODUCTION (1 page)	Brown 4-cut tab Pos 3
V. PROJECT SPECIFICS (at least 1 page intro)	Brown 4-cut tab Pos 4
A. SCOPE OF WORK (varies)	Yellow 4-cut tab Pos 1
B. PRIORITIES (varies)	Yellow 4-cut tab Pos 2
C. PLAN OF EXECUTION (varies)	Yellow 4-cut tab Pos 3
D. PROJECT ORGANIZATION (varies)	Yellow 4-cut tab Pos 4
E. MANNING/STAFFING (varies)	Yellow 4-cut tab Pos 1
F. SCHEDULES (varies)	Yellow 4-cut tab Pos 2
G. COST ESTIMATES (varies)	Yellow 4-cut tab Pos 3
H. REIMBURSEMENT (varies)	Yellow 4-cut tab Pos 4
VI. EXHIBITS	Brown 4-cut tab Pos 1

COMBINATION PROPOSALS

Outline and Table of Contents

		Dividers
I.	Title Sheet (1 page) (Special centering if standard window cover used)	None
II.	LETTER OF TRANSMITTAL (1-2 pages)	Brown 4-cut tab Pos 1
III.	TABLE OF CONTENTS (1-3 pages)	Brown 4-cut tab Pos 2
IV.	INTRODUCTION (1 page)	Brown 4-cut tab Pos 3
V.	PROJECT SPECIFICS (at least 1 page intro)	Brown 4-cut tab Pos 4
	A. SCOPE OF WORK (varies)	Yellow 4-cut tab Pos 1
	B. PRIORITIES (varies)	Yellow 4-cut tab Pos 2
	C. PLAN OF EXECUTION (varies)	Yellow 4-cut tab Pos 3
	* D. PROJECT ORGANIZATION (varies)	Yellow 4-cut tab Pos 4
	E. MANNING/STAFFING (varies)	Yellow 4-cut tab Pos 1
	F. SCHEDULES (varies)	Yellow 4-cut tab Pos 2
	G. COST ESTIMATES (varies)	Yellow 4-cut tab Pos 3
	H. REIMBURSEMENT (varies)	Yellow 4-cut tab Pos 4
*VI.	QUALIFICATIONS (1 page intro)	Brown 4-cut tab Pos 4
	*A. CORPORATE HISTORY (2 pages)	Yellow 4-cut tab Pos 1
	*B. VOLUME OF BUSINESS (1 page)	Yellow 4-cut tab Pos 2
	*C. NUMBER OF EMPLOYEES (1 page)	Yellow 4-cut tab Pos 3
	*D. CONSTRUCTION EQUIPMENT (1 page)	Yellow 4-cut tab Pos 4
*VII.	CONSOLIDATED BALANCE SHEET (1 page)	Brown 4-cut tab Pos 1
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Note: *USGSA Form 254-4 pages
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BROWN & ROOT, INC.

INNOVATIVE DESIGN

Brown & Root, Inc., recognized long ago that sustained growth in size and capabilities could never be attained by doing only those things being done by all others. As a result, a large proportion of the Company's work is always concerned with projects which require extending technology a little beyond present borders. The logic in this philosophy of business is that each pioneering effort adds new skills to the organization's capabilities inventory, enabling further advances and additional business.

Ever since those first pre-World War I roadbuilding contracts, Brown & Root, has been the trail blazer in highway construction. It was Brown & Root that pioneered in the development of labor and money saving mechanized equipment; and even though Brown & Root is eminently qualified to build the most modern urban expressway, the Company will not balk from the most treacherous terrain. For more than 4000 years, the Darien Gap, a 480 kilometer reach of pestilence-rodden swamp, prevented land communication between North and South America. In 1965, Brown & Root located and designed a feasible highway routing through the heretofore inpenetrable swampy jungle.

Related to the roadbuilding industry, Brown & Root has amassed a vast storehouse of bridge construction experience. The nature of most major bridge

projects requires ingenious construction techniques including the conception, design, and development of numerous pieces of special construction equipment. Brown & Root has a background of experience in developing these new methods and equipment for the largest and most difficult bridge construction projects. Examples are the 24.5 mile Lake Pontchartrain causeway, the world's longest highway bridge, and the I-610 East high bridge the largest strutted girder bridge in the United States. The precasting and post-tensioning methods developed by Brown & Root for construction have become standard for the construction of the elevated portions of the federal highway system.

The Brown & Root tradition of building the largest and best and of introducing innovative techniques extends also into dam and tunnel construction. The inundation method of cooling concrete aggregate for placing the concrete at a specified temperature from 10° to 18.3°C (50° to 65°F) was first introduced during construction of the Bull Shoals Dam in Arkansas, then the seventh largest massive concrete dam in the United States. The largest massive buttress dam in the Western Hemisphere, the Peligre Dam, was built by Brown & Root in Haiti, as part of the Artibonite River Irrigation Project. Brown & Root once again revealed its tenacity, when as part of the Fena River Dam, a twelve foot (12') diameter tunnel was excavated 1500 feet through solid basalt rock. In another tunneling project, Brown & Root took over construction of the Harold D. Roberts Tunnel in Colorado, after others had tried and failed, and blasted and hauled out over 1,000,000 cubic yards of material from the 23.3 mile tunnel.

Because it is one of the oldest construction activities, it would seem that nothing innovative could be expected in the earthmoving field. It would appear that any contractor using modern equipment would attain almost the same

production, yet Brown & Root continues to set new records in this field. Some small portion of these gains can be attributed to design modifications in standard equipment; but the bulk of this gain is due to better management of resources. Better planning, better maintenance, and the ability to marshal and control very large task forces have been the keys to more yardage at less cost.

The offshore operations of the oil and gas companies, from the first tentative steps off dry land to the present probings of the abyssal ocean depths, is one long record of continuous innovation by Brown & Root. Back in the 1930's Brown & Root pioneered in the construction of single-well drilling platforms at 20 to 30 foot depths on the margins of the Gulf of Mexico. In the mid 1970's Brown & Root designed and constructed the world record multi-well platforms in the 400 foot plus depths in the North Sea. The Brown & Root designs are now standard for use throughout the world, but competitors always are following behind in shallower water.

Offshore production of oil and gas required pipelines for movement of products to shore, so it was only natural that Brown & Root pioneer in this industry as well. The first crude pipelay barges were a far cry from the present ocean-going vessels, but the continuous stalking and welding methods which Brown & Root developed have not yet been bettered. The Brown & Root firsts in this field are so numerous that it is best to just list a sample:

1. A lay barge with a ramp for sliding the pipe into the water, replacing the earlier flotation process in pipelaying.

2. A patented jet suction system for burying underwater pipelines.
3. Tension measuring devices to assure the pipe reaches bottom in a straight condition.
4. A lay barge equipped with a flotation device called a "stinger" to keep pipe from buckling as it is lowered from the lay barge to the ocean bottom.
5. An electronic survey system to provide accurate monitoring of position.
6. The first pipelines laid in the North Sea.
7. The first large diameter pipelines laid in more than 400 feet of water.
8. The world's first three 48-inch diameter underwater pipelines.

Brown & Root is again in the fore of this industry, designing for 1000 feet depths.

In a related area, Brown & Root pioneered in the design and construction of the "fast ports." Utilizing standard modular components, many configurations of jetties, piers, and trestles can be very rapidly fabricated and installed by offshore construction equipment. This method is particularly well suited to the development of parts in undeveloped and remote locations and was used on Gulf Oil Company's Asia Trans-Shipment Terminal in Okinawa, which stands as a prototype for sea island superterminals.

Not all innovative design is as spectacular as those in the marine field, but it is interesting to note how often diverse industries come to Brown & Root requesting the unusual or the exceedingly large. One significant project in the metal forming industry was the construction of the 20,000 ton multiple ram forging press, the largest such device in private industry, installed at Cameron Iron Works in Houston. In the area of chemical plants, many new and different mechanical designs and equipment applications were developed for the construction of a Lubrizol Corporation plant, one of the few plants in the South producing oil additives. One instance in the petroleum refinery field which stands out is the dismantling at Destrahan, Louisiana, of a complete catalytic cracking unit with all accessories including boilers, storage spheres, towers, and piping, and its re-erection at the Signal Oil Refinery in Houston.

The "can do" attitude of Brown & Root engineers and constructors toward any project, no matter how difficult or unprecedented, enables Brown & Root to act as a magnet, attracting new and untried ideas, and then implementing them to solve a real-world problem. Pioneering in the pulp and paper industry, Brown & Root designed and developed processes for paper mills using sugar cane bagasse as the primary fiber source. They also designed the first commercial application in the United States of the "dynamic" bleaching principle in a bleached pulp mill expansion. Another first in the United States is the special flash furnace used in the Phelps Dodge copper smelter complex, designed for an annual production rate of 100,000 tons of copper anodes.

The present energy "crunch" has motivated several Clients to commission Brown & Root to design for systems and facilities not currently economic, but which soon will be if present energy cost trends continue. All of these are

proprietary to the commissioning Client and cannot be divulged. It is permissible to say that some are concerned with development of energy sources, some are addressed to better distribution methods, and many more are concerned with maximum utilization of energy available to a specific project. Because of competitive positions, energy utilization innovations are covert but very real, and Brown & Root is heavily involved.

Another innovative first in the public sector involved Project Mohole for the National Science Foundation. Brown & Root designed systems and equipment which would hold a vessel directly over a bore hole on the sea floor 15,000 feet below for a period of more than 2 years. These systems required operation of a string of drill tools more than 30,000 feet in length in order to bore a test hole through the outer crust of the earth's surface. It was necessary that these drill tool strings could be removed from the hole for repair, exchange of cutting bits, or whatever other purpose; and, without fail, re-enter the bore hole irrespective of weather or conditions of the sea. More than 100 patent applications in the name of the United States Government emanated from this effort. Many of today's operations in deep waters and rough seas had their inception with this pioneering research and development.

Brown & Root's many diverse areas of experience support an aggregate of skills that is difficult to better. This experience is a large reservoir from which the varied resources for the design and construction of infrastructures can be drawn. For the Fena River Dam project, semipermanent facilities were built to house 7,000 construction men. Permanent housing was built for several thousand personnel, including family units as well as barracks and all utilities, roads, and service facilities. For the Artibonite River Irrigation project, Brown & Root

designed and constructed shops, roads, a boiler plant, a power generation plant, service facilities, and a townsite for the officials and management personnel. The Es Sider Community in Libya, in association with the operation of a pipeline and oil terminal, is a Brown & Root planned community of over 3,000 persons and contained residential, recreational, and service areas including an airport, utilities, schools, a hospital, and other services. The above jobs were completed with electric power, sanitary sewers or septic tanks, a potable water supply, landscaping, and all-weather roads. The design of the units varied according to climatic conditions and reflected the architectural heritage of the area. The above infrastructures also reflect Brown & Root's innovative approach to design and construction which always considers the total rather than merely a portion.

In one sense, innovative means unusal, and in this context Brown & Root has completed a number of projects which demonstrate a willingness and competence to be different. The following is a list of four examples in four different fields:

1. A machine to produce commercial fiber from a tropical weed.
2. A plant to rear and sterilize 300 million flies per week.
3. A plant to automatically condition steel pipe and to continuously extrude thereon a flexible weight coating for sizes up to 91.5 cm (36") diameter.
4. A manufacturing plant designed "on the round" to minimize logistical problems.

Another unusual task which required a concerted effort by almost all of Brown & Root's facilities was the planning, construction, and operation of the Manned Space Craft Center near Houston. Included in the plan were all of the facilities for development of manned space craft, the training of astronauts, and

all of the sophisticated computerized equipment for directing the manned flights. Following construction, Brown & Root assembled a highly skilled and highly diversified team of scientists, engineers, and technicians to operate and maintain, 1) the thermochemical test area, 2), the space environmental simulation laboratory, 3) the crew systems laboratory, 4) the experimental mechanics laboratory, and 5) the lunar receiving laboratory. Brown & Root performed highly sophisticated engineering and scientific tests and was intimately involved in the programs that allowed NASA to send man to the moon and return him safely to earth. The Company also played a very important role in the rescue of the Apollo 13 crew. A large amount of the highly sophisticated space technology know-how was retained as a Brown & Root resource when the Company withdrew from the Manned Space Craft Center operations in 1972, at the end of one of the most innovative projects in the history of engineering.

By the nature of the engineering-construction business, Brown & Root is forced to perform the new and unusual almost daily. The success that Brown & Root has acquired and the diversity of projects that have contributed to that success are vivid evidence of Brown & Root's skills for deriving innovative solutions to both old and new problems. From the depths of the ocean to the surface of the moon, Brown & Root continues to expand the borders of technology beyond its present limits.

BROWN & ROOT, INC.
WORK EXPERIENCE CATEGORIES

INTERNATIONAL EXPERIENCE

- Africa
- Asia
- Australia
- Canada
- Caribbean
- Mexico & Central America
- Middle East
- Northern Europe
- South America
- Southern Europe

HEAVY CIVIL

- Airports and Railroads
- Dams and Tunnels
- Highways, Roads and Bridges
- Waste and Sewage Systems
- Water Supply Systems

MANUFACTURING AND PROCESSING INDUSTRIES

- Atmospheric Pollution Abatement
- Manufacturing and Processing Industries
- Water and Noise Abatement and Control

MARINE

- Harbor and Marine Facilities
- Offshore Platforms
- Onshore Pipelines

MARINE (Continued)

- Pipeline Compressor Stations
- Slug Catchers
- Submarine and Marsh Pipelines

MINING AND METALS

OIL AND GAS PRODUCTION

- LPG and LNG Services
- Oil & Gas Production Facilities

PETROLEUM AND CHEMICAL

- Chemical Plants
- Gas Compression Installations
- Light Hydrocarbon
- Refineries
- Sour Gas - Liquid Treating

POWER AND UTILITY SYSTEMS

PULP, PAPER AND FOREST PRODUCTS

SITE SELECTION AND INFRASTRUCTURES

- Site Selection and Analysis
- Townsites, Infrastructures and Community Projects

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- Africa
- Asia
- Australia
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- Caribbean
- Mexico & Central America
- Middle East
- Northern Europe
- South America
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MINING AND METALS

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- Light Hydrocarbon
- Refineries
- Sour Gas - Liquid Treating

POWER AND UTILITY SYSTEMS

PULP, PAPER AND FOREST PRODUCTS

SITE SELECTION AND INFRASTRUCTURES

- Site Selection and Analysis
- Townsites, Infrastructures and Community Projects

MANUFACTURING & PROCESSING INDUSTRIES

ENGINEERING DEPARTMENT

Sheet 1 of 4

CLIENT Ghana Piston Proposal

SUBJECT Manufacture of Pistons and Piston Rings

PREPARED BY: R. J. Gannaway

Proposal Scope:

Piston Rings for	1) All Autos
	2) Heavy Trucks
	3) Marine to 20" bore
Aluminum and CJ Pistons for	1) All Autos
	2) All size diesels
	3) A/C and refrigerator compressors
General	Batch Operation Open in Terms of Size Open Production Output Materials and Construction Open

Reference: Johns of California (213) 225-8177 and Emerson Article

Piston Manufacturing Process

Die Cast (Semipermanent mold-sand inside, metal outside)
--some forged

Heat Treated

Automatic chucking lathes turn, face, and cut ring grooves in the castings

Transfer machines drill oil and smoke and locating holes; rough-machine wrist-pin holes. Have auxiliary equipment for repair work.

Feed through a washer that removes chips and oil.

To weight-mills that automatically mill away the required amount of excess metal to reduce the piston's weight to the established standard weight.

Weight milling machines now have sufficient versatility to accomodate a variety of piston sizes and types.

Manually operated Norton and automatic Landis skirt grinders finish the skirt contour.

Feed through automatic tin plating line.

Then to Ex-cell-o and Simplex Boring Machines that finish machine the wristpin holes.

Washed and sent to gaging rooms for inspection and classification.

Piston Plating (Vega Plant)

Aluminum alloy type F132 - 8.5 to 10.5% silicon; 83% aluminum.

4 metal coatings

1) Preparation for electroplating an immersion coating of zinc about .1μm (.00004 in.)
2) Protection from hard iron deposition A strike of copper about 2.5 μm (.0001 in)
3) Wear Resistance Deposition of hard iron 12 to 20 μm (.0005 to .0008 in)
4) Corrosion Protection Thin coating of tin about 2.5μm (.0001 in)

Automatic Plating Facility Process Steps (29 min. for entire process)

1) Pistons are cleaned in a mild alkaline; rinsed in water; immersed in a dilute phosphoric acid solution to neutralize any alkaline residue.

2) Deoxidized in solution of phosphoric acid, nitric acid, and a fluoride salt to dissolve oxides and various alloying elements, particularly silicon.

3) Sincating-displacement of surface layer of aluminum with an immersion coating of zinc.

4) Striking in a low pH copper cyanide bath; acid dip in dilute hydrochloric acid; rinse.

Automatic Plating Facility Process Steps (Cont)

5) Plating hard iron from a ferrous chloride bath; acid dip in dilute hydrochloric acid; rinse.

6) Thin coating of tin from an alkaline stannate bath.

7) Rinsed in hot water to promote drying; dried; unracked. Rocks continue to separate line where previous deposits are stripped.

8) Test of adhesion - shot blast surface with small glass beads - poorly adherent deposits spall readily; are stripped and recycled.

   Satisfactorily adherent deposits do not; require only the tin to be replated.

Reference: Koppers Engineer's Handbook

Methods of Manufacturing:

1) Sand cast

2) Centrifugally cast

3) Pot cast

4) Sintered

Materials and Applications:

1) K-irons - cast grey irons
   - sand cast
   Used for compression rings and oil rings in internal combustion engines, steam engines, pumps, compressors.

2) XL and XLS - pot cast grey irons
   - sand cast in the form of cylinders or pots and subsequently machined into piston rings.

   Used for compression rings in compressors and heavy duty diesel, gas, and steam engines.

3) K-6E - alloyed grey iron
   - individually cast and heat treated
   Used for compression rings and oil rings in internal combustion engines in moderately high temperature service (600°-900° F) such as turbachargers and die casting machines - also base material for chromium plating.

Materials and Applications (Cont)

4) K-14 - heat treated alloyed grey iron
   - statistically cast in sand molds and then given a hardening and tempering treatment
   - Used both chromium plated and unplated for piston rings in heavy duty internal combustion engines

5) K-8 and K-53 - centrifugally cast grey irons used for piston inserts and cylinder liners

6) K-Spun and F-88 - high strength irons - centrifugally cast in the form of cylinders, heat treated and machined into piston rings

   Used for compression rings in high output internal combustion engines

Piston Ring Manufacturing Process

If cast in cylinders
- -cast in free diameter position
- -heat treated to build tension or hammered if necessary for special type
- -individual rings cut out along with gap, grooves, and whatever is required

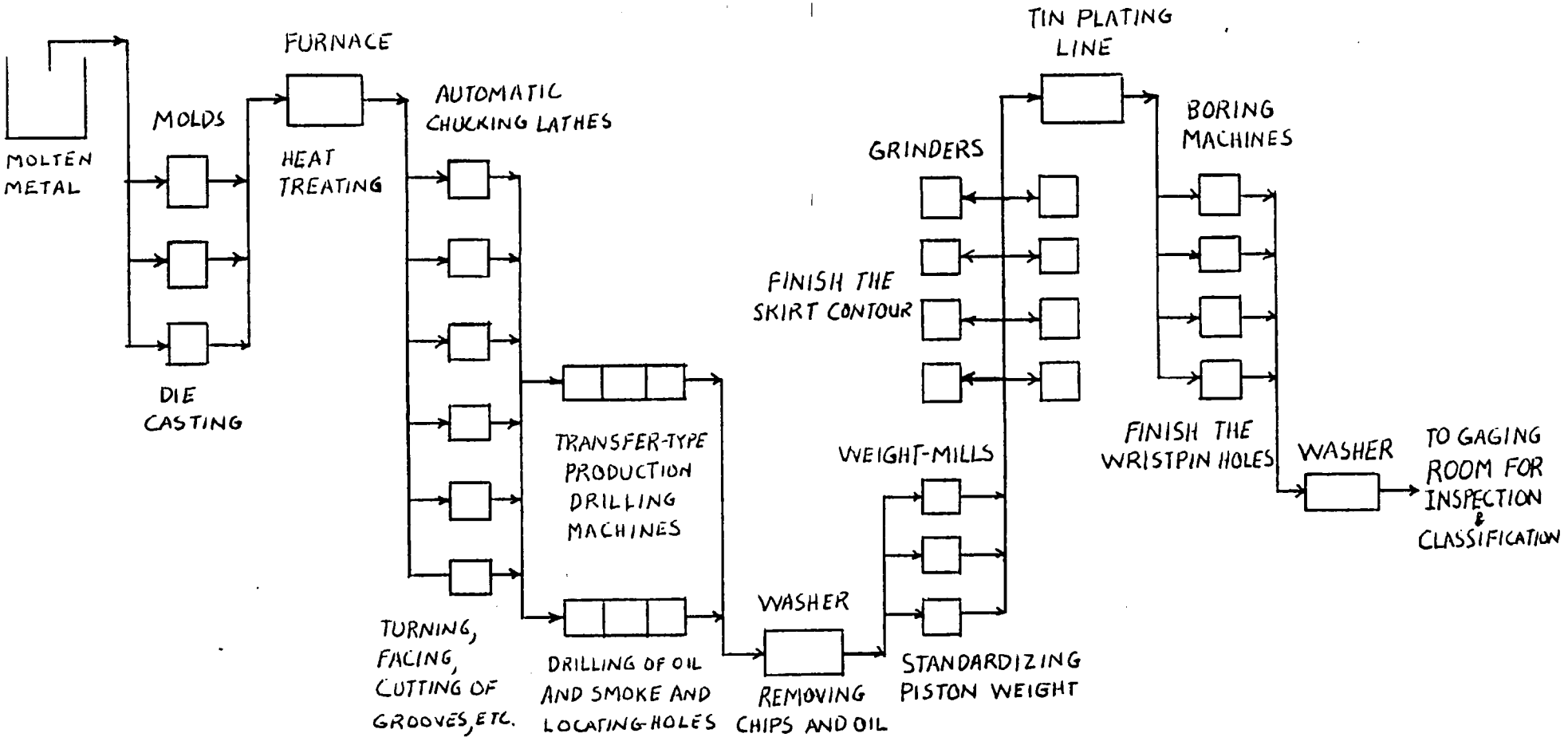
If individually cast
- -tension is built in

Cam Turning - turned down to proper size

There is an average of 15-18 machining operations to grind, cut grooves, turn down, etc.

Then plating if necessary

PISTON MANUFACTURING PROCESS



VENTURE PLANNING SYSTEM

TASK SPECIFICS

In October of 1976, Mr. Keith Sandefer assigned me to develop a venture planning system. Several years earlier, the Solids Processing Department had developed a Brown & Root Engineering Economy Manual that contained a method for mathematically modeling any project or venture and predicting profitability under any conditions. Venture planning involves economic evaluation and site selection, and this manual and site selection information could form the basis of a venture planning system.

The task entailed reviewing the Engineering Economy Manual and updating and modernizing its chapters that dealt with the various aspects of engineering economy. Of special interest were the changes in the tax laws that had occurred since the last revision. Others working with me were to write and request site selection information from state agencies and utility groups across the nation and to establish a site selection file with the information obtained. The objectives of this assignment were:

1. To update and modernize the Engineering Economy Manual.
2. To investigate engineering economy techniques.
3. To aid when necessary in systematizing site selection information.

TASK PLANNING

I was given the previous draft of the manual which already contained a few suggested modifications to be investigated, and then I began a review of the methods of engineering economy and their usefulness. I also researched the most recent articles concerning site selection. Given three weeks to complete the task, I planned to read the manual, identify its shortcomings, and change, or add where necessary. I would examine the economic evaluation methods that were not included in the manual and suggest their inclusion or exclusion. As for site selection, I would contribute whatever site selection information I found.

TASK PERFORMANCE

Following my original plan, I examined each of the fifteen chapters in detail for its completeness and correctness in covering its subject which ranged from planning and estimating to the Brown & Root economic evaluation method. I made correction or inputs to almost every chapter, and then I reworded the manual and put it in a final presentable form. As for the resulting economic model, I worked my way through the model to assure that it was correct, fluent and useful. The result was an economic evaluation model that considers every facility or operation which costs or makes money and that handles functions which vary with time at that point in time when the variations are predicted. The end results of the model can be expressed in indices such as payout, capital

recovery, profitability index, return on book value, return on investment, and net present worth.

One economic evaluation technique I studied was the MAPI (Machine and Allied Products Institute, not Manufacturing and Processing Industries) method. It promised to be a quick technique for evaluating the economic feasibility of an investment, but upon study, it proved to have two significant shortcomings. First, the method ignored the time value of money, and second, it did not consider future revenues after the first year. It also depended on a number of figures that were not constant, such as the percentage borrowed capital and the interest rate. Its advantage rested in the fact that it eliminated the need for estimating future year values by projecting future benefits, based on the first year. After careful analysis, however, I discarded it as a viable approach to quick investment return calculations.

To the site selection files, I contributed a number of articles that included in depth checklists for site selection projects. General site selection literature included site selection procedures, directories to location assistance, site considerations, and general rules and regulations. Files were set up for all fifty states and Canada's ten provinces. The file contained site information, as well as a map file containing individual maps.

This task required the use of my training in engineering economy, without which I would have been lost. I also used site selection skill I had acquired from my plant layout

education. From this assignment, I became familiar with a few new economic evaluation techniques, including the Brown & Root method which is a very sound technique, and I used my programming talents to code a few of the economic evaluation techniques for the HP-25 and HP-65 calculators. I also benefited from several meetings with my supervisor in which we discussed the merits and shortcomings of the various economic evaluation methods.

ASSIGNMENT RESULTS

The Engineering Economy Manual was updated and prepared in a consistent, fluent fashion. Each chapter dealt with a different subject concerning engineering economy and was brought up to the state of the art. I studied and analyzed a number of techniques for their usefulness. A site selection file was established that contained information very beneficial to site selection projects. I required the three weeks to complete the task after which the Engineering Economy Manual was prepared for distribution to those in a position to find it useful. Due to its volume, only the index could be exhibited in this report. The site selection files were placed in the Department file room for reference as required. The Engineering Economy Manual requires periodic updating due to the ever changing tax laws, but whether or not I will be involved in the revision depends on my other tasks. The clerks who maintain the filing systems are responsible for periodically updating the site selection files with new information.

POST-TASK ANALYSIS

The Engineering Economy Manual is a useful manual both as a reference and as a tool. It can be used as part of a venture planning system to analyze the economies of a proposed venture. Its preparation made the task worthwhile. The site selection information gathered was surprisingly detailed and informative, and the resulting system could be very helpful should a site selection project arise. It can be used as part of a venture planning system concerning site related factors. The task followed the original plan of execution, and the result was an effective venture planning system. The supervision and assistance given me on this assignment were excellent. Several meetings were held to discuss the various methods in question, and my supervisor supplied much industry oriented insight.

SUMMARY COMMENTS

This assignment was valuable to my internship, because it supplied me an opportunity to use my engineering talents to develop a system that aids the MAPI Department. Not only is the venture planning system useful, it also blends well into the organizational approach of the MAPI Department toward economics. The venture planning system is within the seventeenth primary activity of industrial engineering as described in the Introduction and which could be summarized as venture planning, and it is also within the thirteenth activity because of the Engineering Economy Manual's relation to mathematical analyses, modeling and decision theory.

Having been trained both in engineering economy methods and in some of the aspects of site selection, I was well-equipped for this assignment. Also beneficial to the task was the very methodical and professional approach taken by the MAPI Department. The only drawback to the engineering economy model developed is that it is all manual. A computer program implementation would be very useful. However, a previous attempt at programming the model proved fruitless because of the complexity of the decision making process. The number of possible paths through the system is very large due to the many possible decisions that can be made at each stage, and which of the paths will be taken is unknown until reaching the decision point. If I become involved in the economy model again, I will look at the computer programming problem.

APPENDIX IV

ENGINEERING ECONOMICS ANALYSIS MANUAL

INDEX

	ITEM	SOURCE	END OF OPERATING YEAR NUMBER									
1	OPERATING MARGIN	SCHEDULE XVII										
2	LESS DEPRECIATION	SCHEDULE XVIII										
3	SUBTOTAL	LINE 1 – LINE 2										
4	LESS INTEREST	LINE 20										
5	GROSS PROFITS	LINE 3 – LINE 4										
6	LESS STATE, LOCAL INCOME TAX	SCHEDULE XX										
7	ADJUSTED GROSS PROFITS	LINE 5 – LINE 6										
8	LESS DEPLETION ALLOWANCE	SCHEDULE XIX										
9	TAXABLE INCOME	LINE 7 – LINE 8										
10	LESS LOSS CARRYOVER	LINE 7 (PREVIOUS)										
11	ADJUSTED TAX BASE	LINE 9 – LINE 10										
12	COMPUTED FED. INCOME TAX	SCHEDULE XX										
13	LESS INVESTMENT CREDIT	SCHEDULE XVIII										
14	TAXES DUE	LINE 12 – LINE 13										
15	NET PROFIT	LINE 7 – LINE 14										
16	ADD DEPRECIATION	LINE 2										
17	ADD INTEREST	LINE 20										
18	AVAILABLE FOR DEBT SERVICE	LINES 15, 16, 17										
19	PRINCIPAL DEBT	SCHEDULE IV										
20	ACCRUED INTEREST	____% OF LINE 19										
21	TOTAL INDEBTEDNESS	LINE 19 + LINE 20										
22	PAYMENT AGAINST DEBT	LINE 18 – LINE 23										
23	~~ACCUMULATED~~ CASH RESERVE	____% OF LINE 18										
24	Accumulated Reserves.	—										

NOTES

REVISIONS	BY	DATE

BROWN & ROOT Inc. HOUSTON, TEXAS

SCHED. XXI PREDICTED CASH FLOWS TO PAYOUT

PLANT ..... LOCATION .....

CAL'D BY _____ CHECKED _____ APPROVED _____ DATE _____

JOB No.

CLIENT

SHT _____ OF _____

BM 8-66

MAPI URGENCY RATING
HP-65 PROGRAM

Line	Code	Key Entry	Comments
01	23	LBL	
02	11	A	
03	34 01	RCL1	Retrieve Net Cost
04	34 02	RCL2	Subtract Old Facility Disposal Value
05	51	-	
06	34 03	RCL3	Subtract Value of Avoided Investment
07	51	-	
08	33 01	STØ1	Net Investment Required
09	34 04	RCL4	Next Year Cost Advantage
10	34 05	RCL5	Decline of Disposal Value
11	33	STØ	
12	61	+	
13	04	4	
14	34 03	RCL3	Avoided Investment
15	34 06	RCL6	Life Extension
16	81	÷	Next Year Allocation
17	33	STØ	
18	61	+	
19	04	4	
20	61	+	Sum Next Year Advantage with
21	61	+	Avoided Consumption
22	33 02	STØ2	
23	14	D	
24	34 02	RCL2	
25	35 07	gx⇄y	
26	51	-	
27	33 03	STØ3	Before Tax Numerator
28	34 01	RCL1	
29	81	÷	
30	84	R/S	Before Tax MAPI Urgency Rating
31	34 02	RCL2	Income Tax Increase Due to Advantage
32	34 04	RCL4	and Cost Depreciation
33	71	X	
34	34 01	RCLL	Income Tax Decrease Due to Interest
35	34 05	RCL5	on Borrowed Capital
36	71	X	
37	34 06	RCL6	
38	71	X	
39	34 02	RCL2	
40	71	X	
41	51	-	
42	33 06	STØ6	
43	14	D	Income Tax Decrease Due to New
44	34 02	RCL2	Depreciation
45	71	X	
46	34 06	RCL6	
47	35 07	gx⇄y	
48	51	-	
49	42	CHS	
50	34 03	RCL3	

Line	Code	Key Entry	Comments
51	61	+	
52	34 01	RCL1	
53	81	÷	
54	84	R/S	After Tax MAPI Urgency Rating
55	23	LBL	
56	12	B	Straight Line Depreciation
57	34 08	RCL8	
58	35	g	
59	04	1/x	
60	22	GTØ	
61	01	1	
62	23	LBL	
63	13	C	Sum of Digits Depreciation
64	34 08	RCL8	
65	01	1	
66	61	+	
67	34 08	RCL8	
68	71	X	
69	83	.	
70	05	5	
71	71	X	
72	35	g	
73	04	1/x	
74	34 08	RCL8	
75	71	X	
76	22	GTØ	
77	01	1	
78	23	LBL	
79	14	D	Find Next Year Depreciation of
80	34 07	RCL7	New Facility by Straight Line or
81	34 07	RCL7	Sum of Digits Method Depending on Key
82	31	f	Input.
83	83	INT	
84	51	-	
85	83	.	
86	01	1	
87	35 23	gx=y	
88	22	GTØ	
89	12	B	
90	35 22	gx≤y	
91	22	GTØ	
92	13	C	
93	01	1	
94	23	LBL	
95	01	1	
96	34 07	RCL7	
97	31	f	
98	83	INT	
99	71	X	
100	24	RTN	

First Inputs	Units	Keys
Net Project Cost	$	ST01
Disposal Value of Assets Retired	$	ST02
Value of Avoided Investment	$	ST03
Next Year Operating Cost Advantage of New Facility Over Old	$	ST04
Next Year Decline of Disposal Value of Old Facility	$	ST05
Life Extension That Would Have Occured Under Avoided Investment (May not be zero)	Year (s)	ST06
Next Year Loss in Value of New Facility 2 Parts:		ST07
1) Dollar Amount	$	
2) Decimal Key	Dec.	
a) .0 use dollar amount		
b) .1 use st. line depreciation taking dollar amount as cost minus salvage value at end of depreciation period.		
c) .2 use sum of digits depreciation taking dollar amount as cost minus salvage value at end of depreciation period.		
Life of New Facility	Year(s)	ST08

First Output

Before Tax MAPI Urgency Rating	Dec.

Second Inputs

Income Tax Rate	Dec.	ST02
Percent Capital Borrowed	Dec.	ST05
Rate of Interest on Borrowed Capital	Dec.	ST06
Next Year Depreciaton for Tax Purposes of New Facility and Depreciation Key - 2 parts - same as above	$ Dec.	ST07

Second Output

After Tax MAPI Urgency Rating	Dec.

MAPI URGENCY RATING
HP-25 Program

Line	Code	Key Entry	Line	Code	Key Entry
00			25	24 03	RCL3
01	24 05	RCL5	26	24 04	RCL4
02	15 71	gx=0	27	61	X
03	13 46	GTØ46	28	24 00	RCL0
04	24 00	RCL0	29	24 05	RCL5
05	24 01	RCL1	30	61	X
06	41	-	31	24 06	RCL6
07	24 02	RCL2	32	61	X
08	41	-	33	24 04	RCL4
09	23 00	STØ0	34	61	X
10	24 03	RCL3	35	41	-
11	24 04	RCL4	36	24 07	RCL7
12	235103	STØ+3	37	24 04	RCL4
13	24 02	RCL2	38	61	X
14	24 05	RCL5	39	41	-
15	71	÷	40	32	CHS
16	23510	STØ+3	41	24 02	RCL2
17	51	+	42	51	+
18	51	+	43	24 00	RCL0
19	24 06	RCL6	44	71	÷
20	41	-	45	74	R/S After Tax Urgency Rating
21	23 02	STØ2	46	01	1
22	24 00	RCL0	47	23 05	STØ5
23	71	÷	48	13 04	GTØ4
24	74	R/S	49		

Before Tax MAPI Urgency Rating

First Inputs		Second Inputs	
Net Project Cost	STO 0	Income Tax Rate	STO 4
Disposal Value of Assets Retired	STO 1	Percent Capital Borrowed	STO 5
Value of Avoided Investment	STO 2	Rate of Interest on Borrowed Capital	STO 6
Next Year Operating Cost Advantage of New Facility Over Old	STO 3	Next Year Depreciation of New Facility	STO 7
Next Year Decline of Disposal Value of Old Facility	STO 4		
Life Extension That Would Have Occured Under Avoided Investment	STO 5		
Next Year Loss in Value of New Facility	STO 6		

CHECKLIST OF REIMBURSABLE JOB COST ITEMS

TASK SPECIFICS

In January of 1977, Mr, Keith Sandefer assigned me to develop a cost reimbursement checklist. Continuing with the MAPI Department's systematic approach to department activities, my supervisor desired a method that would give consistency to the Department's portion of negotiations with a prospective client prior to the signing of the contract. If the prospective client can see the basis for figures quoted him during negotiations, then weight is added to what the Department has said.

The task involved developing a checklist of reimbursable job cost items which specifies the rate(s) at which costs incurred by Brown & Root during the course of a project will be reimbursed by the client. I was also to consider a means of computing a factor which took into account a proposed project's location and labor situation and that represented the Construction Division's likelihood of accepting the project. The objectives of the assignment were:

1. To give consistency to the MAPI Department's input before and during contract negotiations.
2. To show the client for what he will be paying if he chooses Brown & Root for a project.
3. To aid the Department in the computation of pre-project estimates.

TASK PLANNING

To aid me in the assignment I was given a manual which described Brown & Root's cost classification system and expense reporting system. Along with the cost classification manual, I could use any sources that I could find to simplify the task. I was given three weeks to a month to complete the assignment. I began with the plan to derive a list of costs and their corresponding reimbursement from the Brown & Root cost classification system and expense reporting system. The plan required that I take each cost item which is individually reported in the accounting system and attempt to arrive at the proper reimbursement by tracing the cost through the expense accounting documents. Concerning the Construction-related factor, I planned to review the Construction Division's past projects for their distances from Houston, their dollar value, and the union activity in the area.

TASK PERFORMANCE

I had not proceeded far into the task before I developed the distinct feeling that I was reinventing the wheel. Realizing that, with my lack of Brown & Root experience and my unfamiliarity with the Brown & Root cost system, my first approach would have taken an excessive amount of time, I began searching to see if a similar effort had previously been performed. This search included talking with the Cost Engineering Department and examining past proposals by other industry departments. As a result of my investigation, I

I found three cost reimbursement lists being used by other departments. After analyzing the contents of the lists and the methods used for reimbursing costs, I chose one of the lists and after updating values cited and clarifying explanations included, proposed its use by the MAPI Department.

As for the Construction-related factor, I met with my supervisor and after a lengthy discussion discarded the factor, because it was too complex for the time available. The study would have necessitated the inclusion of too many variables in a distribution so complex that a large computer capability would probably have been required for storage and maintaining order. The expense of the research necessary, the computer programming, and the development time was thought to be too great to justify the development of the factor.

Throughout the assignment, my cost accounting and engineering economy education aided my understanding of the documents with which I was working. This formal academic training also helped me in my discussions with the cost engineers that also involved the contract negotiation process. The supervision given me took the form of engineering discussions to weigh the pros and cons of the various courses of action.

ASSIGNMENT RESULTS

The resulting checklist of reimbursable job cost items takes into account every item which has a cost. It categorizes each cost item by its classification and states whether or not the item is reimbursable or non-reimbursable. If the item is a reimbursable cost, the list specifies the percentage

markup over the cost that must also be reimbursed. By studying the list, a prospective client can readily see how he most probably will be reimbursing Brown & Root for its costs during the course of a project, and if the preliminary expected costs of the project are categorized to conform to the list, then a very preliminary estimate of the project cost can be achieved. However, neither the list nor any resulting estimate takes the place of a formal contract. Since the checklist can be used for all projects, consistency in arriving at the cost figures is achieved.

Since I based the checklist of reimbursable job cost items on one already in existence, I completed the task in two weeks. The checklist is more complete and contains much more detail than was originally thought possible, and following its acceptance by the MAPI Department, is being included, where appropriate, in project proposals. Occasional revisions will be required to update the percentages stated in the cost reimbursement checklist to assure that they represent Brown & Root's current costs.

POST-TASK ANALYSIS

The checklist of reimbursable job cost items is useful to the MAPI Department. It supplies Department personnel with cost information which they can be reasonably sure is as accurate as can be expected and which they can use in their negotiations with prospective clients. Any task which results in valid, useful information for the Department is worthwhile.

Initially, I fumbled through the Brown & Root cost classification system and was not very effective. My original plan was futile, and my initial efforts proved that to be the case, but the alternative plan that I followed resulted in a checklist of reimbursable job cost items that was both effective and efficient. My supervisor readily accepted my suggestions for simplifying the task and offered helpful suggestions of his own in our meetings which helped me in the competion of the assignment.

SUMMARY COMMENTS

The value of this task to my internship stems from my use of cost engineering principles to develop an information generating document that is useful to the MAPI Department. It involved an organizational, systematic approach to the problem involving costing of contracts. The assignment is within the fifth primary activity (cost analysis) of industrial engineering as described in the Introduction and also the eighth activity which concerns management information systems.

The only shortcoming of my background was my lack of familiarity with specific cost classification and expense reporting systems. A shortcoming of the approach taken by Brown & Root is that each department at Brown & Root has its own method of operations and develops its own systems. This mode of operation results in unnecessary duplication of effort between departments. I realize that Brown & Root is a large corporation, but I recommend that there be more

communication between departments to reduce duplication of effort in the development of systems helpful to obtaining and processing projects.

APPENDIX V

BROWN & ROOT, INC
MANUFACTURING AND PROCESSING INDUSTRIES
CHECKLIST OF REIMBURSABLE JOB COST ITEMS

Items check in Column 1 are nonreimbursable
Items checked in Column 2 are reimbursable at cost
Items checked in Column 3 are reimbursable at cost plus a handling charge of_____-- (10%; 2/10/77)
Items checked in Column 4 are reimbursable at cost plus an overhead charge of_____-- (80%; 2/10/77)
Items checked in Column 5 are reimbursable at cost plus an overhead charge of_____-- (35%; 2/10/77)

DESCRIPTION	1	2	3	4	5
I. HOME AND ESTABLISHED OFFICES					
A. GENERAL ADMINISTRATIVE COSTS					
1. Company officers directing the work	X				
2. Director of purchasing	X				
3. Corporate accounting and auditing staff	X				
4. Insurance manager	X				
5. Personnel manager	X				
6. Safety director	X				
7. General counsel and legal staff	X				
8. Sales manager and staff	X				
9. Data processing manager	X				
10. Employees engaging in general administrative work such as telephone operators, janitors, watchmen, clerks, and general stenographic and clerical services.	X				
11. Engineering department heads, when not directly engaged in the work.	X				

A. GENERAL ADMINISTRATIVE COST (Continued)

	DESCRIPTION	1	2	3	4	5
12.	Construction department manager, assistant managers, estimators, and schedulers when not directly engaged in the work.	X				
13.	Indirect payroll costs and benefits for personnel under Item I-A when not directly engaged in the work.	X				
14.	Rent, utilities, maintenance and equipment for presently established offices, including office supplies and stationery.	X				
15.	Travel and living expenses of personnel under Item I-A when occasioned by work in accordance with company policy.		X			

B. ENGINEERING, PROCUREMENT, AND CONSTRUCTION COSTS (Time worked basis)

1.	Project director, managers, and project engineers.				X	
2.	Process and mechanical engineers.				X	
3.	Engineering department heads.				X	
4.	Instrument and electrical engineers.				X	
5.	Structural and civil engineers.				X	
6.	Design supervisors, designers, draftsmen, and contract personnel.				X	
7.	Construction and engineering planners, coordinators, schedulers.				X	
8.	Purchasing agents.				X	

B. ENGINEERING, PROCUREMENT AND CONSTRUCTION COSTS (Time worked basis) (continued)

	DESCRIPTION	1	2	3	4	5
9.	Buyers.				X	
10.	Traffic controllers.				X	
11.	Expeditors and inspectors.				X	
12.	Home office specialist personnel when engaged in work whether performed in office or field.				X	
13.	All stenographic and clerical personnel.				X	
14.	Material control personnel.				X	
15.	Modeling					
	a) Labor				X	
	b) Materials			X		
16.	Estimators and cost control personnel.				X	
17.	Specialists as required, such as: architects, air conditioning engineers, and technicians, technical illustrators.				X	
18.	General accounting personnel.				X	
19.	Indirect payroll costs and benefits for personnel listed under Item I-B				X	
	To be charged at the fixed rate of_____ -(23.0%; 2/10/77) of the salary cost of items in I-B.*					
20.	Reproduction charged in accordance with current rates.		X			

* The fixed rate for indirect payroll costs and benefits is guaranteed for the project duration. It includes the following at current rates: workmen's compensation, bodily injury, permanent disability; F.I.C.A.; Federal Unemployment; State Unemployment; retirement and savings; hospitalization and life insurance; vacation; long-term disability and accident insurance, and all other indirect labor costs not specifically provided for reimbursement elesewhere.

B. ENGINEERING, PROCUREMENT, AND CONSTRUCTION COSTS (Time worked basis) (continued)

DESCRIPTION	1	2	3	4	5
21. Postage, packaging, shipping, long distance telephone, telegraph and teletype charges.		X			
22. Special artwork and photographs, including time and materials, plus cost of printed forms, drafting paper or stationery required by and used for this particular project.		X			
23. Outside consulting, inspection or testing services and laboratory services as required, excepting that all billing from the Anaconda Company to be billed at cost.			X		
24. Purchased or subcontracted designs and drafting services performed in offices other than those of Brown & Root or Anaconda.			X		
25. Outside computer services.			X		
26. Computer service charges in accordance with current rates.		X			
27. Travel and living expenses of employees occasioned by the work in accordance with company policy.		X			
28. Process or other royalties and know-how fees paid by Brown & Root.		X			

II. JOBSITE OFFICES

A. JOBSITE OFFICES AND CONSTRUCTION STAFF EXPENSES

1. Salaried

a. Construction project manager, managers, project engineers. X

A. JOBSITE OFFICES AND CONSTRUCTION STAFF EXPENSES (Continued)

DESCRIPTION	1	2	3	4	5
b. Project, craft, and assistant superintendents.					X
c. Engineers, schedulers, and inspectors.					X
d. Accountants, buyers, timekeepers, and expeditors					X
e. Warehouse and safety					X
f. Medical personnel		X			
g. Specialists, as required.					X
2. HOURLY					
a. All other personnel as necessary including stenographic and clerical personnel.		X			
3. Indirect payroll costs and benefits for personnel identified under Column 5, item II-A-1; to be charged at the fixed rate of_____(26.0%; 2/10/77) of the salary cost.*					X
4. Indirect payroll costs and benefits for personnel identified under Column 2, Item II-A-2; to be charged at the fixed rate of_____(26.0%; 2/10/77) of the salary cost.*		X			
5. Office equipment, such as desks, chairs, typewriters, calculators, file cabinets, etc.		X			
6. Consumable office supplies such as stationery, printed forms, first aid supplies.		X			
7. Telephone, telegraph, postage, telex, and other communications expense.		X			

* The fixed rate for indirect payroll costs and benefits is guaranteed for the project duration. It includes the following at current rates: Workmen's compensation, bodily injury, permanent disability; FICA; Federal Unemployment; State Unemployment; retirement and savings; hospitalization and life insurance; vacation; long-term disability and accident insurance, and all other indirect labor costs not specifically provided for reimbursement elsewhere.

A. JOBSITE OFFICES AND CONSTRUCTION STAFF EXPENSES (Continued)

DESCRIPTION	1	2	3	4	5
8. Cost of blueprinting, photostating, duplicating, issurance of drawings, specifications, etc., including reproduction equipment and field engineering supplies.		X			
9. Travel, living expenses and subsistence expenses for jobsite office, and construction staff personnel all in accordance with Company policy.		X			
B. JOBSITE LABOR					
1. Salaries or wages of personnel (other than jobsite office and construction staff personnel) such as:		X			
a) General Foremen, foremen, and subforemen.					
b) Craftsmen and helpers.					
c) Laborers					
d) Warehouse and material handling employees					
e) Toolroom employees					
f) Watchmen and guards					
g) Rodmen and chainmen					
h) Other field personnel as required to perform the work					
2. Indirect payroll costs and benefits for personnel listed under Item II-B to be charged at the fixed rate of _____(26.0%; 2/10/77) of the salary cost.*		X			
3. Travel and transportation to and from jobsite.		X			
4. Cost of testing completed work and of remedying or adjusting defects.		X			

* The fixed rate for indirect payroll costs and benefits is guaranteed for the project duration. It includes the following at current rates: workmen's compensation, bodily injury, permanent disability; F.I.C.A.; Federal Unemployment; State Unemployment; retirement and savings; hospitalization and life insurance; vacation; long-term disability and accident insurance, and all other indirect labor costs not specifically provided for reimbursement elsewhere.

C. MATERIAL, SUBCONTRACTS, AND RELATED COSTS.

DESCRIPTION	1	2	3	4	5
1. All equipment, materials and subcontracts purchased.		X			
2. All sales, use, excise and other taxes for Item II-C-1, above.		X			
3. Transportation, demurrage, loading or unloading charges on Item II-C-1.		X			
4. All Risk Insurance (exclusive of insurance covering leased, hired or borrowed construction equipment and small tools).		X			
5. Premiums for construction equipment damage or other special insurance.		X			
6. Materials to replace, remedy or adjust defects.		X			
7. Welding supplies and miscellaneous materials.		X			
8. Cost for welding qualification, concrete or other special tests.		X			

D. CONSTRUCTION EQUIPMENT, TOOLS, AND CONSUMABLE SUPPLIES

1. Cost of preparing and loading out for shipment all construction equipment, and upon return of such equipment, the cost of unloading and storing.		X			
2. Transportation of construction equipment to and from jobsite.		X			
3. Rental of Brown & Root owned construction equipment at_____(80%; 2/10/77) of current AED rates.		X			

D. CONSTRUCTION EQUIPMENT, TOOLS, AND CONSUMABLE SUPPLIES (Continued)

	DESCRIPTION	1	2	3	4	5
4.	Third party equipment rental.		X			
5.	Construction equipment plus operating expense, including gas, oil and operating supplies		X			
6.	Cost of operation, maintenance and repair of construction equipment.		X			
7.	Unloading, handling and loading of construction equipment at jobsite.		X			
8.	Small tools.		X			
9.	Expendable construction and workmen's supplies.		X			

E. OTHER JOB COSTS

1.	Cost of temporary housing, camps and construction facilities, including handling and transportation to and from jobsite, erection, rental, maintenance and dismantling at completion of work for buildings and structures such as offices, warehouses, sanitary facilities, fabrication sheds, fences, etc.		X			
2.	Temporary construction utilities, including labor and materials for installation of electrical power, natural gas, fuel oil, drinking water, service water, air, communications, etc.		X			
3.	Temporary construction site facilities such as docks, site fill, roads, parking areas, rail spurs, etc.		X			
4.	The cost of setting up and operating any field or service office established exclusively for the completion of the project and approved by client.		X			

E. OTHER JOB COSTS (Continued)

	DESCRIPTION	1	2	3	4	5
5.	The actual costs of transportation, travel and living expenses subsistence and onsite living allowances, moving expenses, or other necessary expenses paid in connection with the services and in accordance with Company policies.		X			
6.	All taxes, levies, or other excise payable on or in connection with the purchase or use of any equipment, apparatus, materials or supplies in connection with the performance of work under this contract, or otherwise in connection with the performance of work under this contract including licenses or permits, and gross receipts tax excepting only the following: taxes levied directly on or measured by net income on Contractor's corporate activity and the cost of licenses or permits required in order for Contractor to engage in business.		X			
7.	Costs arising from suspension of the work for any reason including force walkout.		X			
8.	Building permits, land taxes, licenses, royalties.		X			
9.	Premiums on performance bonds and payment of other bonds required for the work.		X			
10.	Losses and expense not compensated by insurance.		X			
11.	Outside consulting and laboratory services as required by construction.		X			
12.	Cost for legal services for other than contractor's corporate matters.		X			

E. OTHER JOB COSTS (Continued)

	DESCRIPTION	1	2	3	4	5
13.	Cost of recruitment, labor relations and related services		X			
14.	All other jobs related costs incurred which are not otherwise specifically reimbursed or specifically excluded.		X			

TECHNICAL FILING SYSTEM

TASK SPECIFICS

In December of 1976, Mr. Keith Sandefer assigned me to develop a technical filing system. The development of a technical filing system had already been sporadically under way for some months before I joined Brown & Root. Engineers were working on its development, because they possessed the expertise necessary to categorize the engineering-related subjects. They were also updating the files with recent information, technical articles, equipment brochures, and advertisements. Initially, the organization of the technical files corresponded to the organization of the Solids Processing Department with sections corresponding to General Corporation, General Solids Processing Department, Mining and Minerals, Air Pollution Control, Mechanical Design, Bulk Material Handling, and Industrial Engineering. These sections were numbered 000, 100, 101, 102, 103, 104, and 105 respectively. When the MAPI Department replaced the Solids Processing Department, the primary sections applicable to the MAPI Department were the Industrial Engineering and Bulk Material Handling Sections.

The assignment involved reorganization of the technical files to better correspond to the MAPI Department organization. The initial technical filing system had not emphasized the Industrial Engineering and Bulk Material Handling sections and many additions and modifications were required. The goals of the new technical filing system were:

1. To provide uniform filing of technical information accrued by the MAPI Department.
2. To provide the quick retrieval of information so filed.
3. To obtain similarity in the organization of the technical filing system and the organization of the MAPI Department.

TASK PLANNING

I took the previous attempts at the technical filing system, and since they were totally inadequate in some areas, I referenced the Standard Industrial Classification Manual, the Industrial Engineering Handbook, and several other industrial engineering related books for technical categories. I was given two weeks to develop the first draft.

My plan of execution was to take the former technical filing system, scrap what was not useful, and modify the rest. I decided to maintain the former numbering system to facilitate changeover to the new filing system. The numbering system consisted of three parts: 1) a three digit prefix denoting the section, 2) two middle digits following a period and denoting divisions within sections, and 3) three final digits following a dash and denoting individual items within divisions. The two sections with which I was working were formerly numbered 104 and 105.

TASK PERFORMANCE

I followed the original plan with one exception. Instead of maintaining the Bulk Material Handling and Industrial

Engineering sections as separate sections, I placed the Bulk Material Handling section under Industrial Engineering as its own division so that all material handling information, whether it be bulk or otherwise, is in the same section. Eight other divisions completed the section, and within the nine divisions I placed the categories I had accumulated from my references (see the exhibits at the end of this section).

During my work on this assignment, I used my educational training in industrial engineering to divide the files into rational groups and to give the system a good start toward completeness. Through my research and involvement with the numerous technical categories, I broadened my knowledge of industrial engineering, especially in relation to bulk material handling. I had little supervision on the assignment, but little was required.

ASSIGNMENT RESULTS

The resulting technical filing system allows for systematic filing and retrieval of technical information related to the MAPI Department. Its organization is similar to that of the MAPI Department, and the categories are such that every piece of information has a place either in a specific or a general category. The arrangement of categories and the complexity of the numbering system allow for easy expansion to new categories when such an expansion is warranted. The new filing system is much more useful than what had been used previously.

Following two weeks of work, I completed the technical filing system and gave a copy of it to each of the clerks who are responsible for maintaining the system. Maintenance consists of monitoring technical journals for information and filing of new material. Though I will probably not be directly involved in the follow-up to the assignment, the technical filing system is by no means final. It will be continually evolving as the MAPI Department develops and as omissions are discovered. Expansion of the files to include information on specific industries in detail is one area for improvement.

POST-TASK ANALYSIS

The technical filing system is a useful tool for systematic filing and retrieval of technical information accumulated by the Department and was therefore a worthwhile task, but my talents could have been better utilized on an engineering project if one had been available. The only weakness in my procedure was the decision to stay with the old numbering system. While developing a new filing system, I should have followed through and changed the numbering system to conform more closely to the numbers now associated with the MAPI Department. For instance, the 105 prefix should now be converted to 270, which is the MAPI Department number. Even with the old numbering system, however, the new technical filing system is greatly improved over the former system. Only time and expansion will make the system more complete.

SUMMARY COMMENTS

A technical filing system, though it may not be the most

glamorous of systems, is nevertheless a system and one that required engineering input for its development. Therefore, this assignment was of value to my internship. Development of a technical filing system would be included under the fifteenth primary activity of industrial engineering as described in the Introduction to include the development of office systems.

I developed the technical filing system in great detail as desired by my supervisor. Though sometime in the future sufficient information may have been accumulated to warrant such fineness in category division, fewer categories and a simpler system could be used just as well, if not more easily, at the present time. I recommend that the numbering system be reworked around the MAPI Department number 270 and that the filing system be simplified around fewer more general categories. Since material handling has been reorganized as a function under the Mechanical Department, the technical filing system will require extended modification in any case.

APPENDIX VI

105.00-000 INDUSTRIAL ENGINEERING AND INDUSTRIES; GENERAL AND LITERATURE

105.10-000 VENTURE PLANNING; GENERAL AND LITERATURE

105.20-000 MANUFACTURING AND INDUSTRIES PROCESSING; GENERAL AND LITERATURE

105.30-000 PHYSICAL DISTRIBUTION;GENERAL AND LITERATURE

105.40-000 WAREHOUSE AND STORAGE SYSTEMS; GENERAL AND LITERATURE

105.50-000 PACKAGING SYSTEMS; GENERAL AND LITERATURE

105.60-000 OPERATION AND QUALITY CONTROL; GENERAL AND LITERATURE

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DESIGN CRITERIA HANDBOOK

TASK SPECIFICS

On two occasions, in September of 1976 and February of 1977, Mr. Keith Sandefer assigned me to develop a design criteria approach to engineering design. The Chahbahar industrial complex project, which had entered the doldrums several months earlier, began showing signs of revitalization. Due to internal Iranian political matters which had plagued the project from its outset, every design decision made concerning the industrial complex required a large amount of documented justification. The gold plated U. S. Navy version, which was to serve as a basis for engineering design, had to be economized, and the reasoning behind removing or inserting a piece of equipment had to be meticulously documented. This situation made evident the need for a design criteria approach, but rather than limit this approach to just the Chahbahar industrial complex, my supervisor and I decided to generalize it to encompass any venture entered into by the MAPI Department.

The first step in the task involved the development of an equipment installation checklist to assure that every requirement for a piece of equipment had been provided at or before its installation. This initial step later blossomed into the Design Criteria Handbook, which considered material handling, specifications, shop arrangements, equipment

selection and arrangement, and general shop requirements. The goals of this handbook were:

1. To develop a practical, systematic approach to design.
2. To establish guidelines to which designers can work with confidence.
3. To facilitate the verification of designs by providing standards against which the work can be evaluated.
4. To provide a means of documenting the justification for design decisions.
5. To be capable of applying the approach to any manufacturing situation.

TASK PLANNING

After my supervisor, based on his past experience, supplied me with some suggested items to be included in the checklist and handbook, I referenced enough sources on every topic until I felt confident of the validity and completeness of the information with which I was working. In my research, I looked primarily for checklists, criteria, and algorithms rather than theoretical discourses. I was given two weeks to complete the equipment installation checklist and three weeks to complete the first draft of the Design Criteria Handbook.

My plan of execution for the equipment installation checklist was to look at the equipment from the material flow viewpoint and then to consider the administrative and service

functions where they were necessary. My plan for the Design Criteria Handbook was to cover in detailed specifics as many as possible of the aspects concerning the design of manufacturing facilities and then to circulate the resulting first draft to experienced design engineers for their comments.

TASK PERFORMANCE

In the development of the equipment installation checklist, I followed the material flow to a generalized piece of equipment and noted the needs of those materials from ordering through the operation to shipping, with the services and systems inputs added where necessary. Via this approach, I divided the checklist into four modules: 1) Logistics, 2) Production, 3) Utilities and Services, and 4) Plant Engineering. The Logistics portion included most of the material aspects related to the equipment; therefore, under Logistics, I placed the ordering and processing of everything required by the equipment, the receiving and shipping of these entities, and the storage facilities both before and after the operation. Under Production, I included the administrative functions such as production control, inventory control, quality assurance and control, and tool procurement methods in the checklist. This was done to insure that the designer allowed for and accommodated their existence. Under Utilities and Services, I placed all of the services required by the equipment and its operators, and under Plant Engineering, I placed research and development, maintenance and equipment selection.

I approached the Design Criteria Handbook from the viewpoint that it was to be a first draft, and though what was to be included should be accurate, valid, and professional, the handbook itself would, on account of the time restriction and necessity for input from others than myself, be short of its ultimate content. Relying heavily on my supervisor's experience as well as my own knowledge and research, I compiled sections on analysis of manufacturing shop requirements, site selection, equipment selection and arrangement, specification preparation, materials handling, space requirements, utilities requirements, safety and personnel care provisions. The sections took the form of checklists, step-by-step procedures, and criteria; such as, capacities, speeds, dimensions, and other useful data.

In performing this task, I used almost all of my industrial engineering education. Especially helpful were the courses that spanned the spectrum of industrial engineering such as logistics and plant layout. From these courses, I learned the material flow approach to an industrial design problem. Because of my supervisor's vast experience, I acquired many new skills during the completion of this task. I learned a procedure for the preparation of specifications and new considerations for the selection and arrangement of equipment. I also increased my knowledge of and familiarity with the various aspects of material handling. The inputs

from my supervisor were very valuable and helped me fill gaps when they appeared.

ASSIGNMENT RESULTS

The resulting equipment installation checklist (see the exhibits at the end of this section) is a means of documenting that every requirement for a piece of equipment has been considered. It is sufficiently general that it can be applied to any manufacturing facility yet sufficiently specific to accomplish its purpose. The Design Criteria Handbook (too voluminous to be included in this report) carries one step farther the concept of a systematic approach to design by specifying criteria and establishing guidelines which are to be met and followed during the design process. By meeting the standards recorded in the handbook, a designer may be confident in the results of his efforts, and checkers can verify the designs more quickly and efficiently. I used the full time alloted me to complete the task, after which time both the checklist and the handbook were distributed to Project Engineers. The first comments returned were very favorable. Both the checklist and handbook will be updated continuously as their shortcomings are determined from use.

POST-TASK ANALYSIS

Before this task was begun, no standard design process existed in the MAPI Department as did no standard verification or documentation procedures. A systematic approach to design, if effective and if followed, could be very valuable to a project's operations. Engineers following the same

design process work better together as a team both in the coordination of engineering skills and in the communication of ideas. Standard criteria facilitates more efficient verification and enhance documentation at both the design and checker levels. Thus, the equipment installation checklist and the Design Criteria Handbook in final usable forms could be a great engineering aid. In the performance of this task, I used almost all of my educational training and brief experience to produce documents that, although they were by no means final in their form or content, did provide a basis for a systematic approach to design. I followed my original plans very closely, and my supervisor was very helpful in using his experience to channel my efforts to the production of usable documents rather than theoretical discourses.

SUMMARY COMMENTS

The value of this assignment to my internship rests in the application of my educational skills to the establishment of an organizational approach to design. It was a task that produced results which, if properly utilized and continued, could be a significant contribution to MAPI Department operations. This task is within the fourth and eighth primary activities of industrial engineering as described in the Introduction to be the design of planning and control systems and the design of management information systems respectively.

The major shortcoming of my background was my lack of industrial experience. My educational background gave me knowledge of many engineering techniques and tools but also

emphasized a lot of theory that did not directly impact this assignment. Concerning industry's approach to this assignment, I noted that industry operates for a long period of time without the benefits of a system that could have been implemented much earlier, and then when the need is finally recognized, it rushes the task such that a complete job cannot be accomplished. I recommend that the development of the Design Criteria Handbook be continued until a semi-final draft is completed and distributed to all design engineers.

APPENDIX VII

EQUIPMENT INSTALLATION CHECKLIST

LOGISTICS

PURCHASING
- ___ INVENTORY REORDER SYSTEM
- BUYING
  - ___ RAW MATERIALS
  - ___ COOLANT
  - ___ REPLACEMENT PARTS
  - ___ SUPPLIES
  - ___ TOOLS

RECEIVING AND SHIPPING FACILITIES

MATERIAL HANDLING
- ___ MATERIAL HANDLING EQUIPMENT FROM RECEIVING TO STORAGE
- ___ STOCK WITHDRAWAL / DELIVERY EQUIPMENT
- ___ MATERIAL HANDLING SERVICE FOR MACHINE (S)
- ___ FINISHED MATERIAL REMOVAL TO STORAGE

STORAGE
- ___ STOCK STORAGE FACILITIES AND SPACE
- ___ PROCESSED MATERIAL STORAGE FACILITIES AND SPACE
- ___ FINISHED PRODUCT STORAGE FACILITIES AND SPACE

PRODUCTION

PRODUCTION CONTROL
- ___ FORECASTING TECHNIQUES
- ___ METHODS STUDY TECHNIQUES
- ___ TIME STUDY METHODS
- SCHEDULING AND PLANNING OPERATIONS
  - ___ TASK BREAKDOWN
  - ___ TASK SEQUENCING
  - ___ MATERIAL ROUTING PLANS
  - ___ MACHINE LOADING
  - ___ MANPOWER ALLOCATION
- ___ WORK ORDER AND DISPATCHING PROCEDURES
- ___ PROGRESS CONTROL METHODS

INVENTORY CONTROL
- ___ COUNT OF PRODUCTIVE RAW MATERIALS ON RECEIPT AND COMPUTATION OF VALUE
- ___ COUNT OF PURCHASED FINISHED PARTS ON RECEIPT AND COMPUTATION OF VALUE
- ___ COUNT OF WITHDRAWAL FROM STORAGE FOR PROCESSING AND COMPUTATION OF VALUE
- ___ COUNT OF ADDITION OF PROCESSED MATERIAL TO STORAGE AND COMPUTATION OF VALUE
- ___ COUNT OF ADDITION OF FINISHED PRODUCT TO WAREHOUSE AND COMPUTATION OF VALUE
- ___ COUNT OF WITHDRAWAL OF FINISHED PRODUCT FOR SHIPPING AND COMPUTATION OF VALUE

___ COMPREHENSIVE QUALITY ASSURANCE PROGRAM

QUALITY CONTROL PROGRAM
- ___ INSPECTION METHODS
- ___ GAGING PROCEDURES

TOOL PROCUREMENT AND STOCKING METHODS
- ___ TOOL REQUIREMENTS DETERMINATION
- ___ TOOL CHECKOUT AND HANDLING PROCEDURES
- ___ TOOL STOCKING SYSTEM

OPERATIONS SPACE LAYOUT
- ___ OPERATOR WORK SPACE
- ___ SPACE FOR AUXILIARY EQUIPMENT
- ___ SPACE FOR MATERIAL HANDLING ACTIVITIES
- SPACE FOR OTHER ASSOCIATED ACTIVITIES
  - SPECIFY ACTIVITIES: _____
- SPACE FOR RELATED MOVEMENTS
  - ___ AISLES
  - ___ ACCESS TO SAFETY DEVICES
  - ___ OTHER: _____
- ___ PROXIMITY AND ACCESS TO TOOLING STORAGE

UTILITIES AND SERVICE

___ POWER CONTROL SYSTEM

___ POWER SUPPLY
- ___ ELECTRICITY
- ___ GAS
- ___ STEAM
- ___ OTHER: _____

___ EMERGENCY POWER SOURCE
- ___ GENERATOR
- ___ OTHER: _____

___ SERVICE AIR SUPPLY

___ TEMPERED AIR SUPPLY

___ WATER SUPPLY

___ TREATED WATER SUPPLY

___ GAS SUPPLY
- SPECIFY GAS (ES): _____

___ COOLANT SUPPLY
- SPECIFY COOLANT (S): _____

CAPABILITY TO RECYCLE MACHINE EFFLUENTS
- ___ COOLANT
- ___ MATERIAL
- ___ OTHER

___ POLLUTANT REMOVAL SYSTEM

___ WASTE REMOVAL METHODS

___ SEWAGE FACILITIES

___ PROPER DRAINAGE

___ JANITORIAL SERVICE

PERSONNEL

SAFETY
- ___ FIRST AID FACILITY
- ___ COMPLIANCE WITH SAFETY STANDARDS

EMPLOYEE SERVICES WITHIN REASONABLE PROXIMITY
- ___ RESTROOMS
- ___ WATER FOUNTAINS
- ___ LUNCH ROOM
- ___ SMOKING AREAS
- ___ LOCKERS OR COAT RACKS
- ___ PARKING AREA

OPERATOR COMFORT PROVISIONS
- ___ PROPER LIGHTING
- ___ TEMPERATURE CONTROL
- ___ PROPER VENTILATION
- ___ OTHER: _____

COMMUNICATION SYSTEM
- ___ VERBAL
- ___ MECHANICAL
- ___ AUTOMATED
- ___ OTHER: _____

___ RECRUITING AND HIRING PROGRAMS

TRAINING PROGRAMS
- ___ OPERATOR
- ___ MAINTENANCE
- ___ MANAGEMENT
- ___ OTHER: _____

PLANT ENGINEERING

RESEARCH AND DEVELOPMENT PROGRAMS
- ___ PRODUCT DESIGN ENGINEERING
- ___ TOOL DESIGN ENGINEERING

MAINTENANCE
- ___ PREVENTIVE MAINTENANCE PROGRAM
- ___ SPACE / ACCESS FOR MAJOR MAINTENANCE WORK
- ___ DEFECTIVE COMPONENTS INSPECTION SYSTEM
- ___ CAPABILITY TO REBUILD / DISCARD DEFECTIVE PARTS
- ___ PROXIMITY AND ACCESS TO MAINTENANCE EQUIPMENT
- ___ PROXIMITY AND ACCESS TO MAINTENANCE TOOLING
- ___ REPLACEMENT PARTS SUPPLY
- ___ STORAGE FOR REPLACEMENT PARTS
- ___ OUTSIDE SPECIAL MAINTENANCE SERVICES
  - SPECIFY: _____

___ PRODUCTION EQUIPMENT SELECTION METHODS

COMMENTS:

NOTES

1. USE (V) TO INDICATE ACCEPTABILITY AND TO SPECIFY TYPE WHERE APPLICABLE

REVISIONS	BY	DATE

BROWN & ROOT Inc. HOUSTON, TEXAS

EQUIPMENT INSTALLATION CHECKLIST

DRAWN BY R.L.G. CHECKED ____ APPROVED ____ DATE 9-22-76

CONT. No.

DWG. No.

SHT 1 OF 1

EMPLOYEE MERIT EVALUATION SYSTEM

TASK SPECIFICS

In September of 1976, Mr. Keith Sandefer assigned me to make input to an employee merit evaluation system. When the Department recommends pay increases and promotions, or the opposite, an evaluation of the employee on a scale of 1-5 must be reported to corporate management along with the recommendation. The Solids Processing Department, now the MAPI Department, had a very sophisticated system for arriving at these evaluations which was followed once very four months. The employee evaluation was computed from the weighted sum of four evaluations of that employee by his supervisors, with the evaluations of the supervisors closer to the employee given the greater weight. Each employee was given his evaluation and the range of evaluations at his skill level which allowed him to see how he compared to other people at his level as they revealed to him his strengths and weaknesses. Poor evaluations could be discussed with the employee's supervisor to determine what was necessary to improve the employee's contribution.

My involvement with the merit evaluation system included analyzing the system and suggesting improvements both in relation to the fairness and accuracy of the evaluations and to their computation. The objectives of my assignment were:

1. To insure fair evaluations.
2. To shorten the time that must be devoted to computing the evaluation.

TASK PLANNING

My supervisor supplied me a description of the employee merit evaluation system, including copies of the evaluation forms and scoring procedures. I performed a brief study of employee evaluation systems to reacquaint myself with the various aspects of merit evaluations. I had three weeks to complete the task, and I planned to begin by familiarizing myself with the employee merit evaluation system and monitoring the evaluations for the Department's engineers and technicians. Based on my observations, I would then comment on the system, suggest improvements, and attempt to shorten the time necessary for computation.

TASK PERFORMANCE

From my contact with the system, I learned that employees were evaluated by skill level groups according to their type of work production, supervision, or both production and supervision. In each of these types of work, the evaluation form contained five grades of eight categories. The grades were arranged randomly within the category (no order to best or worst traits), and no number values were shown on the form to encourage the evaluators to think about their evaluations. Besides the supervisor evaluations, which are weighted according to their distance from the employee, there is a self-evaluation which is not used in the figuring of the final

evaluation but is compared to the computed evaluation. Transparent overlays containing the values assigned to the grades were used to aid in computing the individual supervisor evaluations. The overlays were placed over the evaluation form, and the evaluation scores were read from them. The individual evaluations were weighted and summed to give the final evaluation. The employee is notified of his evaluation by a notification form in a sealed envelope.

One weakness in the employee merit evaluation rested in the fact that to get the desired four evaluations from supervisors, in many cases it was necessary for the employee to be evaluated by a supervisor from a department other than the employee's department. The very complexity of the system, which assures fairness to the employee when evaluated by supervisors within the Department could frustrate a supervisor unfamiliar with the system and could result in inaccurate evaluations. Therefore, I designed a new form to be used by evaluators outside the Department (see the exhibits). It follows the same philosophy of the original form but is much simpler.

To shorten the time necessary for computation of the evaluations, I wrote programs for the HP-65 and HP-25 calculators. Due to limited storage space, the programs do not eliminate the use of the overlays, but they do take the individual evaluations as input, determine the number of evaluations obtained, weigh the evaluations inversely to

supervisor level, and sum the weighted evaluations to obtain the final employee evaluation.

In the course of performing this task, I used portions of my management training received in management courses, and I employed my computer programming skills. I learned many new techniques in employee evaluation that insure fairness and accuracy in the evaluation process and which provide maximum openness and communication with the employee. I had little supervision given me until I suggested changes to the system, at which time meetings were held in which I discussed the ideas and means of implementing them with my supervisor.

ASSIGNMENT RESULTS

The result of my efforts was a more complete employee merit evaluation system. With the addition of the new form for outside evaluations, the employee merit evaluation system produces more accurate evaluations which are fairer to the employees. The calculator programs make computation of the evaluation less difficult and less time consuming. I required two weeks to complete the task, and the approach I took of monitoring the process and then making constructive criticism afterwards worked well. Both my supervisor and the Department's administrative assistant were very helpful to me during the assignment.

Even though the employee merit evaluation system is a very useful tool, both for its fair employee evaluations and its capability to document an employee's past work record, it was temporarily discontinued when the MAPI Department

replaced the Solids Processing Department. The very low number of employees and lack of a large number of supervisory levels in the MAPI Department did not justify such an elaborate system. The system will again be used after the number of employees in the MAPI Department increases and will constantly be modified to conform to newly devised methods of achieving fairness and accuracy.

SUMMARY COMMENTS

This assignment allowed me to make a valuable contribution to the development of a management tool which involved employee relations. It emphasized professional fairness as well as engineering accuracy. This task is within the tenth primary activity of industrial engineering as described in the Introduction to include development of performance measures and evaluation systems.

The substantial effort made by industry to insure that the employee is evaluated fairly and has an input to the system was very reassuring to me. The methods used to achieve that fairness were the result of many past attempts at developing the employee merit evaluation system and were quite sensible. I recommend that the employee merit evaluation system be reinstated as quickly as the number of employees in the MAPI Department will justify its implementation. It is a device which offers communication from the Department to its employees at the same time that it reveals to the employee his/her strengths and weaknesses and his/her standing in the Department.

APPENDIX VIII

MANUFACTURING AND PROCESSING
INDUSTRIES ENGINEERING DEPARTMENT
MERIT EVALUATION FORM

100.44 01 1 - 77

144

NAME _____ SKILL RANGE:

050, 051, & 056 ☐
04X ☐
03X ☐
02X ☐
01X ☐

EVALUATION LEVELS

IMMEDIATE ☐
INTERMEDIATE ☐
STAFF ☐
HOME OFFICE ☐
SELF ☐

PRODUCTIVE

Understanding of Own Skill Level Duties	Doesn't seem to understand his (her) job	Is vaguely aware of what he(she) is supposed to do	Know own duties in general way	Knows duties of skill level very well	Knows duties appreciates responsibilities
Ability to Grasp and Understand Assignments	Understands task, sees way to do	Completely grasps task in context of whole job	Never seems to quite get the idea	Needs considerable explanation before understanding	Sees and understands task satisfactorily
Ability to Plan Out Doing Work	Needs help in getting started	Makes suitable use of time and material	Plans work and gets started immediately	Always working one step ahead of assignment	Continuous guidance required
Level of Work Produced	Professional quality, always	Can be used but not of desired quality	Not quite up to standards	Acceptably neat, orderly and fairly accurate	High quality, consistently
General Productivity	Steady, satisfactory rate of work	Higher than normal work production	Exceptional producer	Slow, requires constant prodding	On the slow side, but steady
Attitude	Not aware, helps only when pushed	Will help when problem shown	Alert, willing, helps out when asked	Very alert, cooperative	Knows in advance what to do, does without coaching
Self-Discipline; Work Rules Observance	Good worker, stays busy	Observes all rules conscientously gives full day's work	Rules violator, or will not stay on work	Violates work rules sometimes, needs push to keep busy	Pretty well is on hand, on time
Desire and Work toward Improvement	Tries to better self sporadically	Really tries to do better	Has a general long range plan for doing better	Firm plan for self-improvement, implements	Drifts with events

SUPERVISORY

Job Scope Visualization and Analysis	Grasps job immediately, automatically sees all facets	Understands job, analyzes in considerable detail	Sees job well, analyzes in general way	Has fair understanding of work; but not in detail	Cannot appreciate ramifications of total job
Work Planning and Task Sequencing	Does only passable job of planning and sequencing	Sloppy planning, inadequate scheduling	Plans in great detail, sets priorities, schedules comprehensively	Very good planning, task sequencing above average	Plans and schedules work satisfactorily
Making Assignments	Makes assignments well, with good coverage	Assigns work in satisfactory manner	Work assignments not complete-leaves gaps	Inadequate quality in assignments	Subordinates know task completely, all facets covered
Initiative, Effort and Diligence in Watching Job	Has to be pushed, does not keep up with work	Always ahead of others, top pace, is right on top of job	Full self-starter, maintains full speed, keeps close tabs on job	Self-starter sustains effort well, watches job adequately	Needs help to start, sometimes slackens efforts, watches job only in general
Direction and Control Of Personnel	Works crew fairly well, needs help in administration	Not too good at handling routine, often needs help on problems	Crew runs job, always has to be bailed out	Always has crew occupied, handles every problem without help	Gets good production from crew, can handle most problems alone
Instruction of Subordinates	Instructions and teaching well done and constant, ahead of need	Good at instruction teaches well at fairly constant rate	Teaches and instructs satisfactorily when needed	Instructions not satisfactory, teaching of inferior quality	Poor at giving instructions and teaching others
Cooperative with Other Groups	Avoids cooperative actions	Works satisfactorily with other groups when needed	Sets up and maintains procedures for continual cooperation	Initiates and fosters group cooperation	Works very well with other groups, initiates some actions
Establishing and Maintaining Communications	Maintains very good communications and records	Communicates and documents satisfactorily	Careless in maintaining communications and records.	Incommunicative, keeps inadequate records	Sets up, maintains and monitors communication methods & records

EVALUATOR _____ RAW SCORE

(PLEASE PRINT)

SOLIDS PROCESSING DEPARTMENT

EMPLOYEE EVALUATION FORM

FILE NO. 100.30-502
FOR SUPERVISORS OUTSIDE THE DEPARTMENT

JAN MAY SEPT
(CIRCLE MONTH)

To: M _____

Dept. No. _____

From: Keith Sandefer / _____ Dept. Rep.

Subject: MERIT EVALUATION

EMPLOYEE _____

SKILL LEVEL NO. _____ SKILL LEVEL TITLE _____

You are requested to assist us in evaluating our people by checking the box which nearest fits this individual.

TRAIT	DESCRIPTION				
PRODUCTION QUALITY	Superior ☐	Below Average ☐	Above Average ☐	Poor ☐	Average ☐
PRODUCTION QUANTITY	Low ☐	High ☐	Average ☐	Very High ☐	Very Low ☐
GRASP OF ASSIGNMENT	Poor ☐	Superior ☐	Average ☐	Below Average ☐	Above Average ☐
GENERAL BEHAVIOR	Acceptable ☐	Unworkable ☐	Difficult But Workable ☐	Good ☐	Excellent ☐

Please complete and return within 3 days
To Dept. Representative shown above

☐ Immediate
☐ Intermediate A
☐ Intermediate B

Evaluator _____
(Please Print)

OVERLAY ASSOCIATED WITH THE PRECEDING EVALUATION FORM.

	1.44	0.57	1.15	0.29	0.86
	0.53	1.05	0.79	1.31	0.26
	0.25	1.25	0.75	0.50	1.00
	0.60	0.20	0.40	0.80	1.00

Solids Processing Department

Merit Rating Notification

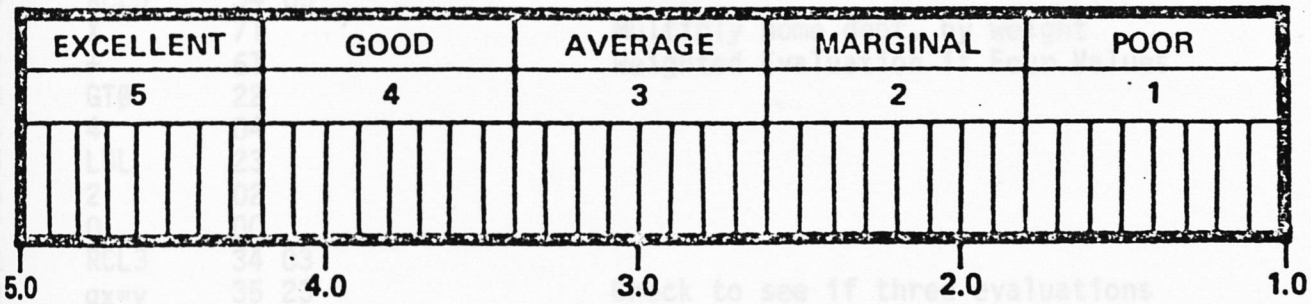
4-month Period Ending _____

To _____

In the period shown you have been evaluated on the basis of:

1. Your own work, only ☐
2. Only on your qualities as a supervisor ☐
3. On a combination of 1 and 2, above ☐

The Skill Level Range in which you have been evaluated is _____. In this range, and evaluated on the same basis as you, are _____ individuals. The final evaluation for all of you, for this period, averages _____. The chart below shows the evaluation spread of all this group. The dot shows how your evaluators consider you fit within this range. You have been asked to evaluate yourself--your own evaluation is shown as an "x."



Remarks: _____

_____

_____

_____

_____

_____

_____

_____

Keith Sandefer

_____

Date

EMPLOYEE MERIT EVALUATION SYSTEM

HP-65 Program

Line	Key Entry	Code	Comments
01	LBL	23	
02	A	11	
03	0	00	
04	RCL4	34 04	
05	gx=y	35 23	Check to see if four evaluations
06	GTØ	22	If not go to three eval. check
07	2	02	
08	gNØP	35 01	
09	RCL6	34 06	
10	X	71	Multiply Internal A by weight
11	RCL3	34 03	
12	RCL7	34 07	
13	X	71	Multiply Internal B by weight
14	+	61	
15	RCL2	34 02	
16	RCL8	34 08	
17	X	71	Multiply Supervisor by weight
18	+	61	
19	RCL1	34 01	
20	RCL5	34 05	
21	X	71	Multiply home dept. by weight
22	+	61	Weighted Evaluation if Four Values
23	GTØ	22	
24	4	04	
25	LBL	23	
26	2	02	
27	0	00	
28	RCL3	34 03	
29	gx=y	35 23	Check to see if three evaluations
30	GTØ	22	If not go to two eval. check
31	3	03	
32	gNØP	35 01	
33	RCL8	34 08	
34	X	71	Multiply Internal by weight
35	RCL2	34 02	
36	RCL6	34 06	
37	X	71	
38	2	02	
39	X	71	Multiply Supervisor by weight
40	+	61	
41	RCL1	34 01	
42	RCL6	34 06	
43	X	71	Multiply Home Dept. by weight
44	+	61	Weighted Evaluation if three values

Line	Key Entry	Code	Comments
45	GTØ	22	
46	4	04	
47	LBL	23	
48	3	03	
49	RCL2	34 02	
50	RCL8	34 08	
51	X	71	
52	2	02	
53	X	71	Multiply Supervisor by Weight
54	RCL1	34 01	
55	RCL8	34 08	
56	X	71	Multiply Home Dept. by weight
57	+	61	Weighted evaluation if two values
58	LBL	23	
59	4	04	
60	R/S	84	Write down weighted evaluation
61	0	00	
62	STØ1	33 01	Zero out previous evaluations
63	0	00	
64	STØ2	33 02	
65	0	0	
66	STØ3	33 03	
67	0	00	
68	STØ4	33 04	
69	RTN	24	

INSTRUCTIONS	Data	Keys
1. Key in constants		
	0.167	STØ5
	0.222	STØ6
	0.278	STØ7
	0.333	STØ8
2. Key in Variables		
a. Store 0 for any evaluation not made	Home Dept	STØ1
	Immed Sup	STØ2
	Internal A	STØ3
b. Home Dept. and one additional must be made	Internal B	STØ4
3. Calculate Weighted Evaluation		A
4. Go to 2 and repeat for not variable set		

CONTINUING EDUCATION

TASK SPECIFICS

In March of 1977, Mr. Keith Sandefer assigned me the task of acquainting the Project Engineers of the MAPI Department with the state of the art in microprocessors. When the MAPI Department was formed, a large majority of the Project Engineers remaining in the Department had been primarily involved in industries other than manufacturing and had not utilized the most recent innovations in manufacturing technology. The task entailed the design of a short course that would describe microprocessors and their applications and would touch on other manufacturing methods. I was to establish the program on the basis that the engineers benefiting from the short course would have been out of school up to twenty years. The objectives of this assignment were:

1. To acquaint the MAPI Department with the state of the art in manufacturing methods.
2. To describe the application of microprocessors to the extent that they could be considered in manufacturing designs.

TASK PLANNING

Since I was given nothing with which to begin the task, the first stage was entirely research. This research included both the location and analysis of recent technical articles and the contacting of many vendors for information on their products. For some of the manufacturing methods

and background information, I also referenced some of my past textbooks and course notes. I was given four weeks to complete the assignment. My plan of execution was to first perform the initial research and contacting of vendors and then to organize the information obtained into a report that could later be divided by sections and presented in short course form. I saw no way or reason to make microprocessor experts out of the Project Engineers or to present a detailed education on microprocessors in a short course; therefore, I planned to familiarize these engineers with microprocessors to the point that they would be able to consider them in a manufacturing design or at least be able to take part in an intelligent conversation about them with a vendor or client.

TASK PERFORMANCE

Immediately after I began the task, it was limited to the subject of microprocessors. From my research I collected information on the history of computers, numerical control machines and microprocessors. I contacted nineteen microprocessor suppliers and obtained from them brochures, handbooks and other literature describing their microprocessor products. My greatest difficulty arose in the area of applications. While I found many examples that presented the use of microprocessors in the process industries, I could find almost no examples of their applications to the manufacturing industries even though I knew such applications to exist. Another difficulty that I experienced was the representation of current information. The microprocessor

industry is one of the fastest changing industries in existence. In the time that is required to write and publish a technical article, the microprocessor industry changes to the extent that the article is no longer current.

To overcome these obstacles, I decided to have a specialist in the area of microprocessors come to Brown & Root and hold a conference. Through my contacts with the Learning Center of Texas Instruments, Incorporated, I spoke with two men who agreed to speak at Brown & Root. These men were specialists in the field of microprocessors, and their primary job with Texas Instruments was to travel the country speaking about microprocessors and their application. Two half-day conferences were held to which not only MAPI Department personnel but also any other interested Project Engineers were invited. The first conference emphasized the programming and application of programmable calculators, and the second conference emphasized the basics and application of microprocessors. Following these two conferences, I received for examination from the Learning Center eight ninety-minute cassette tapes which, based on the description given me, showed potential for becoming a taped introduction to microprocessors that could be purchased and kept within the Department for use by its engineers. After listening to the tapes, however, I decided that they were too specialized in the programming of Texas Instruments microprocessors and did not offer enough general information on microprocessors and their application to warrant their purchase.

Throughout this assignment I employed my computer background and my industrial engineering training in the application of computer related products. I greatly increased my knowledge of microprocessors and my realization of the inevitability of their use, and I became familiar with microprocessor vendors and their products. The supervision given me in this assignment took the form of short meetings in which my supervisor and I discussed the benefits and costs of possible courses of action.

ASSIGNMENT RESULTS

The conferences that I held introduced the application of microprocessors for control in manufacturing facilities. They also introduced devices that are used in conjunction with microprocessors such as photoelectric controls, pressure sensitive controls, temperature detectors, and analog to digital converters. I worked on the assignment for four weeks, and during that time, the MAPI Department was undergoing transformation in which the number of engineers in the Department was being reduced to the necessary nucleus and new, more specialized engineers were being hired. This transformation associated with the new MAPI Department will require a constant follow-up to this assignment in programs that educate the engineers to the state of the art in manufacturing such as the use of microprocessors.

POST-TASK ANALYSIS

This assignment and assignments like it are necessary to the MAPI Department to keep it from becoming obsolete.

Without keeping up with the state of the art in manufacturing design, the MAPI Department would have difficulty competing in the manufacturing industry. My approach to this task took the form of inviting specialists to come and speak on microprocessors to the engineers who would benefit from the knowledge. I decided on this approach, because I found out that, though technical articles and books may help in an introductory fashion, they cannot provide immediate state of the art information. My supervisor went along with my suggestions, and I received aid from the Department administrative assistant who helped me with the conferences.

SUMMARY COMMENTS

The value of this assignment to my internship rests in its contribution in an area of practical concern - remaining current in a quickly changing field. It involved primary activities of industrial engineering such as selection of equipment and design of facilities and required the participation of many within the MAPI Department organization. My educational background had not included a detailed study of many of the new manufacturing methods, such as the use of microprocessors, and I recommend a course that spans the manufacturing industry and studies the state of the art. The MAPI Department is making an effort to produce innovative designs which utilize the most recent manufacturing developments, and to do that it will have to familiarize its engineers with those methods and then use them in its designs.

APPENDIX IX

CONTINUING EDUCATION CONFERENCES

SPEAKER	SUBJECT	DATE
Harold Utsler	Programming and Use of Programmable Hand Calculators	May 4, 1977
Sam Weller	Microprocessors and their Applications	June 8, 1977

GENERAL GROUNDWORK

TASK SPECIFICS

In December of 1976, Mr. Keith Sandefer assigned me to perform some of the general groundwork necessary for the newly organized MAPI Department. Since the MAPI Department was new, it did not have the communication links to the manufacturing industry or a working knowledge of the regulations peculiar to the food, pharmaceutical, and personal care industries; therefore, I was assigned to establish a means of maintaining current information by recommending periodicals to which to subscribe and associations to join and by locating regulations concerning the food, pharmaceutical, and personal care industries. Since the MAPI Department is an industry department and will be sponsoring projects, it utilizes Project Engineers to manage the project and assume responsibility for its progress and output. A physical representation of this responsibility is the Professional Engineer's seal, and I was assigned to report on the regulations concerning the use of the seal. Each state has its own set of regulations governing the practice of engineers both as individuals and as corporations within the state, and since the projects that the MAPI Department will be sponsoring could possibly be located in any of the states, it is important for the Project Engineer to be aware of the state regulations under which he is operating. Of particular concern is when the Professional Engineer's seal is required on drawings, plans, specifications, reports, etc.

The task involved reviewing publications and associations for evaluation based on what they had to offer the MAPI Department and locating applicable regulations both to the food, pharmaceutical, and personal care industries were from the various state engineering regulatory acts. The objectives of the assignment were:

1. To recommend publications and associations that would be beneficial to the MAPI Department.
2. To locate regulations which apply to the food, pharmaceutical, and personal care industries.
3. To report on the regulations concerning the use of the Professional Engineer's seal.

TASK PLANNING

The only data I was given for the task were copies of the fifty Engineering Regulatory Acts; therefore, a large amount of research was necessary. My primary sources were the Encyclopedia of Associations which references associations by subject as well as by name and gives a brief description of the association along with its address, telephone number, date founded, number of members, officer to contact, publication titles, and meetings; the Texas List of Periodicals which lists publications and where they can be found; the Code of Federal Regulations; and the Engineering Acts of the fifty states. I was given three weeks to complete that part of the task involving publications, associations, and regulations and another two weeks to report on the use of the Professional Engineer's seal.

My original plan of execution was to review my sources for candidate publications and associations. I then would select the publications for recommendation based on how well they represented the technology, personnel, and events of the food, pharmaceutical, and personal care industries or for the general information they contained on manufacturing methods, systems and equipment. I planned to recommend associations for their publications, their potential as sources of technical information and client contacts, and their continuing education capabilities. Concerning the industry regulations, I planned only to refer to the titles and parts within the Code of Federal Regulations which referenced the food, pharmaceutical and personal care industries. I planned the same procedure for the regulations governing the use of the Professional Engineer's seal.

TASK PERFORMANCE

I basically followed the original plan of execution and reported my findings to my supervisor (see the exhibits in this section.) I recommended specific industry and generally related publications and associations and gave all the necessary information for subscribing or joining. Concerning food, pharmaceutical, and personal care industry regulations, I listed each of the regulatory bodies that I found to have control over the industries, stated their address and purpose, and gave the location in the Code of Federal Regulations of the regulations they enforce. Additionally, I included in the report the beginnings of an acronym glossary, because

I constantly had run into undefined and unexplained acronyms in my research. I later expanded that list. In order to bring the Department up to date quickly, I included a bibliography of related technical articles and explained the process to follow to order past issues of the publications which contained the articles. To represent the information that I found concerning the use of the Professional Engineer's seal, I selected from the Engineering Regulatory Acts the sections related to the use of the seal, categorized them, and then listed them by state in both a report and table.

This assignment familiarized me with some of the non-technical aspects of the food, pharmaceutical, and personal care industries as well as a professional concern associated with being a Professional Engineer. It was primarily a research activity and involved few educational or technical skills. The supervision given me took the form of discussion on my findings.

ASSIGNMENT RESULTS

The results of my efforts were presented in two reports. I fulfilled the objectives of the task by recommending publications and associations, locating industry regulations, and reporting on the use of the Professional Engineer's seal. In addition, I included a bibliography to technical articles, developed a glossary of acronyms, and tabularized the Professional Engineer's seal information. By referencing the Professional Engineer's seal table, the user can learn when it is mandatory under the law to use the seal. I used the entire five weeks allotted me for the task.

In February, after Brown & Root had sent announcements of the expansion to the MAPI Department to over fifty publications, I followed up on the earlier assignment by corresponding with the publications, requesting information, and again recommending those to which to subscribe. Further follow-up will be required as the MAPI Department expands its operations and emphasizes more manufacturing industries.

POST-TASK ANALYSIS

This assignment was not very prestigious but was one that had to be done. It provided the Department with information that will be useful for a long time from the standpoints of both the technical and professional sides of engineering. My approach to the assignment accomplished it very well and represented the information I accumulated in a compact form. The little supervision given me was all that was required, and my supervisor gave me helpful assistance when necessary.

SUMMARY COMMENTS

The value of this assignment to my internship rests in the fact that it is another example of the organizational approach taken by the MAPI Department in the development of systems and gathering information that are to its benefit. This approach entails the gathering of useful information and then synthesizing and analyzing that information to represent it in a systematic manner. The approach applies to the most important and complex of systems and to those assignments which at first might appear minor in comparison. Because

an organizational approach was taken, the information obtained may result in the acquisition of a project or the prevention of a legal action taken against Brown & Root.

APPENDIX X

BAKER [illegible] INC.

OFFICE MEMO

TO: Mr. Keith Sandefer DATE: December 13, 1976

FROM: Randall J. Gannaway

SUBJECT: Food, Drug, and Personal Care Industries Information

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The following lists represent a means of gathering, and keeping current, information on the food, drug, and personal care industries via their publications, associations, and regulatory bodies. After the lists is a bibliography of articles that give a snapshot of these industries over the past three years. Maintaining currentness is accomplished by keeping subscriptions and memberships active and by watching for amendments to regulations as explained in the Regulatory Bodies section.

PUBLICATIONS

Four publications were chosen that, along with their feature articles, represent well the technology, personnel, and events of the food, drug, and personal care industries:

Drug and Cosmetic Industry
Food Engineering
Food Processing
Soap/Cosmetics/Chemical Specialties

Five other publications contain general information on manufacturing methods, systems, and equipment:

Industrial Engineering
Manufacturing Engineering
Material Handling Engineering
Modern Packaging
Package Engineering

Three publications, though not immediately eliminated, were rated lower, and probably should not be obtained, because of their emphasis on some area other than manufacturing:

Cosmetics and Perfumery
Food Technology
Manufacturing Chemist and Aerosol News

All of these publications are presented below with their cost, frequency of publication, and publishers. The content described is what appears regularly in each issue. Feature articles are also present. In some cases the publications may be obtained free of charge.

BROWN & ROOT, INC.

OFFICE MEMO

TO: Mr. Keith Sandefer DATE: December 13, 1976

FROM: Randall J. Gannaway

SUBJECT: Food, Drug, and Personal Care Industries Information

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Drug and Cosmetic Industry

Yearly Cost: $9
Published monthly
Publisher: Drug Markets, Inc.
757 Third Avenue
New York, NY 10017
Contents: Contains a large amount of industry news including new products, regulations, personnel changes, technological advancements, and packaging techniques.

Food Engineering

Yearly Cost: $10; $25 if not in field
Published monthly
Publisher: Chilton Company
P. O. Box 2035
Radnor, PA 19089

Contents: Contains field reports, new equipment, people and industry news, and packaging techniques.

Food Processing

Yearly Cost: $24; possibly obtained free
Published monthly
Publisher: Putman Publishing Company
430 North Michigan Avenue
Chicago, IL 60611

Contents: Contains industry news, plant and personnel news, processing and packaging techniques, sanitation and maintenance ideas.

Soap/Cosmetics/Chemical Specialties

Yearly Cost: $10
Published monthly
Publisher: McNair-Dorland Co., Inc.
101 W. 31st Street
New York, NY 10001

Contents: Contains cosmetic industry news, personnel changes, new patents, and packaging ideas.

Industrial Engineering

Yearly Cost: $25
Published monthly
Publisher: American Institute of Industrial Engineers, Inc.
25 Technology Park/Atlanta
Norcross, GA 30071

Contents: Contains all functions of industrial engineering including material handling, plant layout, human factors, etc. and the related equipment.

Manufacturing Engineering

Yearly Cost: $10
Published monthly
Publisher: Society of Manufacturing Engineers
20501 Ford Road
Dearborn, MI 48128

Contents: Discusses production technology and equipment.

Material Handling Engineering

Yearly Cost: $18; possibly obtained free
Published monthly
Publisher: Industrial Publishing Comapny
P. O. Box 5746-U
Cleveland, OH 44101

Contents: Discusses material handling equipment and systems, computers, and control systems.

Modern Packaging

Yearly Cost: $20
Published monthly
Publisher: McGraw Hill, Inc.
1221 Avenue of the Americas
New York, NY 10020

Contents: Discusses technical aspects of packaging such as computer control; contains plant and personnel news.

Package Engineering

Yearly Cost: $25; possibly obtained free
Published monthly
Publisher: Cahners Publishing Company
270 St. Paul Street
Denver, CO 80206
Contents: Contains packaging methods and materials.

Cosmetics and Perfumery

Yearly Cost: $15
Published monthly
Publisher: Allured Publishing Corporation
1031 S. Boulevard
Oak Park, IL 60302

Contents: Contains much theory;
Discusses color matching and chemical reactions.

Food Technology

Yearly Cost: $30
Published monthly
Publisher: Institute of Food Technologists
221 North LaSalle Street
Chicago, IL 60601

Contents: Discusses makeup of food and aids for food technologists.

Manufacturing Chemist and Aerosol News

Yearly Cost: $37.50
Published monthly
Publisher: Morgan-Grampian Ltd.
30 Calderwood Street
London, England SE186QH

Contents: Contains industry news and therapeutics;
Discusses uses for aerosol sprays.

ASSOCIATIONS

The associations that best represent the food, drug, and personal care industries are the Institute of Food Technologists (IFT) and the Cosmetic, Toiletry, and Fragrance Association (CTFA). CTFA offers only corporate memberships, but whether Brown and Root qualifies for membership is questionable. Both IFT and CTFA members are actually within the food and personal care industries rather than engineers.

Two associations more closely related to a manufacturing oriented department are the American Institute of Industrial Engineers and the Society of Manufacturing Engineers. Both of these organizations are professional societies of engineers who are involved with manufacturing methods and who seek solutions to manufacturing problems.

A fifth association that could be of benefit is the Society of Packaging and Handling Engineers. Packaging is a substantial portion of the food, drug, and personal care industries, and material handling is important to all manufacturing.

These associations are listed below along with their addresses, publications, and costs.

Institute of Food Technologists (IFT)
221 North LaSalle Street
Chicago, IL 60601
312:782-8424
Mr. Calvert L. Willey, Executive Director

Publications: Food Technology - monthly
Journal of Food Science - bimonthly
Membership Directory - annually

Cost: $25/year includes Food Technology
$35/year also includes Journal of Food Science
Membership: 14,000
Description: Professional society of technical personnel in food industries in the areas of production, product development, research, and product control.

Cosmetic, Toiletry, and Fragrance Association (CTFA)
1133 15th Street
Washington, DC 20005
202:331-1770
Mr. James H. Merrit, President

Publications: Legislative Bulletin - weekly
Executive Newsletter - biweekly
Inside News From CTFA - semimonthly
Trademark Bulletin - semimonthly
CTFA Cosmetic Journal - Quarterly
CTFA Ingredient Dictionary

Cost: $720/yr
Membership: 400

Description: Association of manufacturers, packagers, or distributors of cosmetic and toilet preparations and suppliers of raw materials and services.

American Institute of Industrial Engineers (AIIE)
25 Technology Park/Atlanta
Norcross, GA 30071
404:449-0460
Mr. Jack F. Jericho, Executive Director

Publications: Industrial Engineering Journal - monthly
Transactions - quarterly

Cost: $42/year
Membership: 23,000

Description: Professional society of industrial engineers concerned with the design, improvement, and installation of integrated systems of people, materials, equipment, and energy.

Society of Manufacturing Engineers (SME)
20401 Ford Road
Dearborn, MI 48128
313:271-1500
Mr. R. William Taylor, Executive Vice President

Publications: Manufacturing Engineering - monthly
Newsletters - quarterly
Transactions - annually

Cost: $28/year
Membership: 40,000

Description: Professional society of manufacturing engineers and management executives concerned with manufacturing techniques.

Society of Packaging and Handling Engineers (SPHE)
14 E. Jackson Boulevard
Chicago, IL 60604
312:321-1662
Ms. Kay Butler, Administrative Secretary

Publications: News and Trend - bimonthly
Cost: $30
Membership: 1,700

Description: Practicing engineers in the field of packaging or materials handling.

REGULATORY BODIES

Five regulatory bodies control various aspects of the food, drug, and personal care industries:

Consumer Product Safety Commission
Federal Trade Commission
United States Department of Agriculture
Occupational Safety and Health Administration
Food and Drug Administration

The Consumer Product Safety Commission and Federal Trade Commission administer primarily over commercial practices, and the Department of Agriculture is mainly concerned with the pre-manufacturing stages. The Occupational Safety and Health Administration develops and enforces regulations for construction and the work place; whereas, the Food and Drug Administration issues sanitation regulations and tests ingredients.

The regulations cited below are found in the Code of Federal Regulations (CFR). The CFR collection consists of fifty titles, and some of the titles are in more than one issue. The subscription price for the whole collection is $350, but each issue may be bought separately at varying prices ranging from two to nine dollars. They are sold by the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

Amendments to the CFR appear in the Cumulative List of CFR Sections Affected, issued monthly at a cost of ten dollars per year, and in the "Cumulative List of Parts Affected," appearing daily in the Federal Register which costs fifty dollars per year. The department's knowledge of regulations can be kept current by subscribing to either of these publications.

Consumer Product Safety Commission (CPSC)
1750 K. Street N.W.
Washington, DC 20207
202:634-7780

Purpose: To reduce the unreasonable risk of injury to consumers from consumer products.

Location of Regulations: CFR, Title 16, Chapter II

Federal Trade Commission (FTC)
Pennsylvania Avenue at Sixth Street, N.W.
Washington, DC 20580
202:963-1110

Purpose: To promote free and fair competition; to safeguard the public from deceptive advertisement; to prevent discrimination in price; to regulate packaging and labeling under the Fair Packaging and Labeling Act.

Location of Regulations: CFR, Title 16, Chapter I; by industry - various food industries appear in Parts 22, 65, 74, 114, 132, 133, 134, 144, 146, 148, 186, 194; cosmetic industry in Part 221; Fair Packaging and Labeling Act in Parts 500-503.

Initial Jargon: TRR - Trade Regulation Rules

United States Department of Agriculture (USDA)
Fourteenth Street and Independence Avenue, S.W.
Washington, DC
202:655-4000
--Agricultural Marketing Service (AMS)

Purpose: To administer grading, broad standards, and regulatory programs for food and farm products.

Location of Regulations: CFR, Title 7, Part 42 for standards for condition of food containers; Parts 46-209 for marketing standards, inspections, and practices.

--Animal and Plant Health Inspection Service (APHIS)

Purpose: To conduct regulatory and control programs to protect wholesomeness of meat and poultry products.

Location of Regulations: CFR, Title 9, Parts 1-199 and 300-399.

United States Department of Labor
Third Street and Constitution Avenue N.W.
Washington, DC 20210

--Occupational Safety and Health Administration (OSHA)

Purpose: Develop and promulgate occupational safety and health standards; develop and issue regulations; investigate compliance; and issue citations for noncompliance.

Location of Regulations: CFR, Title 29, Parts 1901 to End; safety and health regulations for construction in Part 1926.

United States Public Health Service (USPH)
5600 Fishers Lane
Rockville, MD 20852
301:443-3380

--Food and Drug Administration (FDA)

Purpose: To protect the health of the nation against impure and unsafe foods, drugs, and cosmetics.

Location of Regulations: CFR, Title 21, all Parts; Parts 128 and 1250 for sanitation regulations concerning preparing packing, and holding.

Initial Jargon: FOI - Freedom of Information
FDLI - Food and Drug Law Insititute
OTC - Over the Counter Drugs
GMPR - Good Manufacturing Practice Regulations.

INITIAL JARGON

Some of the initials, other than those associated with the above departments and agencies, that commonly appear without explanation in food, drug, and personal care literature are given meaning in the following list:

AAA - American Academy of Allergy

BISSC - Baking Industry Sanitation Standards Committee
- Develops and publishes standards for its members and food inspection agencies.

CAST - Council for Agricultural Science and Technology

CCMA - Certified Color Manufacturers Association
- Manufacturers of food colors

GRAS - Generally Recognized As Safe

ICMAD - Independent Cosmetic Manufacturers and Distributors
- Association of mostly small cosmetic manufacturers

NCA - National Canners Association

NMFS - National Marine Fisheries Service

SCC - Society of Cosmetic Chemists

BIBLIOGRAPHY

The following bibliography is composed of articles, grouped within their publication, which represent much of what has been happening in the food, drug, and personal care industries over the past three years. Rather than suffering the expense of Xeroxing these articles, a wiser choice would be to order past issues of the magazines. Past issues would contain equipment advertisements, personnel changes, and industry news that would not be contained in article copies.

The addresses, costs, and estimated supplies for ordering past issues is given below. All publishers requested a written request rather than a phone order. Following the ordering information appears the bibliography.

Drug and Cosmetic Industry

Harcourt, Brace, Govanovich Publications
1 East First Street
Duluth, MN
218:727-8511

Cost: $1.50/issue plus postage and handling
Supply: Mostly 1976 issues with possibly some in earlier years. Enter a full request and they will send what they have.

Food Engineering

Chilton Company
P. O. Box 2035
Radnor, PA 19089
215:687-8200

Cost: $1/issue plus postage and handling
Supply: Probably everything desired

Food Processing

Putnam Publishing Company
430 North Michigan Avenue
Chicago, IL 60611
312:644-2020

Cost: $2/issue plus postage and handling
Supply: Back into 1975. Enter a full request and they will send what they have.

Soap/Cosmetics/Chemical Specialties

McNair-Dorland Co., Inc.
101 W. 31st Street
New York, NY 10001
212:279-4455

Cost: $3/issue plus postage and handling
Supply: Enter a full request and they will send what they have.

Alguire, Donald. "Ethylene Oxide--Propylene Oxide Treatment of Foods, Drugs, Cosmetics." Drug and Cosmetic Industry, Vol. 119, No. 5, Nov. 1976, pp. 46-52, 109-111.

Dickinson, J. W. "Those New Cosmetic Regulations." Drug and Cosmetic Industry, Vol. 114, No. 2, Feb. 1974, pp. 40-42.

Dubeck, Joseph B. "Tool Maintenance in Tabletting." Drug and Cosmetic Industry, Vol. 115, No. 2, Aug. 1974, pp. 38-41.

Feinstein, William. "Manufacturing the New Dry Product." Drug and Cosmetic Industry, Vol. 116, No. 5, May 1975, pp. 38-41, 131-134.

Pushparaj, A. and J. Nine. "Design for Manufacturing and Packaging Solid Dosage Forms." Drug and Cosmetic Industry, Vol. 115, No. 5, Dec. 1974, pp. 41-45, 129-131.

"Canning: A Special Section." Food Engineering, Vol. 45, No. 12, Dec. 1973, pp. 71-87.

"Checklist for OSHA Requirements." Food Engineering, Vol. 45, No. 9, Sept. 1973, pp. 83-85.

Copper, Anthony and Gerald J. Bugman. "How to Conserve Energy Using Plate Heat Exchangers." Food Engineering, Vol. 48, No. 11, Nov. 1976, pp. 73-75.

"Distribution 75: Where the Savings Are." Food Engineering, Vol. 47, No. 4, April 1975, pp. 59-68.

"Food Materials Handling: Special Report." Food Engineering, Vol. 47, No. 3, March 1975, pp. 55-62.

"Food Waste Fermentation." Food Engineering, Vol. 48, No. 11, Nov. 1976, pp. 61-71.

Gray, M. H. and Dan Devendorf. "An Old Plant Renews Itself." Food Engineering, Vol. 46, No. 1, Jan. 1974, pp. 78-80.

Izzo, Joseph. "Complex Waste Problems Yield to Integrated Systems." Food Engineering, Vol. 45, No. 11, Nov. 1973, pp. 166-170.

Lawler, Frank K. "High-Rise Tunnel Freezes Almost Anything." Food Engineering, Vol. 46, No. 4, April 1974, p. 83.

Miller, Richard K. "You Can Reduce Plant Noise." Food Engineering, Vol. 45, No. 3, Mar. 1973, pp. 133-140.

"Plant Design Series." Food Engineering, Vol. 45, No. 9, Sept. 1973, pp. 62-81.

"Plant Update 74." Food Engineering, Vol. 46, No. 9, Sept 1974, pp. 61-88.

"Pollution Control, Don't Lag Behind." Food Enginering, Vol. 45, No. 6, June 1973, pp. 67-81.

Regan, W. J. "Cream-Style Corn at 100 Tons an Hour." Food Engineering, Vol. 46, No. 10, Oct. 1974, pp. 64-65.

Slater, Lloyd E. "The Digital Take-Over in Food Manufacturing." Food Engineering, Vol. 47, No. 8, Aug. 1975, pp. 39-55.

"20 Innovative Cost-Cutters," Food Engineering. Vol. 45, No. 2, Feb. 1973, pp. 70-73.

"Unmask Your True Costs with 'Trade-Off' Techniques." Food Engineering, Vol. 48, No. 4, April 1976, pp. 67-70.

VanBrederode, H. "Automated System Processes Cocoa Beans at 60,000 Tons/Year." Food Engineering, Vol. 46, No. 11, Nov. 1974, pp. 69-72.

Ziemba, John V. "Wilson Plant Processes in Missouri Hog County--Meets All Anti-Pollution Standards." Food Engineering, Vol. 46, No. 6, June 1974, pp. 62-66.

Collins, John L. and John V. Ziemba. "Sunkist saves $90,000/Year with Continuous-Tray Dryers." Food Processing, Vol. 37, No. 11, Nov. 1976, pp. 98-99.

DeBenedetto, John and Karl Robe. "Filler-Capper Combination Speeds Production 48%, Saves 1/3 Labor." Food Processing, Vol. 37, No. 11, Nov. 1976, pp. 114-115.

"FDA Announces 'Phase 4' ... 18 Food Labeling Actions." Food Processing, Vol. 35, No. 8, Aug. 1974, pp. 8-11.

"Food and Dairy Expo '74 Preview." Food Processing, Vol. 35, No. 10, Oct. 1974, pp. 52-67.

Hlavacek, Roy G. "Food Processing's Guide to FDA...USDA...NMFS...OSHA...EPA." Food Processing, Vol. 35, No. 7, July 1974, pp. 50-54.

Hollinger, Donald. "Exact Weight Labels Printed and Applied Accurately to Moving Mixed-Weight Cartons." Food Processing, Vol. 37, No. 11, Nov. 1976, p. 120.

"Spotlight on Food Service Processing/Packaging." Food Processing, Vol. 36, No. 9, September 1975, pp. 23-39.

"Spotlight on FPI Trends." Food Processing, Vol. 36, No. 12, Dec. 1975, pp. 21-28.

"Spotlight on Material Handling and Transportation." Food Processing, Vol. 36, No. 3, Mar. 1975, pp. 26-44.

"Spotlight on New Food Plants." Food Processing, Vol. 36, No. 6, June 1975, pp. 32-54.

"Spotlight on New Processing Developments." Food Processing, Vol. 35, No. 1, Jan. 1974, pp. 50-70.

"Spotlight on New Processing Developments." Food Processing, Vol. 36, No. 1, Jan. 1975, pp. 50-76.

"Spotlight on Packaging." Food Processing, Vol. 35, No. 4, April 1974, pp. 49-67.

"Spotlight on Packaging." Food Processing, Vol. 36, No. 4, April 1975, pp. 24-78.

"Spotlight on Process Control." Food Processing, Vol. 36, No. 10, Oct. 1975, pp. 70-95.

Thill, Robert M., Oak M. Russell and Eugene R. Dye. "Foremost Takes Management Approach to a Multi-Plant Sanitation Program." Food Processing, Vol. 37, No. 11, Nov. 1976, pp. 132-133.

Raften, Barry. "How Avon Bottom Labels at High Speeds." Soap/Cosmetics/Specialties, Vol. 52, No. 10, Oct. 1976. pp. 82, 106.

Randall J. Gannaway

Randall J. Gannaway

RJG:jfk

ACRONYM GLOSSARY

AACC: American Association of Cereal Chemists - professional society of scientists in the cereal processing industry.

AACE: American Association of Cost Engineers - society of cost engineers seeking to standardize and advance cost engineering.

ABA: American Bakers Association - association of manufacturers and wholesale distributors of bread, roll, and pastry products.

ACEC: American Consulting Engineers Council - association of individuals and firms providing fully independent professional engineering services.

AIIE: American Institute of Industrial Engineers - professional society of industrial engineers concerned with the design, improvement, and installation of integrated systems of people, material, equipment and energy.

AIPE: American Institute of Plant Engineers - society of engineers responsible for plant engineering activities.

AMA: American Management Association - association of professional management executives.

AMS: Agricultural Marketing Service - an agency within the United States Department of Agriculture responsible for the administration of grading, broad standards, and regulatory programs for food and farm products.

ANSI: American National Standards Institute - organization of industrial firms, trade associations, technical societies, consumer organizations, and government agencies which serves as a clearing house for nationally coordinated voluntary safety, engineering, and industrial standards.

APCA: Air Pollution Control Association - organization dedicated to advancing the science and art of air pollution control.

APHIS: Animal and Plant Health Inspection Service - an agency within the United States Department of Agriculture responsible for conducting regulatory and control programs to protect the wholesomeness of meat and poultry products.

APICS: American Production and Inventory Control Society - professional society of production and inventory control management personnel.

ARBA: Associated Retail Bakers of America - association of retail bakeries producing bread, cake, and other baked products for sale in their own shops.

ARI: Air Conditioning and Refrigeration Institute - association of corporations engaged in the manufacture of air conditioning and refrigeration equipment.

ASAE: American Society of Agricultural Engineers - professional society of agricultural engineers.

ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers - professional society of individuals in the above engineering fields.

ASLE: American Society of Lubricating Engineers - society of engineers and others engaged in the technological development and use of lubricants, lubricating equipment and systems.

ASME: American Society of Mechanical Engineers - professional society of mechanical engineers which develop standards, safety procedures, and operating principles for mechanical operations.

ASMMA: American Supply & Machinery Manufacturers Assocation - association of manufacturers of industrial machinery and mill supplies.

ASSE: American Society of Safety Engineers - society of individuals with experience in the safety profession.

BCDA: Biscuit & Cracker Distributors Association - association of distributors and manufacturers of cookies, crackers, and related products.

BEMA: Bakery Equipment Manufacturers Association - association of manufacturers of bakery equipment, machinery, ovens, and pans.

BISSC: Baking Industry Sanitation Standards Committee - committee that develops and publishes standards for its members and food inspection agencies.

CAM: Computer Aided Manufacturing

CASA: Computer and Automated Systems Association - association seeking to integrate the functions of the plant through automation.

CAST: Council for Agricultural Science and Technology.

CCMA: Certified Color Manufacturers Association - association of food color manufacturers.

CEMA: Conveyor Equipment Manufacturers Association - manufacturers and engineers of conveyors and conveying systems, portable and stationary machines used in transportation of raw materials and finished goods in warehouses and on assembly line operations.

CFR: Code of Federal Regulations - collection of issues containing the federal regulations.

CPSC: Consumer Product Safety Commission - federal agency established to reduce the unreasonable risk of injury to consumers from consumer products.

CTFA: Cosmetic, Toiletry, and Fragrance Association - association of managers, packagers, or distributors of cosmetic and toilet preparations and suppliers of raw materials and services.

DFISA: Dairy and Food Industry Supply Association - association of manufacturers and distributors of dairy and food processing equipment, machinery, and supplies.

DREF: Distribution Research & Education Foundation - a research organization administered through Ohio State University, funded by wholesaler organizations with interests in inventory control, sortation, and order picking systems. DREF code is a symbology for a standardized, machine readable identification code for use on shipping containers.

EJC: Engineers Joint Council - association of engineering societies that seeks to advance the art and science of engineering to the public interest.

EPA: Environmental Protection Agency - federal agency that endeavors to abate and control pollution systematically by proper integration of a variety of research, monitoring, standard setting, and enforcement activities.

FDA: Food and Drug Administration - agency within the United States Public Health Service responsible for protecting the health of the nation against impure and unsafe foods, drugs, and cosmetics.

FDLI: Food and Drug Law Institute.

FEA-FAC: Federal Energy Administration Food Advisory Committee - that section of the Federal Energy Administration devoted to the food industry.

FEMA: Flavor and Extract Manufacturers Association - association of firms engaged in the manufacture and sale of flavoring extracts, flavors, syrups, or colors.

FNS: Food Nutrition Service - agency within the United States Department of Agriculture that administers food assistance programs.

FOI: Freedom of Information

FPRDC: Food Protein Research and Development Center - protein research center at Texas A & M University.

FTC: Federal Trade Commission - federal agency established to promote free and fair competition; regulates packaging and labeling under the Fair Packaging and Labeling Act.

GPC: Grocery Pallet Council

GMPR: Good Manufacturing Practice Regulations - manufacturing regulations under the Food and Drug Asministration.

GRAS: Generally Recognized As Safe - a rating given by the Food and Drug Administration.

ICMAD: Independent Cosmetic Manufacturers and Distributors - association of mostly small cosmetic manufacturers.

IFT: Institute of Food Technologists - professional society of technical personnel in food industries in the areas of production, product development, research, and production control.

IHEA: Industrial Heating Equipment Association - association of individuals engaged in the design and/or manufacture of industrial heating equipment.

IMMS: Internal Material Management Society - professional society of engineers, educators, and executives which seek to advance the theory and practice of material management and material handling systems.

INCE: Institute of Noise Control Engineering - society of individuals who have professional responsibilities for noise control seeking to advance noise control technology.

ITA: Industrial Truck Association - association of manufacturers of industrial trucks.

JIC: Joint Industry Conference - producers and users of machine tools and industrial machinery and equipment.

MCA: Manufacturing Chemists Association - association of manufacturers of basic chemicals who sell a substantial portion of their production to others.

MHEDA: Material Handling Equipment Distributors Association - association of manufacturers and distributors of material handling equipment and machinery.

MHI: Material Handling Institute - manufacturers of industrial material handling equipment and systems.

NAFD: National Association of Flour Distributors - association of jobbers, distributors, brokers, and mill representatives engaged in the distribution of bakery flours.

NASFT: National Association for the Specialty Food Trade - association of manufacturers, processors, importers, and brokers of specialty and gourmet foods.

NAW: National Association of Wholesalers - association of wholesaler distributors.

NAWG: National Assocation of Wheat Growers - federation of eleven state wheat growers associations.

NCA: National Canners Association - association of commerical packers of food products.

NCPDM: National Council of Physical Distribution Management

NCS: Numerical Control Society - society of users and manufacturers of numerical control equipment seeking the advancement and dissemination of knowledge and application of numerical control.

$NFPA_1$: National Fire Protection Association - association that compiles annual statistics on causes and occupancies of all fires, of large-loss fires, and of fire deaths.

$NFPA_2$: National Flexible Packaging Association - association of converters of paper, foils, and plastic packaging materials.

NMFS: National Marine Fisheries Service - a section of the National Oceanic and Atmospheric Administration.

NPBI: National Pretzel Bakers Institute - association of manufacturers and suppliers of pretzels and associated products.

NSWMA: National Solid Waste Management Association - association of waste management service organizations and manufacturers of waste-handling equipment seeking to advance the technology of waste management services.

NWPCA: National Wooden Pallet & Container Association - association of manufacturers and distrubutors of pallets, wooden skids, and all forms of wooden containers.

OSHA: Occupational Safety and Health Administration - an agency within the United States Department of Labor, responsible for developing occupational safety and health standards and enforcing compliance to the resulting regulations.

OTC: Over the Counter - drugs sold over the counter.

PI: Packaging Institute - association of users and manufacturers of packaging materials, machinery, and services.

PMMI: Packaging Machinery Manufacturers Institute - association of manufacturers of machinery to perform all varieties of packaging operations.

SAVE: Society of American Value Engineers - society of value engineers seeking to advance the knowledge and application of value engineers.

SCC: Society of Cosmetic Chemists - professional society of cosmetic and perfume chemists.

SLE: Society of Logistic Engineers - professional society of logistic engineers.

SME: Society of Manufacturing Engineers - professional society of manufacturing engineers and management executives concerned with manufacturing techniques.

SPHE: Society of Packaging and Handling Engineers - Society of practicing engineers in the field of packaging and materials handling.

TRR: Trade Regulation Rules - regulations under the Federal Trade Commission.

UPC: Universal Product Code - the product and price identification symbol composed of a ten-digit human-readable symbol expressed in bars that will permit supermarkets to largely automate their checkout systems.

USDA: United States Department of Agriculture - the federal department required by law to study, regulate, and gather information on agricultural subjects.

USDA-MID: Meat Inspection Division of the United States Department of Agriculture - a division under the Animal and Plant Health Inspection Service.

USPH: United States Public Health Service - federal agency charged by law to promote and assure the highest level of health attainable for every individual.

WPCF: Water Pollution Control Federation - an association seeking the advancement of fundamental and practical knowledge concerning the collection and treatment of industrial waste waters.

MANUFACTURING AND PROCESSING INDUSTRIES
ENGINEERING DEPARTMENT

INTER OFFICE MEMO

TO: Keith Sandefer DATE: December 29, 1976

FROM: Randall J. Gannaway

SUBJECT: Use of Professional Engineer's Seal

The following list was composed from the individual state engineering regulations governing the use of the professional engineer's seal. For each state, the regulations concerning both the individual and the corporation are supplied if they exist.

In some instances, no mention of the seal was made in relation to the corporation. A typical corporate practice regulation could be the following:

> A firm association, partnership or corporation may not engage in the practice of engineering as a professional except through its officers, agents or employees and then not unless one of the owners or incorporators is a registered engineer and unless the practice of engineering as engaged in is done under the supervision and direction of a registered engineer.

In such a case, where no mention of the seal is made, it must be assumed that the regulation governing the individual registrant's use of the seal also governs those professional engineers within a corporation.

The list is in alphabetical order by State and gives the individual registrant regulation first, followed by the corporation regulation.

ALABAMA

Individual: Each engineer, upon registration, may obtain a seal. Engineering drawings, plans, specifications, plats, and reports issued by a registrant or by qualified persons under his direction and for which he assumes full responsibility, shall be certified.

ALABAMA - (continued)

Corporation: All drawings plans, specifications, plats, and reports involving the practice of engineering shall, when issued, be dated and bear the seal or facsimile of such seal or signature and registration number of the professional engineer in responsible charge thereof.

ALASKA

Individual: Final drawings, specifications, surveys, plats, plates, reports and other similar documents shall, when issued, be signed and stamped with the seal.

Corporation: Plans, specifications, designs and reports when issued in connection with work performed by a corporation under its certificate of authorization shall be prepared by or under the responsible charge of and shall be signed by and shall be stamped with the official seal of a person holding a certificate of registration under this chapter.

ARIZONA

Individual: An imprint of the registrant's valid seal shall appear on each and every sheet of drawings, on the cover and index page of each set of specifications, on the cover and index page of details bound in book form and prepared specifically to supplement project drawings, on the cover and index page of reports and/or other professional documents prepared by a registrant or his bona fide employee. Superimposed over the imprint of the seal shall be the original signature of the registrant and the date indicated when the seal imprint was signed.

ARKANSAS

Individual: Final drawings, specifications, plats and reports prepared by a registrant shall, when issued, be stamped with the seal or facsimile thereof.

Corporation: All final drawings, specifications, plans, reports, or other engineering documents involving the practice of engineering as defined in the Acts, when issued, or filed for public record, shall be dated and bear the seal of the professional engineer who prepared or approved them.

CALIFORNIA

Individual: All engineering plans, specifications, reports or documents shall be prepared by a registered engineer or by a subordinate employee under his direction and shall be signed by him to indicate his responsibility for them. In addition to his signature, he shall show his registration number or the stamp of his seal.

Corporation: All engineering plans, specifications, and reports must be prepared by or under the direct supervision of a registered engineer in the appropriate branch of professional engineering, who shall sign or stamp with his seal such plans, specification, and reports.

COLORADO

Individual: The final plans, of which designs, drawings, specifications, and reports may be a part, resulting from the practice of engineering, shall be identified with and bear the seal or facsimile and signature of the licensee in responsible harge.

COLORADO - (continued)

Corporation: All engineering plans, designs, drawings, specifications, or reports, which are involved in such practice, issued by or for such corporation shall bear the seal and signature of a Colorado professional engineer in responsible charge of and directly responsible for such engineering work when issued.

CONNECTICUT

Individual: The seal shall be applied to all plans, maps, surveys, sketches, drawings, specifications and documents pertaining to any project submitted by the registrant to his client. Where drawings or documents are bound together, the application of the seal on one sheet or page shall be sufficient, except in filing plans for building permits and appurtenant structures, where each sheet shall be sealed.

Corporation: All final drawings, specifications, plats, reports, or other engineering papers or documents involving the practice of engineering which are prepared or approved by any such corporation or engineer for use or for delivery to any person or for public record within this State shall be dated and bear the signature and seal of the engineer who prepared them or under whose supervision they were prepared.

DELAWARE

Partnership and Corporation: All final drawings, papers or documents involving the practice of engineering as defined in this Act when issued or filed for public record shall be dated and the signature and seal of the Registrants or Permittees who prepared or approved them.

DISTRICT OF COLUMBIA

Individual: Such seal, or a facsimile imprint of same, shall be stamped on all plans, specifications, and reports by the registrant responsible for the accuracy and adequacy of such plans, specifications, and reports, when filed with public authorities.

FLORIDA

Individual: All plans, specifications, plats, or reports prepared or issued by a registrant shall be stamped with said seal.

Corporation: All final drawings, specifications, plans, reports, or other engineering papers or documents involving the practice of professional engineering which shall have been prepared or approved for the use of such corporation or partnership or for delivery to any person or for public record within the state shall be dated and bear the signature and seal of the professional engineer who prepared or approved them.

GEORGIA

Individual: Plans, specifications, and reports issued by a registrant shall be stamped or sealed and countersigned by such registrant.

HAWAII

Individual: All plans, specifications, maps and reports prepared by or under the supervision of a registered engineer, architect or surveyor, shall be stamped with such seal or stamp when filed with public officials.

IDAHO

Individual: All drawings, specifications, plats, reports, or other engineering papers or documents involving engineering work which shall have been prepared or approved for the use of or for delivery to any person or for public record within this State, shall be impressed with said seal.

Corporation: All final drawings, specifications, plats, reports, or other engineering papers or documents involving the practice of engineering which shall have been prepared or approved for the use of or for delivery to any person or for public record within this State shall be dated and bear the signature and seal of the engineer who prepared or approved them.

ILLINOIS

Individual: Plans and specifications, designs, drawings, reports, and other documents rendered as professional engineering services, and revisions thereof, shall be stamped with the seal or facsimile of the registrant preparing the plans or under whose personal supervision the plans have been prepared. The registrant shall also affix his signature and date thereof on or close to his seal or facsimile so stamped.

Corporation: All final plans, designs, drawings, reports and specifications and other documents rendered as professional engineering services and revisions thereof, issued by or for the corporation are dated and bear the seal or facsimile and signature of a registered professional engineer.

INDIANA

Individual: During the period of time that a registrant's certificate is valid the registrant is authorized to apply his seal to plans, specifications, plats, drawings, and reports prepared by him or by his regularly employed subordinates.

KANSAS

Individual: Final plans, specifications, plats and reports prepared by a licensed professional engineer shall be stamped with the said seal during the life of the license.

KENTUCKY

Individual: Plans, specifications, plats and reports approved by a licensee shall be stamped with the seal when filed with public authorities.

LOUISIANA

Individual and Corporation: All registrants engaged in the practice of engineering or land surveying either in a private professional practice or as an employee of a corporation shall impress with his official seal all plans, specifications, plats, maps, studies, reports, or other drawings or documents which he shall prepare or which shall be prepared under his supervision.

MAINE

Individual and Corporation: Plans, specifications, plats and reports issued by a registrant shall be stamped with the said seal. Said seal shall be impressed in the proper location in the following cases:

A. On all plans or documents filed or offered for filing with any public body or agency.

B. Registered Engineers engaged in private or consulting practice shall affix their seals to plans, specifications and reports.

C. Seals need not be affixed on any engineering documents which are inter-company routine.

D. Seals shall be affixed to all plans and documents formally submitted to contractors for bids or estimates.

Any registered engineer may impress his seal on any plans or documents, whether made by him or others, provided he takes full responsibility therefor, whether adequate compensation is received or not. Where drawings or documents are bound together, the application of the seal on the first page shall be considered sufficient, but said first sheet must bear a statement of the number of sheets covered by the seal. The seal shall be affixed over the signature or title of the responsible professional engineer.

MARYLAND

Individual: Plans, specifications, plats and reports prepared by a registrant shall be stamped with the said seal or facsimile thereof and signed by the registrant when issued to any clients or when filed with public authorities during the life of the registrants certificate.

MASSACHUSETTS

Individual: Plans, specifications, plats and reports prepared by a registrant shall be stamped with the said seal when filed with public authorities.

MICHIGAN

Individual: Plans, specifications, plats and reports issued by a registrant shall be sealed when filed with public authorities. All sheets of plans, plats, drawings, maps and the title sheet of specifications, addenda, bulletins, and reports or, where bound copies are submitted, the index sheets of plans, specifications, and reports, when prepared by a registrant and required to be submitted to a governmental agency for approval or record, shall carry the embossed or printed seal of persons in responsible charge.

MINNESOTA

Individual: Plans, specifications, plats, reports, and other documents prepared by a registrant may be stamped with the seal. The certification and signature on plans, specifications, plats, reports, etc., is mandatory.

MISSISSIPPI

Individual: Plans, specifications and reports prepared by a registrant shall be stamped with the said seal when filed with public authorities.

MISSOURI

Individual: Each registered professional engineer shall affix the seal to all plans, specifications, estimates, plats, reports, surveys, and other documents prepared by him, or under his direction.

Corporation: Any registered professional engineer may practice his profession through the medium of or as an employee of a corporation if the plans, specifications, estimates, plats, reports, surveys, or other like documents or instruments of the corporation are signed and stamped with the personal seal of the professional engineer by whom or under whose personal direction the same were prepared.

MONTANA

Individual: Plans, specifications, plats and reports prepared by a registrant shall, when issued, be certified, signed and stamped with the said seal or facsimile thereof. For stamping plans, specifications, and reports registrants are authorized to have a rubber stamp copy made of their official seal; however, the title page of all sets of plans and all documents filed with public authorities must bear the imprint of the official seal.

NEBRASKA

Individual: Final plans, specifications, plats and reports issued by a registered professional engineer shall be stamped with his seal or facsimile thereof.

NEVADA

Individual: Plans, specifications, plats and reports issued by a registrant shall be stamped with the seal when filed with public authorities.

NEW HAMPSHIRE

Individual: Plans, specifications, plats, and reports prepared by a registrant shall be stamped with the said seal.

Corporation: All final drawings, specifications, plans, reports or other engineering as defined in this act when issued, or filed for public record, shall be dated, and bear the signature and seal of the professional engineer who prepared or approved them.

NEW JERSEY

Individual: Plans, specifications, plats, and reports issued by registrants, shall be stamped with said seal when filed with public authorities.

NEW MEXICO

Individual: All plans, specifications, plats and reports prepared by a person registered under the Engineering Practice Act shall be impressed with a seal of a design authorized by the board.

Corporation: All plans, design, drawings, specification, or reports, which are involved in such practice, issued by or for such corporation, shall bear the seal and signature of a professional engineer, in responsible charge of and directly responsible for such work when issued. A rubber stamp, in the same size and design as the seal, may be used on copies and reprints of the original drawings.

NEW YORK

Individual: All plans, specifications, plats and reports relating to the construction or alteration of buildings or structures prepared by such professional engineer, or by a full-time or part-time subordinate under his supervision, shall be stamped with such seal and shall also be signed, on the original with the personal signature of such professional engineer when filed with public officials. If an item bearing the seal is altered, the altering engineer shall affix to the item his seal and the notation "altered by" followed by his signature and the date of such alteration, and specific description of the alteration.

NORTH CAROLINA

Individual: Each registrant is required to possess a seal and to use it on all plans, specifications, plats, and reports where a registrant is required to blueprint or reproduce his original drawings or specifications in multiple copies he may employ a suitable replica, or rubber stamp to facilitate reproduction. The original drawings, specifications, or documents shall bear the seal.

NORTH DAKOTA

Individual: Final engineering drawings, specifications, maps, plats, reports or other documents prepared by a person required to be registered under this Act, shall, when issued, be signed and stamped with the said seal or facsimile thereof.

NORTH DAKOTA - (continued)

Corporation: All final drawings, specifications, plans, reports, or other engineering or land surveying papers or documents involving the practice of professional engineering, when issued, shall be dated and bear the seals and signatures of the professional engineers by whom or under whose responsible charge they were prepared.

OHIO

Individual: Plans, specifications, plats, and reports issued by a registrant shall be stamped with the said seal when filed with public authorities.

OKLAHOMA

Individual: Final engineering drawings, specifications, plats, and reports prepared by a registrant shall, when issued, be signed and stamped with the seal or facsimile thereof.

Corporation: All final drawings, specifications, plans, reports, or other engineering papers or documents involving the practice of engineering, when issued or filed for public record, shall be dated and bear the signature and seal of the professional engineer who prepared or approved them.

OREGON

Individual: All final drawings, specifications, designs, reports, maps and plans issued by a registrant shall be stamped and signed by the registrant. Every map, plan and drawing required by law to be certified or approved by an engineer shall be stamped with the seal of, and signed by, a professional engineer.

Corporation: All final drawings, specifications, designs, reports maps and plans issued by the corporation must bear the seal and signature of at least one of the designated engineers.

PENNSYLVANIA

Individual: Such seal, or a facsimile imprint of same, shall be stamped on all plans, specifications, plats and reports issued by a professional engineer.

Corporation: It shall be unlawful for any firm or corporation to engage in the practice of engineering...unless the directing heads and employees of such corporation in responsible charge of its activities in the practice of such profession are licensed and registered in conformity with the requirements of this act, and whose name and seal shall be stamped on all plans, specifications, plats and reports issued by such corporation.

RHODE ISLAND

Individual: Final engineering drawings, specifications, plats, and reports prepared by a registrant shall, when issued, be signed, and stamped with the said seal or facsimile thereof.

Corporation: All final plans, designs, drawings, specifications and reports involving engineering judgement and discretion, when issued, shall be dated and bear the seals and signatures of the engineers who prepared them.

SOUTH CAROLINA

Individual: Plans, specifications, plats and reports prepared by a registrant shall be stamped with such seal when filed with public authorities.

SOUTH DAKOTA

Individual and Corporation: All final drawings, plans, specifications, reports, plats, or other engineering documents, papers or diagrams involved in the practice of professional engineering prepared for the use of others by any corporation for delivery by it to any person to be made a part of any public record within the State shall be dated and bear the signature, stamp or seal of the professional engineer who was in responsible charge of the preparation thereof.

TENNESSEE

Individual: The registrant shall stamp over signature and date with the seal the first sheet of any bound set and loose sheets of every set of working drawings, plans, specifications, plats, and/or reports prepared by him or under his responsible charge. Either rubber stamp or embossed seal may be used.

TEXAS

Individual: Plans, specifications, plats and reports issued by a registrant shall be stamped with the said seal when filed with public authorities.

UTAH

Individual: Plans, maps, sketches, surveys, drawings, documents, specifications, plats, and reports prepared by a registrant shall be stamped with the said seal when submitted to a registrant's client or filed with public authorities.

VERMONT

Individual: Plans, specifications, plats and reports issued by a registrant shall be stamped with such seal.

VIRGINIA

Individual: Each professional engineer shall apply a seal of the rubber stamp or preprinted type to final and complete cover sheets or signature sheets of plans, drawings, plats and specifications prepared by him or under his direct responsibility. Plans, documents and sketches which are incomplete, whether advance copy or preliminary, shall be so identified and no seal or signature shall be required. When used as hereinbefore outlined, the seal imprint applied to original sheets, tracings, cover sheets or signature sheets shall be signed.

Corporation: Only one seal is required for the documents of a single project as prepared by each firm. However, the professional whose seal is to be used must be a principal in the firm who has the primary responsibility for the particular project. In addition the seals of other professionals in the firm may be used. When there is a joint venture comprising an association of two or more firms, each firm shall use the seal of its professional who has the primary responsibility for his firm.

WASHINGTON

Individual: Plans, specifications, plats and reports prepared by the registrant shall be signed, dated and stamped with said seal or facsimile thereof.

WASHINGTON - (continued)

Corporation: All plans, specifications, designs and reports when issued in connection with work performed by a corporation under its certificate of authorization shall be prepared by or under the responsible charge of an shall be signed by and shall be stamped with the official seal of a person holding a certificate of registration under this chapter.

WEST VIRGINIA

Individual: Plans, specifications, plats and reports issued by a registrant shall be stamped or sealed.

WISCONSIN

Individual: Each sheet of plans, drawings, documents, specifications, and reports for engineering practice shall be signed, sealed and dated by the registrant or permit holder preparing them, or in direction and control of their preparation.

Corporation: All final drawings, specifications, plans, reports or other engineering papers or documents involving the practice of professional engineering prepared for the use of the corporation, for delivery by it to any person or for public record within the State shall be dated and bear the signature and seal of the professional engineer who was in responsible charge of their preparation.

WYOMING

Individual: All maps, plats, plans, or designs necessary to be filed in the State Engineer's Office, the Office of Commissioner of Public Lands, all County Clerks Offices, all City or Town Officer, or any other office of public record in the State of Wyoming, shall be made and certified by a professional engineer registered under this act.

LEGAL REQUIREMENTS
ON
USE OF ENGINEERS'SEALS ON DOCUMENTS

STATE	INDIVIDUAL REGISTRANTS			CORPORATIONS		
	All Prepared By	All Issued	All Filed For Public Record	All Prepared By	All Issued	All Filed For Public Record
LABAMA		X			X	
LASKA		X			X	
RIZONA	X					
RKANSAS		X			X	
ALIFORNIA	X			X		
OLORADO	X				X	
ONNECTICUT		X		X		
ELAWARE		X			X	
ISTRICT OF OLUMBIA			X			
LORIDA	X			X		
EORGIA		X				
AWAII			X			
DAHO	X			X		
LLINOIS	X				X	
NDIANA	X					
OWA	X					
ANSAS	X					
ENTUCKY			X			
OUISIANA	X			X		
AINE		X			X	
ARYLAND		X				

STATE	INDIVIDUAL REGISTRANTS			CORPORATIONS		
	All Prepared By	All Issued	All Filed For Public Record	All Prepared By	All Issued	All Filed For Public Record
SSACHUSETTS			X			
CHIGAN			X			
NNESOTA	X					
SSISSIPPI			X			
SSOURI	X			X		
NTANA		X				
BRASKA		X				
VADA			X			
W HAMPSHIRE	X			X		
W JERSEY			X			
W MEXICO	X				X	
W YORK	X					
RTH CAROLINA	X					
RTH DAKOTA		X			X	
IO			X			
LAHOMA		X			X	
EGON		X			X	
NNSYLVANIA		X			X	
ODE ISLAND		X			X	
UTH CAROLINA			X			
UTH DAKOTA		X			X	
NNESSEE	X					
EXAS			X			
AH		X				
ERMONT		X				

STATE	INDIVIDUAL REGISTRANTS			CORPORATIONS		
	All Prepared By	All Issued	All Filed For Public Record	All Prepared By	All Issued	All Filed For Public Record
RGINIA	X			X		
SHINGTON	X				X	
ST VIRGINIA		X				
SCONSIN	X			X		
OMING			X			

PATERSON ZOCHONIS PROJECT

TASK SPECIFICS

During May of 1977, Mr. Keith Sandefer assigned me to travel with him and Mr. Archie Kotara, the Structural Department Senior Manager, to Manchester, England and Lagos, Nigeria in order to collect and assess data for the expansion of Paterson Zochonis UK Limited (hereafter referred to as Paterson Zochonis) Operations in Nigeria. Some time earlier, representatives of Paterson Zochonis had met with Mr. Sandefer to discuss Brown & Root and the MAPI Department engineering and constructing a refrigerator manufacturing plant, a powder detergent plant, plus other plants and facilities. The Paterson Zochonis representatives interviewed several other engineering and construction firms but selected Brown & Root. Though no contract had yet been signed, this project was to be the first manufacturing project by the MAPI Department, and I was selected to take part in the first phase of the project which was data collection and assessment.

The assignment entailed travelling to Manchester, England and Lagos, Nigeria to meet with the directors and engineers of Paterson Zochonis and to discuss the project. The trip was to serve the dual purpose of initiating contract negotiations during the data collection and assessment phase. Travel to Manchester was necessary, because both the home office of Paterson Zochonis and of Cussons, Limited, a subsidiary of Paterson Zochonis which had engineers working on the project,

were located there. Travel to Lagos was necessary, because the construction site would be outside of Lagos, and the existing Paterson Zochonis operations could be observed. The objectives of the assignment were:

1. To collect and assess data pertinent to the Paterson Zochonis project.
2. To discuss the design of the project with Paterson Zochonis engineers.
3. To observe existing Paterson Zochonis operations in Nigeria.
4. To initiate contract negotiations.

TASK PLANNING

A couple of weeks before I was to leave for England, I was given the little data that had already been given to the Department and was instructed to prepare myself for the data collection and assessment trip which was thought to consist primarily of the refrigerator manufacturing plant and the powder detergent plant. I prepared myself for the task by reviewing my industrial engineering training and by making a list of what data I thought would be necessary for the design of the plants. To help me obtain the information necessary in the other disciplines, I obtained a list of questions from each of the discipline departments that would be involved in the project. I took the combined list along to obtain answers from the Paterson Zochonis personnel. The actual trip was to take two weeks, and then two more weeks would be allocated to assess the data obtained.

We travelled on the weekend, and on Sunday night before we were to meet with the Paterson Zochonis directors and engineers on Monday, Archie Kotara and I met to plan our method of approach in obtaining the answers to our questions. The original plan of execution became to answer financial questions first, to review and develop the job scope second, to answer general design questions third, and to answer the specific discipline checklist questions last.

TASK PERFORMANCE

Included in the exhibits of this section is the report that I submitted to my supervisor following the data collection and assessment trip. In it I included a trip diary and a detailed account of the data that I obtained; therefore, there is no need to present more than a summary of the assignment in this section. The original plan of execution was followed to a degree but not exactly, because the client had already prepared for our arrival. While Mr. Sandefer met with the directors to discuss the contract, I met with the engineers to discuss the technical aspects of the projects. We first discussed the general aspects of the project, then moved to the detergent plant, and then to the refrigerator plant. At night, following the sessions, Mr. Sandefer, Mr. Kotara, and I would meet and discuss what we had learned during the day. At these times, I would be informed on the results of the contract and financial meetings, and I would relate the information I had obtained.

In Nigeria, I toured the existing Paterson Zochonis facilities, including their powder detergent plant, refrigerator manufacturing plant, and confectionary plant. I also toured the proposed plant sites in the tropical rain forest and observed the highway and barge port facilities. In meetings with the Paterson Zochonis engineering director, I discussed and clarified the preliminary process flow sheets. After returning to England again, I took part in a meeting to summarize the data and discuss the cost estimate that the client had prepared.

In the course of these meetings, I quickly became aware that the project entailed much more than just the two plants as first thought. The project involved the development of a master plant which would utilize a sixty-five acre site and would consist of a refrigerator manufacturing plant, a powder detergent plant, a plastics plant, site services, carton folding and glueing facilities, a cooler line and a liquid detergent plant. The first phase of engineering and construction, before the expansions, was estimated to cost approximately fifty million dollars.

In this assignment I used almost all of my educational skills that had been directed toward manufacturing facilities. The project involved site selection, logistics both outside and within the plant site, design of manufacturing, material handling, and special storage facilities, and many other applications of my engineering skills. It also required very close contact with the client at two levels -

the board of directors and the engineers. From my supervisor and the meetings in which I took part, I gained experience in both dealing with a client and in looking at a project from a global point of view, which takes into account much more than a single aspect of design.

ASSIGNMENT RESULTS

I again refer to the report in the exhibits for a detailed account of the data collected and my assessment of that data. I was not able to collect some of the data I thought necessary, because no contract had been signed between Paterson Zochonis and Brown & Root, but I left a list of the data that would have to be supplied before the MAPI Department could begin design. After returning to Houston, I reported on the data I had collected and used some of the figures I had obtained to produce a very preliminary layout of the site which took into account every aspect of the master plan (see the exhibits in this section.) A major concern that resulted from the effort was the excessive utilization of square footage. Because of design considerations that were peculiar to this project's situation, such as the transit stores system (desired by the client to reduce pilferage) and other considerations mentioned in the exhibited report, the project would require placing almost thirty-six percent of the sixty-five acres under roof.

Though everyone was very optimistic after leaving England concerning the status of the project, no contract had been signed. When construction was included in the contract

negotiations, they estimated their costs to be much higher than originally thought. The final estimate was approximately one hundred percent higher than the original estimate. Upon seeing the very high costs of the project, Paterson Zochonis hesitated to proceed and later contacted the MAPI Department to say they were re-evaluating the project. Thus, I did not get the opportunity to follow through with the engineering of the facilities.

POST-TASK ANALYSIS

As it turned out, the assignment has not yet resulted in a project for the MAPI Department, but the assignment was worth a great amount to me in my development as an engineer and my training as a project manager. This assignment was my first in-depth contact with a client, and it entailed almost every aspect of a large manufacturing facility. Besides just the technical side of the project, I experienced travelling, took part in meetings with both the directors of an international company and its engineers, discussed contract negotiations and cost estimates, and felt the futility of watching my efforts possibly proving fruitless because of the inability of Brown & Root and Paterson Zochonis to reach a contract agreement.

Though the MAPI Department has not yet acquired the project, the data collection and assessment phase went well. I approached the assignment in a manner which resulted in the collection of the data that was necessary in that early stage, and my supervisor maintained control of the situation

at all times. We were accepted fondly by the directors of Paterson Zochonis and left with the sincere feeling that we would be engineering the project. It just was not to be, until the extravagant schemes of Paterson Zochonis's Nigerian managers were reduced to a cost compatible with the money available to the project.

SUMMARY COMMENTS

The value of this task to my internship is obvious. First, I functioned in a non-academic environment that included client negotiations in three countries on three continents. Second, I made an identifiable contribution toward the possible acquisition of a large manufacturing project. Third, my portion of the assignment entailed many of the primary activities of industrial engineering as described in the Introduction, including site selection, logistics, design and layout of facilities, and design of equipment and processes. Finally, this assignment provided me experience that will be very beneficial in my development as an engineer and a Project Manager.

The only shortcoming in the approach taken in this assignment was the exclusion of a representative from the Construction Division in the team that made the trip, and this exclusion was not by choice. The Construction Division Manager that was to make the trip had unavoidable conflicts. He travelled to Paterson Zochonis at a later date after the initial negotiations. A major shortcoming of my own was my

lack of experience in dealing with clients, but hopefully I will overcome that shortcoming through my work.

APPENDIX XI

BROWN & ROOT, INC.
MANUFACTURING AND PROCESSING INDUSTRIES
ENGINEERING DEPARTMENT
OFFICE MEMO

TO: Mr. Keith Sandefer DATE: May 27, 1977

FROM: Randall J. Gannaway

SUBJECT: Data Collection and Assessment for Paterson Zochonis Nigerian Project

During the period from May 8 through May 19, I was involved in the collection and assessment of data for a project in Nigeria for Paterson Zochonis. That task required trips to Manchester, England and Lagos, Nigeria where meetings were held with key members of the Paterson Zochonis operations. The following account is to report what I obtained from those meetings.

Trip Itinerary

May 7-8 Travelled to Manchester, England

May 8 Met with Archie Kotara and decided on method of approach.

1. Financing
2. Job Scope Reviewal and Development
3. General Questions
4. Detailed Questions involving Discipline Checklist

May 9 Met with Graham Morris (Chemical Engineer for Cussons Imperial Leather Soap) and Archie Kotara. Discussed project breakdown and general site data and began on detergent plant.

May 10 Met with Graham Morris, John Riley (Cussons detergent man), Keith Sandefer and Archie Kotara. Discussed what is to be located on 65 acre site. Went through detergent plant process.

May 11 Met with Graham Morris, Rudy Kratschmer (Paterson Zochonis manufacturing man), Keith Sandefer, and Archie Kotara. Discussed Thermocool plant and looked over preliminary layout.

May 12 Travelled to Lagos, Nigeria

May 13 Met with Andreas Sideris (Paterson Zochonis Engineering Director), Theo Gregoris (Paterson Zochonis Managing Director), Keith Sandefer and Archie Kotara. Toured Nigerian facilities. Discussed Master Plan.

May 14 Visited proposed sites and barge port with Theo Gregoris and Keith Sandefer.

May 15 Met with Andreas Sideris. Discussed Thermocool and detergent plant process flow sheets.

May 16 Met with Andreas Sideris, Theo Gregoris, Keith Sandefer, and Archie Kotara. Discussed in more detail the operations and amenities.

May 17 Travelled to Manchester, England.

May 18 Met with Lyc Ludiaris (Paterson Zochonis Technical Director), Keith Sandefer, Archie Kotara, and Peter McMasters (Brown and Root, London). Summarized data. Discussed cost estimate.

May 19 Travelled to Houston, Texas.

Site and General

Two 65-acre sites were under consideration.

First site: near Losi Village approximately 5 km north of Ikorodu. Has 33 kv power lines that border site. Possible drainage problem.

Second site: on Epe Road approximately 5 km east of Ikorodu. Good drainage prospects. Would have to connect to power station in Ikorodu.

The 65 acres will be divided - 20 acres for Thermocool operations and 45 acres for Paterson Zochonis Industries Limited (PZIL). The two companies are to be considered separate entities with separate feedlines from the power source. Paterson Zochonis realizes they are to supply a boundary survey, topographical survey, and soil survey.

A major site consideration is drainage. Three classifications of effluents will be produced on the site:

1. Rain water and process cooling water which can be left untreated to drain.

2. Sewage which must be treated before discharged.

3. Chemical contamination such as sulphonic acid, sulphuric acid and caustic soda which must be collected and neutralized or recycled.

Another major consideration is the logistics involved in the plant activities. All raw materials will arrive and all finished goods will leave by truck. Estimates of the number of trucks making deliveries per eight hour day went above 25 trucks. The logistics problem has difficult aspects both on and off

the site. The traffic in the Greater Lagos area is a tremendous obstacle, but except for its effect on the hauling of construction equipment and supplies, it is more a problem for the Paterson Zochonis staff. One alternative proposed to be studied is to use the new Ikorodu barge port which would eliminate much of the wait in the harbor as well as much of the traffic infested road between unloading and the plant site. A problem which Brown and Root will have to solve is the on-site logistics. The large number of trucks that will be on the site demands an efficient logistics design. Compounding problems are the seasonal trucking in the area around the site, which may result in empty trucks waiting for loads, the total lack of standardized truck sizes, and the possibility of mixed product loads (refrigerators and detergent). One simplification being considered is a centralized warehouse or at least centralized distribution.

When designing for the Nigerian plants, several points must be emphasized. As already mentioned, there is almost no standardization of anything outside the plant sites, so any assumptions based on normally standard conditions in the United States are invalid. Another problem is the lack of skilled workers and the great difficulty in training them. Likewise, maintenance capabilities are so poor that they should be considered very delayed at best, and Paterson Zochonis wishes to have standbys where economically feasible. Therefore, the facilities design should look to more machines which are simply operated rather than the highly sophisticated labor saving equipment normally considered. One more ever-present obstacle is the weather which has six months of rainy season and another six months of dry which includes a hot very dirty wind that blows from the Sahara Desert.

The buildings will be of two types. The standard buildings such as for the Thermocool plant and the warehouse will be Butler buildings. The customized buildings such as for the detergent plant will be engineered by Brown and Root. According to Nigerian regulations, fifteen feet from the boundary inward must remain uncovered on the sides and back, and 30 feet must remain uncovered along the front of the site. Another regulation limits the amount of acreage that can be covered to 60 percent of the total site acreage.

The power supply, supplied by the Nigerian Electric Power Authority (NEPA or No Electric Power at All), is a major difficulty. NEPA has the power available, but distribution is very poor, and very frequent power cuts hamper production several times per day. The voltage stability is also very poor. Brown and Root will design the electrical facilities using United Kingdom 50 cycle equipment, probably Reyroll equipment because of a distribution discount available to Paterson Zochonis. A standby power generator must also be supplied and will probably be a Rolls Royce diesel. The Power will be delivered at 33 kv which will be stepped down to 11 kv and then to 420 V. The standby power will be generated at 11 kv.

The initial problems in beginning the site work will be finding equipment to rent (possibly from Wimpy), finding operators for the equipment once it is found and getting the supervisors to the site. Once design is begun, according to Nigerian regulations, all drawings submitted for planning approval must be

submitted by a Nigerian architect-engineer, but this regulation does not apply to working or construction drawings. The design standards may conform to either American or British standards but are traditionally British. Virtually no Nigerian safety standards exist; therefore, design to normal safety considerations is adequate.

The project priorities, at last analysis, appear in the following list:

Phase I of Project:

1. Master Plan
2. Thermocool Plant including Toolroom - 500 units/day of Refrigerators, Bottle Coolers, and Freezers.
3. Detergent Plant - 10 tons/hour of dry powder.
4. Plastics Plant - Thermocool Parts and PCC Caps
5. Site Services
6. Folding and Glueing of Packages

For Future Expansion but Included in Master Plan:

7. Assembly Line for Air Conditioners (in Thermocool)
8. Development of Plastics Plant to Include Blow Molding for Liquid Detergent Bottles
9. Tin Fabrication for Talcum Powder and Robb Lines
10. Corrugation of Cartons
11. Cutting and Printing of Packages
12. Expansion of Thermocool to Include Gas or Electric Coolers
13. Liquid Detergent Plant

Thermocool Refrigerator Plant

The status of the data available for the Thermocool refrigerator plant is very good. Paterson Zochonis has already ordered much of the necessary equipment and has supplied a process flow sheet that has been detailed in meetings with Paterson Zochonis personnel. A very preliminary layout has also been supplied.

The Thermocool plant will be housed in a standard Butler building and at first approximation will entail an area of 160,000 square feet. Utilities and drainage will be run underground. A major effluent problem will be that produced by the wet paint booth when it is in operation. The wet paint booth will be only a standby operation, but allowance for its operation must be made.

Included under the Thermocool operations will be a 250 units/day refrigerator, bottle cooler and freezer plant with immediate expandability to 500 units/day, (present optimum is 60 units/day), a near future assembly line for air conditioners, a distant future line of gas or electric cookers, and probably the near future fabrication of tins for the pharmaceutical, cosmetics, and confectionery (PCC) products. The plastics section, presently located within the Thermocool plant will be moved off the 20 acres assigned to Thermocool and set up as a plant under PZIL. The present 300,000 units/year flourescent light fitting operation will probably be discontinued until it is economically justifiable.

The Thermocool plant will operate a single shift (approximately 2000 hours/year) and, with a theoretical capacity of 120,000 units/year, will seek to produce 80,000 refrigerators/year to 10,000 units/year of the deep freezes and bottle coolers. Of the refrigerators 10 percent will be of the two-door variety, and both the 4 and 6 cubic feet models will be produced.

Because of difficulties in importing raw materials, storage for four months of raw materials and parts (three months stock plus overlap of one month) must be allowed. The major raw material will be maximum five ton steel coils which will necessitate the use of a crane for handling. Three to 5-ton diesel fork lift trucks will also be used in storage operations. Within the plant, space must be allowed for buffer stores which allow for orderly storage at each work station. The maximum batch size was given to be fifteen days production. The finished products from the production floor will enter a transit store which will house the day's production. At the end of a day the contents of the transit store will be counted and then locked off to allow for transport to the warehouse while another transit store is being filled the next day. Storage for one month's production of finished goods is required, and a warehouse central to both Thermocool and PZIL is desirable.

The refrigerator manufacturing process is represented in detail on the process flow sheet. It consists mainly of production of the cabinet, door, top, electric box, shelves, condenser, evaporator, and other small items which are assembled, sealed, tested, and packaged. Two questionable areas are the shelf production, which may require chrome plating, and the door welding, which may necessitate a new door design. Under the present system of one welder and one scurfer processing 10 doors per hour, 14 workers (7 welders and 7 scurfers) would be required. There is also need for improvement in the handling facilities between work stations. Presently, cabinets are dragged along the floor, resulting in many scratches in the paint.

The air conditioner assembly line operations are still vague and unplanned, and implementation of the cooker expansion is too far in the future. A toolroom is to be included as part of Thermocool and will allow the training of a few Nigerian machine tool men. The tins manufacture will consist of fabricating from tin 19 million containers for the Robb line, 6.5 million for the 14 ounce talc, and 4 million for the 3.5 ounce talc and fabricating from aluminum 19 million containers for the all-purpose cream.

Detergent Plant

A large amount of data has been supplied for the detergent plant including a preliminary process flow sheet, a process and material description, and a relative equipment size layout, but the process flow sheet is not entirely correct and a recent process description from Chemithon, who is supplying the process and equipment, is not available. However, all of the necessary equipment, though not ordered, is already known.

The process basically is to react sulphuric trioxide with an alkayne to produce sulphoric acid which is then reacted with caustic soda to produce the active matter. The active matter, a liquid, is joined with sodium silicate and solids such as phosphate, resulting in a 40 percent solid slurry which is spray dried, cooled, perfumed, and packaged. The process cost centers, which will have metered flows in and out, are the (1) sulphonation plant, (2) the additives of caustic soda and silicate dissolving, (3) the spray dryer, and (4) the packaging facilities. Two separate buildings (factories) are desired--one which produces sulphonic acid and need its own drainage system, and another which produces detergent.

The detergent plant is to be designed for an output of 10 tons/hour or 50,000 tons/year of dry detergent but will operate initially at 5 tons/hour. The plant will operate at 3 shifts/day or approximately 6000 hours/year when it increases to full production. The high volume of detergent will require a large number of trucks delivering raw materials and picking up finished product. At 10 tons/hour (240 tons/day) and 10 tons/truck, at least 24 trucks/day will be required just to pick up the finished product. Paterson Zochonis is not opposed to unitizing packages in paper wrap with bands or stretch film if a system can be devised which will take into consideration the various unit sizes, odd order sizes, split or double orders, and the variable truck sizes.

The warehousing facilities will probably be centralized with those of Thermocool. Presently pallets containing packages of detergent can be stacked two or three pallets high without damaging the product. The detergent, like the refrigerators, will have a transit storage area between the packaging area and the warehouse. Two transit area philosophies were discussed by Paterson Zochonis--either two areas based on a day's production or three areas based on a shift's production.

The varieties of unit sizes changed twice while we were on the trip. First we were told that the 2 ounce varieties would be discontinued, and later we were told the 4 ounce size would be discontinued and the 2 ounce size maintained. Paterson Zochonis has supplied dimensions for most of the package and outer carton sizes and has promised to supply the missing sizes at a later date. Paterson Zochonis already knows the make and number of the package filling machines for each unit variety. In the present plant cartons are folded, stapled, and filled manually.

A major consideration in the detergent plant is the handling of effluents. When mixed with the soil in that area, sulphonic acid destroys 68 percent of the soil weight. If washed away or mixed with rain after a spill, the amount of corrosive materila is increased many times. Another effluent is the caustic soda which results in a 23 percent soil weight loss. Paterson Zochonis mentioned that, if possible, they wished to recycle the above effluents in the process. Acid tiling to prevent destruction of the concrete and soil was labelled debatable because of the effect the high rains and humidity would have on it. A by-product of the process is 98 percent sulphuric acid and must be drummed and hauled away if no better system is developed. The tower and packing plants produce dust which should be gathered and reworked into the slurry.

Another serious problem is the number of power cuts. The costs of the detergent plant are due one third to tripolyphosphate, one third to other materials, one third to packaging and less than one percent to labor and utilities. Thus the plant would be better off to pay more for power and be assured of producing more powder. When a power cut does occur, the standby generator must run for four hours afterwards.

Other Facilities and Plants

The plastics forming area is to be a separate plant that will include space for the manufacture of the plastic parts required by 80,000 refrigerators and 10,000 bottle coolers and freezers. It will also produce caps for the PCC products--14,400,000 Velvetone, 7,200,000 Sweet Sixteen, and 2,160,000 Venus de Milo. The plastics plant must have enough space to expand to include a blow molding operation for plastic bottles that will be used to package liquid detergent. 15,000 tons of plastic will be formed into one liter containers.

Each plant must have its own maintenance shop and laboratory, but there will be one clinic (2000 square feet) and one canteen with eating seats for 300 employees (6500 square feet for canteen and cooking facilities). A separate entrance will exist to the manager dining room with 30 seats. There should be 50 non-shop offices in a separate building and production offices as required on the second floor of the various plant. Offices will have window unit air conditioners, but the plants will only be ventilated. Four on-site houses will be designed by a local architect-engineer and at a minimum will have 3 bedrooms and 2 bathrooms. A locker room will be provided but must be located between the employee entrance and the clocking area. Sewage facilities must be supplied to handle up to 1250 people on site at one time, and an incinerator must be included for paper and possibly plastic wastes.

Factory Mutual Underwriters Association standards may be used for fire prevention facilities, and lighting protection must be provided for all buildings and boreholes. Plant security is a prime consideration and will take the form of an 8 feet high blocked wall topped by a 4 feet hurricane fence with a "Y" of barbed wire. There will be a 50 feet span between lights. Trucks will be weighted in and out, and trucks may possibly be photographed as the weighing takes place. Close circuit television may be used for counting, and an automatic counter will be used and verified by manual count. The transit store concept has already been mentioned.

The packaging operation is composed of the following steps: (1) printing, (2) die cutting, (3) creasing, (4) folding, and (5) glueing. Folding and glueing will be designed into the first phase operations, and space must be allowed for future expansion of facilities to perform printing, cutting, and creasing. Space must also be planned for a future paper corrugating and cutting operation for the 10 to 12 million outer cartons necessary for the Thermocool and PZIL operations.

An area must be set aside for a liquid detergent plant, for when a second sulphonation unit is added, the two units will have a capacity of 70,000 tons of powder detergent. The sulphonic acid required to produce the excess of 20,000 tons powder can be used to produce 15,000 tons of liquid.

Summary of Non-verbal Data Collected

General Site Data:

- Climatory Data
- Labor Availability and Power Costs
- Preliminary Report on Losi Plot

General Nigerian and Lagos Port Data:

- Port Data
- Importation and Transport Data
- Industrial Machinery Customs Clearance Form
- International Trade Promotion Section by Lloyds Bank Limited
- Nigerian Industry and Economic Review

Maps:

- Lagos State
- Southeast Lagos
- Ikorodu Eastward
- Ikorodu to Ijebu-ode
- North of Lagos State
- Street Guide to Lagos

Thermocool Plant:

Process Flow Sheet
Very Preliminary Equipment Layout

PZIL Detergent Plant:

Preliminary Process Flow Sheet
Process and Material Description
Typical Chemithon Layout

Data Not Collected

Much of the detailed data required for computation of space requirements, design, and layout was not collected for three reasons. First, no one knew for certain that Brown and Root would perform the project so Paterson Zochonis was hesitant to supply a large amount of process and equipment specifics. Second, the general questions had priority at this early stage. Third, much of the detailed data will take time for Paterson Zochonis to gather.

In our last meeting, however, I left a list of the type of data which we would require if Brown and Root began the project. Though short in length, the list entails a large volume of data:

Raw Material List
Purchased Items List
Specifications of Raw Materials and Purchased Items;
  Type and Physical Characteristics
Specification of Material or Items after Each Operation;
  New Dimensions, etc.
Specifications of Finished Goods
Specifications of Equipment;
  Requirements
  Size and Weight
  Rate of Operation
Necessary Manpower at Each Station
Detail on Necessary Offices both Production and Administrative;
  Work Stations that Production Offices must be near.

Randall J. Gannaway

RJG:jfk

MANUFACTURING & PROCESSING INDUSTRIES

ENGINEERING DEPARTMENT

SHEET NO. 1 of 5

CLIENT: Paterson Zochonis UK Limited

SUBJECT: Utilization of Square Footage on Proposed 65-acre plant site

BASED ON: Data collected in recent visit to Manchester and Lagos

PREPARED BY: R. J. Gannaway

Sources of Estimates:

GM - Graham Morris Detergent Plant Design Brief
RK - Rudy Kratschner Thermocool Layout Reviewed by RJG
TG - Theo Gregoris

Raw Materials Store

Detergent Plant

Raw Materials, 3 months at 10 tons/hour	32,000	GM	
Silicate and coustic stores and dissolving areas	11,500	GM	
Preparation Area	3000	GM	
Packing Materials, 1 month to 10 feet	20,000	GM	
			66,500

Bunded Areas

D.D.B. Bulk Storage	20,000	GM	
S.A./A.M. Storage	2000	GM	
Caustic/Silicate Storage	1000	GM	
			23,000

Thermocool Plant

Raw Materials, 3 months at 500/day	12,000	RK	
Packing Materials	10,000	RJG	
			22,000

Plastics Plant

Raw Materials	6000	RK	
			6000

Plus 1/3 Surge (4th month)	39,200	RK	
			39,200
TOTAL PHASE I RAW MATERIALS STORE			156,700
Expansions to Raw Materials Stores			
Liquid Detergent Plant	10,000	RJG	
Tin Line	5000	RJG	
A/C Line	10,000	RJG	
Cooker Line	5000	RJG	
Plastics	3000	RJG	
Packaging	10,000	RJG	
Printing Material	2000	RJG	
			45,000
TOTAL ULTIMATE RAW MATERIALS STORE			201,700
Transit Stores Raw Materials			
Detergent Plant	800	GM	
Thermocool Plant	800	RJG	
Plastic Plant	800	RJG	
TOTAL PHASE I RAW MATERIALS TRANSIT STORES			2400
Doubled by Expansions	2400	RJG	
			2400
TOTAL ULTIMATE RAW MATERIALS TRANSIT STORES			4800
Transit Stores Finished Goods			
Detergent Plant	8000	GM	
Thermocool Plant	4000	RJG	
Plastics Plant	4000	RJG	
TOTAL PHASE I FINISHED GOODS TRANSIT STORES			16,000
Expansions			
Liquid Detergent Plant	4000	RJG	
A/C, Tins, Cooker	4000	RJG	
Plastics Plant	2000	RJG	
			10,000
TOTAL ULTIMATE FINISHED GOODS TRANSITS STORES			26,000

Finished Goods Warehouse

Detergent Plant, 1 month at 10 tons/hour	90,000	GM	
Thermocool Plant, 1 month at 500 units/day	30,000	RK	
Plastics Plant	10,000	RK	
			130,000
Plus 1/3 Surge	43,000	RJG	
			43,000
TOTAL PHASE I FINISHED GOODS WAREHOUSE			173,000
Expansions			
Liquid Detergent	20,000	RJG	
Thermocool	15,000	RJG	
Plastics	2000	RJG	
			37,000
TOTAL ULTIMATE FINISHED GOODS WAREHOUSE			210,000

Detergent Plant

Sulphonation	10,000	GM	
Spray Drying	50,000	GM	
Packing	34,000	GM	
Engineering Offices	2000	GM	
Boiler House	1700	GM	
Water Treatment	1500	GM	
Laboratory	700	TG	
Maintenance Shop	2000	RJG	
Amenities, etc.	2000	RJG	
TOTAL PHASE I DETERGENT PLANT			103,900
Liquid Detergent Expansion	35,000	RJG	
			35,000
TOTAL ULTIMATE DETERGENT PLANT			138,900

Thermocool Plant

500 unit/day plant	130,000	RK	
TOTAL PHASE I THERMOCOOL PLANT			130,000

Expansions			
A/C Assembly	30,000	RJG	
Tins Line	30,000	RJG	
Cooker Line	30,000	RJG	
			90,000
TOTAL ULTIMATE THERMOCOOL PLANT			220,000
Plastics Plant			
Thermocool Parts and PCC Caps	30,000	RK	
TOTAL PHASE I PLASTIC PLANT			30,000
Expansion to Blow Molding	18,000	RK	
			18,000
TOTAL ULTIMATE PLASTICS PLANT			48,000
Future Package Printing and Cutting Plant	50,000	RJG	
Future Paper Corrugating and Creasing Plant	50,000	RJG	
Other Facilities			
Administration Offices (2 floors)	12,000	TG	
Canteen	6500	TG	
Locker and Washroom	10,000	RJG	
Clinic	2000	TG	
Houses (4)	16,000	RJG	
Stand by Power Plant	2000	RJG	
Sewerage Treatment	8000	RJG	
TOTAL ULTIMATE OTHER FACILITES			56,500

Summary

Phase I

Raw Materials Stores	156,700
Transit Stores Raw Materials	2400
Transit Stores Finished Goods	16,000
Finished Goods Warehouse	173,000
Detergent Plant	103,900
Thermocool Plant	130,000
Plastics Plant	30,000
Other Facilities	56,500
	668,500

15.4 Acres under roof
24% of site covered

Ultimate

Raw Materials Stores	201,700
Transit Stores Raw Materials	4800
Transit Stores Finished Goods	26,000
Finished Goods Warehouse	210,000
Detergent Plant	138,900
Thermocool Plant	220,000
Plastics Plant	48,000
Package, Printing and Cutting	50,000
Paper Corrugating and Creasing	50,000
Other Facilities	56,500
	1,005,900

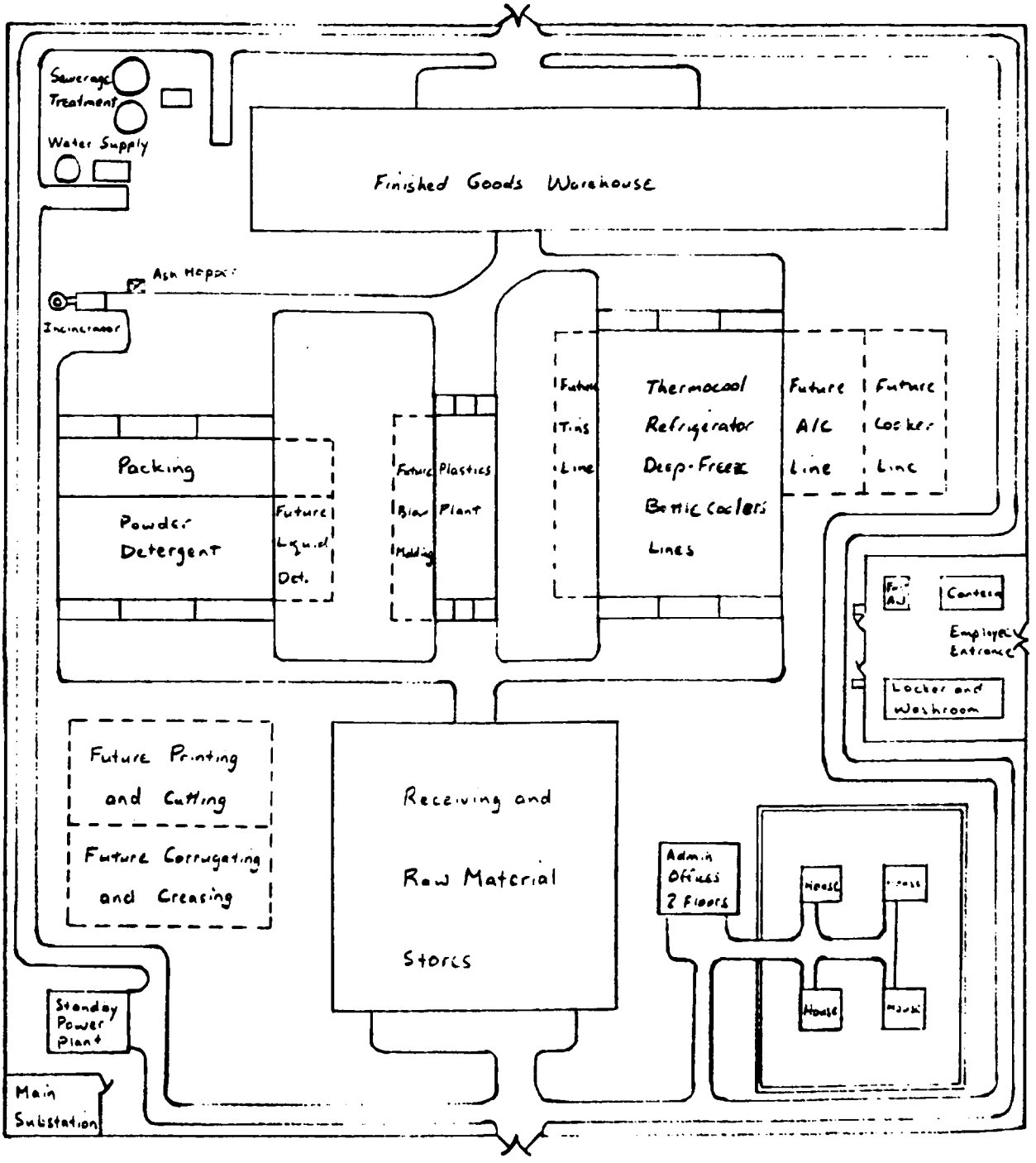
23.1 Acres under roof
36% of site covered

CLIENT Paterson Zochonis JOB NO.

SUBJECT Utilization of Square Footage on Proposed 65-Acre Plant Site

BASED ON Data Collected in Recent Visit to Manchester and Lagos DRAWING NO.

COMPUTER E.J. Conway CHK'D. BY APP'D. BY DATE 19



IDEAL CEMENT PROJECT

TASK SPECIFICS

In August of 1977, Mr. Keith Sandefer assigned me to the managerial staff of the Ideal Cement Company Project. The project consists of a limestone quarry, crushing station, and barge loading facility at the Gaillard Quarry Site on the Alabama River in Monroe County, Alabama and a 1.5 million ton-per-year dry process cement plant at a site in the Theodore Industrial Park adjacent to the planned deep water ship channel near Mobile, Alabama. The Theodore plant would be the largest dry process preheater cement facility ever constructed in a single stage in the United States. A Phase II Engineering study had been performed by H. K. Ferguson Company, and the cost of the project is estimated at $200 million.

The cement plant includes the following major facilities:

1. Two 2,325 ton-per-day suspension-preheater kilns.
2. Two 1,500 hp air-swept autogenous raw grinding mills.
3. One 2,000 hp regrind mill.
4. Two 6,500 hp cement grinding mills.
5. Minimum cement and clinker storage facilities.
6. Marine facilities for loading limestone at the Gaillard Quarry.
7. Marine facilities for unloading raw materials and for barge loading of cement intended for water shipment at the Theodore site.

Of substantial importance to the early stages of the project are the completion of the Environmental Impact Statement, being prepared by Environmental Science and Engineering, Inc. (hereafter Environmental Science and Engineering), of Gainesville, Florida, and the obtaining of any other environmental approvals. No site work at either Theodore or Gaillard can begin until all environmental approvals have been received. The expected completion time of the Environmental Impact Statement is July of 1978 with construction beginning afterward and the plant becoming operational in late 1980.

I entered the project at the very beginning of the Mobilization Phase and my first assignment on the project was to perform a study of what permits would be necessary to the construction and operation of both the quarry and the cement plant. These permits could be related to the environmental, construction, or any other aspect of the project where some approval outside of Brown & Root or Ideal Cement Company was necessary. Included in this assignment was helping to expedite the completion of the Environmental Impact Statement. Since the timing of the construction of the plant depended on the completion of the Environmental Impact Statement and the obtaining of the environmental and construction permits, my assignment was given very high priority.

The assignment entailed researching what permits were necessary, contacting the authorities which issue the permit, and collecting information which would aid the obtaining of the permits at a later time. Besides the permit issuing

authorities, I would have to contact representatives of the client at Denver, Colorado and in Houston plus engineers involved in the development of the Environmental Impact Statement. The objectives of the assignment were:

1. To develop a list of what permits would be necessary to the construction of the Gaillard Quarry and Theodore Cement Plant.
2. To establish contacts within the authorities who issue the permits.
3. To obtain information, application forms, procedures, etc., that would possibly help in the later acquisition of the permits.
4. To develop a CPM-like chart which exhibits when the permits would have to be obtained along with their prerequisites.
5. To initiate and maintain contact with Environmental Science and Engineering to help expedite completion of the Environmental Impact Statement.

TASK PLANNING

To help me in the assignment, I was given a copy of the H. K. Ferguson Phase II Engineering Report for the Gaillard Quarry and Theodore Cement Plant and some very preliminary permit information that had been gathered by Environmental Science and Engineering and a Brown & Root environmental consultant. The rest of the information I needed I would have to obtain from research into the various permits and their issuing authorities. Though the preliminary

information I was given was very poor, it did give me some state and county agencies with which to begin my search. My plan of execution was to study the project itself and the information I was supplied and then to contact those responsible for issuing the permits the project would need. From this communication I would obtain the necessary information and organize it in a systematic manner so that I could later represent it in the form desired.

TASK PERFORMANCE

Before I could hope to succeed in my assignment, I had to familiarize myself with every engineering aspect of the project; therefore, I studied the H. K. Ferguson Phase II Engineering Report placing primary emphasis on those areas which could possibly require a permit. This list of permit areas I then compared to the preliminary permit information I had been given and developed a composite list. From talks with the engineering discipline leaders assigned to the project I obtained details concerning their discipline and more possible permits. With the resulting list of permits, which turned out to be far from complete or correct, I was ready to begin accumulating information. Before taking that step, however, I designed a form which I later used to record and summarize the information I obtained. This form (see the exhibits in this section) allowed for information concerning the authority which issued the permit, the engineering requirements to obtain the permit, any necessary prerequisites to obtaining the permit, and permit cost.

Thus prepared, I began the second phase of my assignment by searching for the telephone numbers and addresses of the authorities responsible for issuing the various permits. These authorities were at the city, county, state and federal levels; and my research resulted in calls and letters to over thirty individuals in ten cities in five states not including my client contacts and the client's representative in Houston. In my calls I obtained enough information to complete the summary form I had designed and requested that a copy of the permit application form, if one existed, and any other related information be sent to me in Houston. I also obtained referrals to other individuals concerning permits about which I had not previously known. The information I received, whether by phone or mail, was collected and organized by facility within agency. For example, a folder for the United States Army Corps of Engineers would contain all the information related to permits issued by it, but that information would be labeled as to whether or not it applied to the Gaillard Quarry or Theodore Cement Plant. In those instances where I received nothing written from the authority on the information I had obtained by phone, I wrote a follow-up letter to my contact which summarized the information I had obtained and requested correction for any misunderstanding. In this manner I always had written verification of the information I reported to the Engineering Project Manager.

Midway through the task, a conflict of responsibilities arose concerning the acquisition of the permits. I had made contact with Environmental Science and Engineering to discuss the completion of the Environmental Impact Statement, and the Project Manager informed me that they were under contract to obtain those permits that involved the environment. They were interpreting their responsibility to include permits which required engineering input and could be applied for only by Brown & Root. To resolve this conflict, I met with the Project Manager for Environmental Science and Engineering, and as a result of our meeting, his responsibility was limited to the eight permits which were purely environmental in nature. During my contact with Environmental Science and Engineering, we discussed the status of the Environmental Impact Statement and ways that Brown & Root could help in its completion.

Before beginning this assignment, I had little idea of how many permits, approvals, rights of way, etc., were required to construct a plant. Besides just those permits which assured the accuracy of engineering or design or the safety of various parts of the constructed facilities, I was involved in permits which concerned the effect of the engineering and construction on the environment. I was also in close contact with many government authorities at all levels. I even had to work with the Alabama Historical Commission concerning archaeological finds on the quarry and plant sites and the United States Coast Guard concerning bridges over navigable waterways. In addition to the Brown

& Root engineers and construction personnel, I worked with the client representatives, government representatives and environmental consultants. My supervisor did not provide close supervision and let me pursue the assignment in the manner I chose, but he did inform me of report deadlines and guided me to some of my client contacts. He also helped me when the conflict of responsibilities arose.

ASSIGNMENT RESULTS

The primary results of my efforts (see the exhibits) were a list of over forty required permits, approvals, rights of way and a CPM-like chart which networked the information I had obtained to show the times required to obtain the permits, the prerequisites of the permits and that area of the quarry or plant to which the permits applied. The approvals and rights of way were included with the permits because of their similarity and importance as a prerequisite to construction. My final report which I turned in to the Engineering Project Manager and through him to the client contained these results; and over five hundred pages of forms, regulations, instructions and other information related to the permits. Included in the report was information that was also helpful to the engineering and construction of the plant. An example involved the clearing of the job sites. Though most thought burning would not be allowed because of environmental concerns, I established contacts which informed me how burning could be used to eliminate the solid waste that resulted from the clearing operation.

I required four weeks to accumulate most of the information and another two weeks on a part-time basis to eliminate discrepancies and to follow-up on some of the more unusual permits and approvals. Additional follow-up will be required throughout the project both to insure that the permits are acquired at the proper time and to investigate any new permits that may arise. Even now the first steps are being taken toward the acquisition of some of the more important permits. My schedule and the information I obtained is being used by the Brown & Root Environmental Section to obtain the permits, freeing me for other tasks.

POST-TASK ANALYSIS

Meeting the ever-expanding government regulations concerning industrial operations is becoming more and more difficult and yet is a very important part of any project without which the construction cannot even begin. Therefore, this assignment was very important and necessary to the Ideal Cement Project. My approach to the task proved successful, and the information I received was very helpful. When a conflicting problem area did arise, and for some reason I could not resolve it myself, my supervisor assisted me quickly and effectively. For the most part, the assignment proceeded very smoothly, and the results were exactly what was desired.

SUMMARY COMMENTS

This assignment was valuable to my internship, because it involved a project management function on a project costing over two hundred million dollars. To complete the assignment,

I had to be familiar with many of the engineering disciplines and had to work with government agencies and other authorities. A primary concern of the assignment was the environment which, in addition to management, is another of the interest areas mentioned in the objectives of the internship program. The skills I learned through this task and my involvement with Project Managers will be invaluable to me in my training to become a Project Manager.

EPILOGUE

I am still assigned to the managerial staff of the Ideal Cement Project and will continue to work on the project in an industrial engineering and/or managerial capacity throughout its length. Presently, in addition to helping obtain permits, I am developing the engineering portion to the Project Procedures Manual. The Project Procedures Manual defines the course of action to follow in every situation and specifies the responsibilities of every discipline and position. Included in the engineering portion of the manual are:

1. Engineering Project General Information.
2. Engineering Project Organization.
3. Project Division of Responsibilities.
4. Project Design Philosophies, Guidelines and Criteria.
5. Project Communications.
6. Job Documents and Document Controls.
7. Valid Charge Numbers.
8. Job Progress Systems.

9. Project Procurement Methodology.

10. Job Costs.

Through this assignment I am becoming more familiar with every aspect of this project as well as the overall project management requirements.

APPENDIX XII

PERMIT: _____

FACILITY: _____ AREA OF INTEREST: _____

GENERAL DESCRIPTION: _____

REQUIREMENT DATE: _____

ISSUING AUTHORITY: _____

MAILING ADDRESS AND PHONE: _____

AGENCY CONTACT AND TITLE: _____

SOURCE OF APPLICATION: _____

PERMIT FEE: _____

ENGINEERING DATA REQUIREMENTS: _____

PREREQUISITES AND/OR CONSTRAINTS: _____

ESTIMATED TIME FOR PERMIT PROCESSING: _____

APPLICATION FORM ATTACHED? YES_____ NO_____

COMMENTS: _____

PERMITS - IDEAL CEMENT PLANT AND QUARRY

* Denotes permits under responsibility of Environmental Science and Engineering

Alabama Air Pollution Control Commission
* Air Pollution Construction Permit/Gaillard
* Air Pollution Operating Permit/Gaillard

Alabama Coastal Area Board
Copies of all U. S. Corps of Engineers permit applications

Alabama Historical Commission
Archaeological Survey

Alabama State Docks
Railroad Spur/Theodore
Waterfront Dock Structures/Gaillard
Waterfront Dock Structures/Theodore

Alabama Water Improvement Commission
Plant Access Road Across Streams/Gaillard
Plant Access Road Across North Fork Deer River/Gaillard
Railroad Crossing of North Fork Deer River/Theodore
* Surface Mining Permit/Gaillard
* Wastewater Treatment System/Theodore

Board of Water and Sewage Commissioners-Mobile County
Discharge of Sanitary Wastes/Theodore
Potable Water Hook-up/Theodore

Environmental Protection Agency
* Discharge of Industrial Wastes/Gaillard
* Discharge of Industrial Wastes/Theodore
Discharge of Sanitary Wastes/Theodore (May not be necessary)

Federal Aviation Agency
Marking and Lighting of all 200+ ft. structures

Mobile County
Plant Access Road Connection to County Road and Possible Traffic Signals/Theodore

Mobile County Building Department
Building (Construction) Permit/Theodore

Mobile County Board of Health
* Air Pollution Construction Permit/Theodore
* Air Pollution Operating Permit/Theodore
Burning Permit/Theodore
Cafeteria Permit/Theodore
Plumbing Permit/Theodore

Monroe County
Plant Access Road Connection to County Road/Gaillard

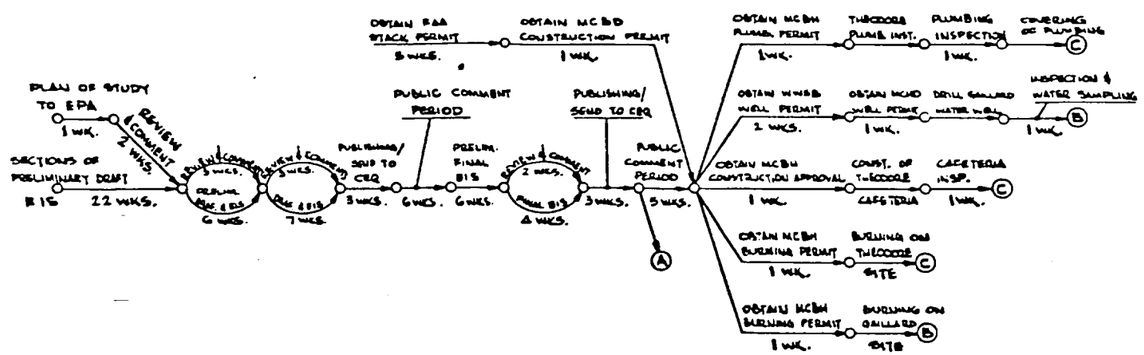
Monroe County Health Department
Burning Permit/Gaillard
Domestic Water Well/Gaillard
Sewage Treatment

U.S. Army Corps of Engineers
Filling and/or Crossing of the North Fork Deer River/Theodore
Filling at Gaillard Quarry Area Streams/Gaillard
Plant Access Road/Theodore
Railroad Spur/Theodore
Runoff Collection Dams/Gaillard
Water Discharge Pipe/Gaillard
Water Discharge Pipe/Theodore
Waterfront Dock Structure & Waterfront Dredging/Gaillard
Waterfront Dock Structure & Waterfront Dredging/Theodore

U.S. Coast Guard
Plant Access Road Across Steams/Gaillard
Plant Access Road Across North Fork Deer River/Theodore
Railroad Crossing of North Fork Deer River/Theodore

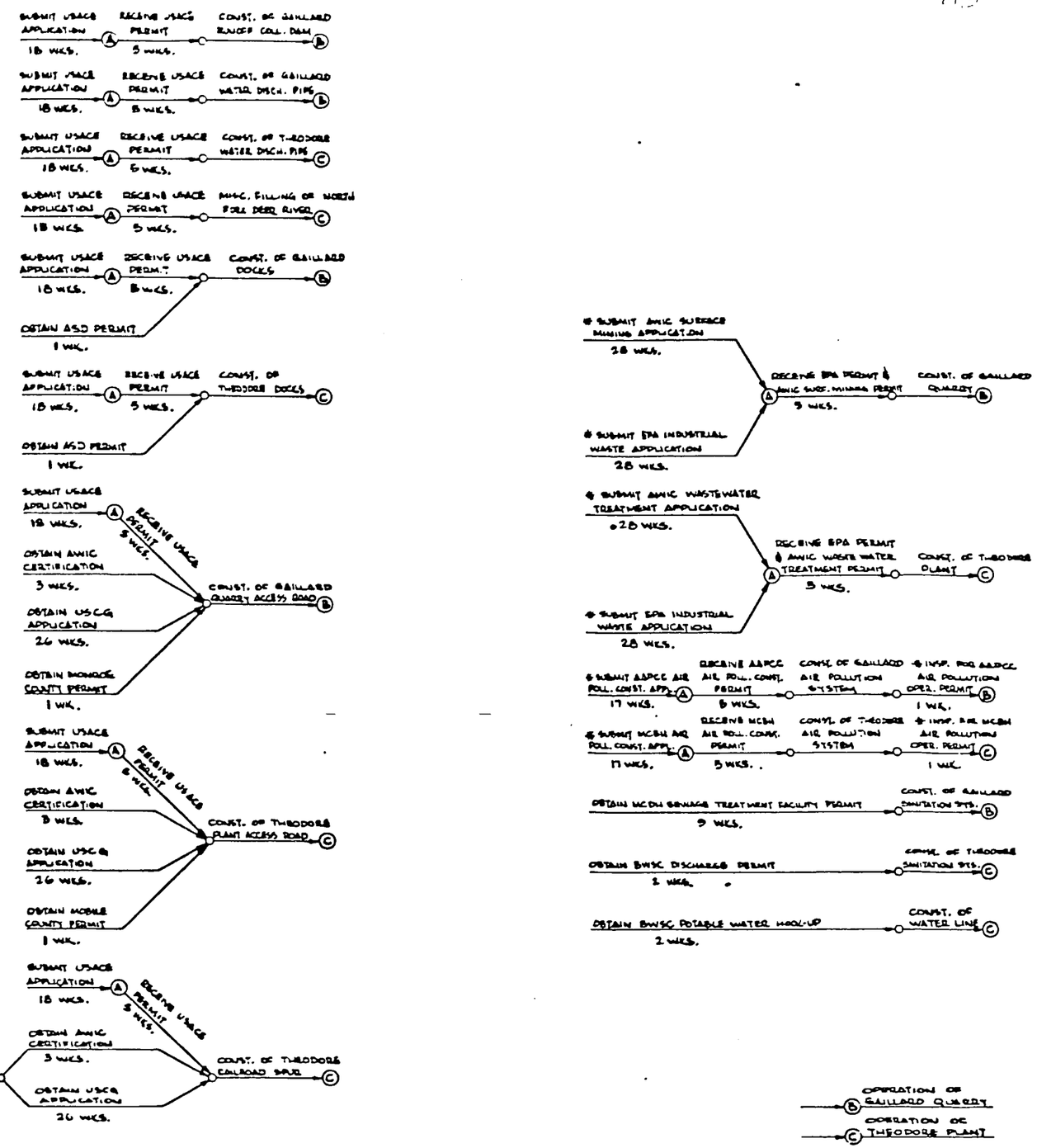
Water Well Standards Board
Domestic Water Well/Gaillard

AAPCC - ALABAMA AIR POLLUTION CONTROL COMM.
ACAB - ALABAMA COASTAL AREA BOARD
ADIR - ALABAMA DEPT. OF INDUSTRIAL RELATIONS
ASD - ALABAMA STATE DOCKS
AWIC - ALABAMA WATER IMPROVEMENT COMM.
BWSC - BOARD OF WATER & SEWAGE COMMISSIONERS
EPA - ENVIRONMENTAL PROTECTION AGENCY
FAA - FEDERAL AVIATION AGENCY
MCBD - MOBILE COUNTY BUILDING DEPT.
MCBH - MOBILE COUNTY BOARD OF HEALTH
MCHD - MONROE COUNTY HEALTH DEPT.
USACE - UNITED STATES ARMY CORPS OF ENGINEERS
USCG - UNITED STATES COAST GUARD
WWSB - WATER WELL STANDARDS BOARD



COMMENTS:

1- IT IS ASSUMED THAT NO CONST. CAN BEGIN UNTIL B.I.S. COMPLETED.
2- ALL FIGURES ARE CONVERTED TO WEEKS & ROUNDED TO NEAREST WEEK.
3- IN MANY CASES THE PERMIT MAY BE APPLIED FOR OR EVEN OBTAINED BEFORE THE TIME SHOWN.
4- THE NODES IN THE NETWORK ARE "AND" NODES - ALL INPUTS MUST BE COMPLETED BEFORE THE OUTPUT CAN BEGIN.
5- NODES MARKED WITH AN "(A)" MUST BE PRECEDED BY PUBLICATION OF THE B.I.S.
6- PATHS FROM NODES MARKED WITH A "(B)" PROCEED TO OPERATION OF QUARRY.
7- PATHS FROM NODES MARKED WITH A "(C)" PROCEED TO OPERATION OF PLANT.
8- PERMITS MARKED WITH AN ASTERISK (*) WILL BE OBTAINED BY ENVIRONMENTAL SCIENCE & ENGINEERING, INC.



NOTES	REVISIONS # BY # DATE	REVISIONS # BY # DATE	Brown & Root, Inc. HOUSTON, TEXAS	DRAWN BY / DATE / CHK'D BY / DATE / SCALE	APPROVED / APPROVED	SEAL	TITLE OF DRAWING: PERMITTING NETWORK / NAME OF OWNER: IDEAL BASIC INDUSTRIES, INC. / LOCATION OF PROJECT: THEODORE & GAILLARD	CONTRACT NO / DRAWING NO: JG-48020 / SHEET OF
SEE ABOVE								

CONCLUSION

During my internship with Brown & Root, Inc., I fulfilled the objectives of the Doctor of Engineering internship program. These objectives are 1) to enable the student to demonstrate his ability to apply his knowledge and technical training by making an identifiable contribution in an area of practical concern to the organization or industry in which the internship is served, and 2) to enable the student to function in a non-academic environment in a position where, in addition to traditional design or analysis he will become aware of the organizational approach to problems; such as, management, labor relations, public relations, environmental protection and economics. In my internship, I made contributions in several areas which addressed each of the problem areas defined in the objectives and more.

My internship entailed planning the organization and laying the groundwork for a new engineering department within the largest engineering-construction company in the world and then following through on the established systems to obtain and make contributions to the first project. Being an industrial engineer, I made system oriented contributions, many of which involved engineering management as well as engineering design. The engineering design involving the application of engineering science toward the development of systems to meet the desired needs. These contributions involved a majority of the primary activities of industrial

engineering and resulted in methods and procedures which will be used by the MAPI Department and Brown & Root for many years. While involved in these activities, I had to be aware of the total organization in which the systems I developed would operate, including the Brown & Root task force approach to project management.

Almost every assignment I was given addressed some aspect of project management or the management of engineers, but they were not limited to those problems. Though not in a union-employer adversary situation, the employee merit evaluation system did involve labor relations, because it involved performance appraisal that affected the salary and position of the employee. The Ideal Cement Project permitting assignment was very closely related to environmental concerns, and I worked closely with environmental consultants both within and outside of Brown & Root, but that assignment also touched upon public relations, because every federal permit has a thirty day public comment period, and the initial groundwork for future involvement with the public and the many issuing authorities was taking place during that assignment. Concerning economics, I developed the venture planning system and cost reimbursement checklist which greatly involved engineering economy and cost accounting. In addition to the above major problem areas, I was involved in legal proceedings, sales and transatlantic travel.

In completing the tasks I was assigned during my internship, I was in some way associated with a large variety of facilities. Among these projects were:

Cement Plant

Copper Smelter

Detergent Plant

Limestone Quarry

Lumberyard

Parboiled Rice Plant

Piston Manufacturing Plant

Pizza Production Facility

Plastics Plant

Refrigerator Manufacturing Plant

Salt Mine

Shipyard

Sugar Refining

In completing the requirements of the internship and fulfilling its objectives, I have received a large variety of experience in many problem areas, but the greatest value of the internship was in two areas. First, it showed me the benefits of a systematic, organizational approach to engineering problems, and secondly, it made a substantial contribution toward preparing me for project engineering management. This latter point is one of the goals of the Doctors of Engineering Program - to prepare engineers for high-level management positions.

VITA

Randall Joe Gannaway was born on September 21, 1952 in Dallas, Texas. His parents, Bill and Joan Gannaway, still reside in the Dallas area. He received two Bachelor of Science degrees in May of 1975 from Texas A&M University with major fields in Industrial Engineering and Computing Science. Continuing his study of Industrial Engineering, he received a Master of Engineering degree in August of 1976 from Texas A&M University. He has sixteen months Industrial Engineering experience at Brown & Root, Incorporated, in Houston, Texas. His permanent mailing address is 1306 Carroll Drive, Garland, Texas 75041.

The typist for this report was Gwen Sudduth.