INTERN EXPERIENCE AT
MEL, INCORPORATED

AN INTERNSHIP REPORT

by

Chu-Chen Chen, P.E.

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

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August, 1985

Major Subject: Mechanical Engineering

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ABSTRACT

Intern Experience at
MEL, Incorporated (August 1985)

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Engineering is learned through practice as well as in the class room. The purpose of this internship was to accomplish the goals and activities of a professional engineer in a consulting business which would lead to a position of responsibility and authority in the future. The engineer, as a professional person, must have keen analytical skills and ability to synthesize these skills in practical applications. A knowledge of the engineering managerial role the intern is to play possessed by those who are responsible for his training, supervising his activities, and administering engineering projects and business, also enhances his possibilities for performing in a successful manner.

The author spent a one year internship at MEL, Inc., a civil and mechanical engineering consulting firm located in Baton Rouge, Louisiana. By special arrangement with the president of the firm, the author was able to participate in roles at various levels within the firm. These activities included engineering design, supervision and management, project cost control, and interface with top level management. During this period, the author has been engaged in the following assignments:

1. Serving as senior project engineer on the Louisiana Training Institution air conditioning and heating project.
2. Serving at the review and advisory level for three projects.
3. Studying and implementing computer aided design and drafting system for MEL, Inc.
4. Developing a project cost control system that is interactive with the firm's payroll program.
5. Upgrading the firm's computer capacity.
6. Performing special assignments from the President, Executive Vice-President, Manager of Operation and Manager of Business and Fiscal Affairs at MEL, Inc.

These activities involved the application of scientific principles to the design, installation, and improvement of integrated systems of people, materials, and equipment to provide the most effective operating and work procedures. As a result of this involvement in a wide range of assignments, the author now has a broadly based experience in a consulting engineering firm as both engineer and manager. The author also found that well-developed, practical courses in communication, business, engineering, law, and management from the Doctor of Engineering program at Texas A & M University contributed greatly to this successful internship with MEL, Incorporated.

ACKNOWLEDGEMENTS

I am deeply grateful to Dr. Warren M. Heffington, Chairman of my Advisory Committee, who not only served as my advisor but also gave much support during my stay at Texas A&M University and subsequently during my internship. My appreciation is gratefully extended to the members of the doctoral advisory committee: Dr. Thomas W. Comstock, Dr. William E. Murphy, and Dr. W.D. Turner for their discerning insight and guidance throughout this study. Grateful acknowledgements also include Dr. D. T. Ward, the representative of the College of Engineering and Dr. Michael W. Pustay, representative of the Graduate College.

I am thankful to Dr. C.F. Kettleborough, graduate advisor of Mechanical Engineering at Texas A&M University, for his encouragement to pursue and persevere in attaining my terminal degree. I am also most grateful to Dr. Leroy S. Fletcher, Associate Dean of Engineering, for his sincere support, interest, and understanding during the development of my final degree plan.

Special thanks are due to Mr. Morgan M. Watson, P.E., and the staff at MEL, Inc. for the opportunity to carry out my internship in an interactive environment so that I could both learn and make effective contributions. Their support of my endeavors are most appreciated.

Most importantly, I wish to express thanks to my wife Lily and my sons, Oliver and David, for managing alone in Louisiana during my studies in Texas. I am especially grateful to Lily for her strength and encouragement to me even after a severe auto accident. My daughter Nancy has reviewed my primary manuscript, and I appreciate the time she has spent.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The Doctor of Engineering program at Texas A&M University emphasizes actual engineering practice in an environment of potential leadership which will lead to a position of responsibility and authority. The period of internship provides the opportunity to forge an essential link of theory and practice in the industrial community. As a professional person, the engineer must have analytical skills and ability to synthesize those skills in practical application.

In partial fulfillment of the Doctor of Engineering degree requirements, this author spent a one year (July 1984 - July 1985) internship with MEL, Inc. Baton Rouge, Louisiana, under the supervision of the president of the firm. This report will review and report all aspects of the author's experience as a senior project engineer. The objectives of my internship included the following items.

OBJECTIVE I - DIRECTION

The internship included work with all aspects of the consulting business with particular emphasis on management, funding allocations, and overall project scheduling. MEL is an engineering consulting firm, completing projects mainly in the area of highway transportation and energy management. Employment by MEL of the author was as a senior project engineer.

OBJECTIVE II - DEVELOPMENT

The following specific objectives were accomplished during internship at MEL, Inc.:

I. Develop basic interpersonal, technical and managerial skills by:
   A. Analyzing and implementing the managerial techniques used by MEL, Inc.
   B. Participating in discussions involving philosophy of management.
   C. Gaining information and experience through routine daily activities.

II. Improve technical expertise by participating in and supervising (as appropriate projects become available):
   A. Design of energy management systems (particularly HVAC in commercial buildings).
   B. Liaison between design and construction engineers.

III. Improve leadership activities by acting as project engineer and coordinating the various disciplines required on projects.

IV. Improve administrative abilities by keeping assigned projects on schedule and at desired quality control levels.

V. Assisting the principals in the preparation of proposals.

OBJECTIVE III - CONTRIBUTION

These objectives were planned with the intent to strengthen the ability of the intern to deal with broadly-based problems. Particularly, involvement with management and other non-technical areas of engineering knowledge were emphasized. The intern was well-suited based upon his past experience and academic background to make a sound contribution to MEL, Inc., during the internship period.

The remainder of this report provides the detailed information regarding my internship activities during the period July 1984-July 1985 with MEL, Inc.. The objectives of my internship have been successfully met through various projects and assignments. Chapter II provides the overall philosophy of operation and managerial techniques at MEL, Inc. Chapter III covers the engineering design projects and special assignments that are concerned with long-term direction and decisions involving investments of the company's future. Chapter IV summarizes the relation between each activity and objectives during the internship with MEL, Inc. and concludes with a discussion of the overall internship accomplishments.

CHAPTER II

THE FIRM

OVERVIEW

This chapter is intended as an introduction to consulting engineering firms in general and to MEL, Inc. in particular. In the course of this report, I will first discuss the foundations of organization, management and disciplines of MEL, Inc., and then I will analyze the interactions of this consulting firm with the market and its financial structure. Finally, I will review the current projects and project structure procedure at MEL, Inc.

Consulting engineering, as an independent profession, dates back only to the first half of the nineteenth century. Consulting engineering firms are independent organizations where the professional engineer performs engineering services for clients. The firms own and manage their own businesses and serve their clients on a contract fee basis.

MEL, Inc. is an engineering consulting firm with multidisciplinary capacities that include civil and structural engineering, construction engineering services, environmental services, mechanical engineering, and planning and technical assistance. The firm is minority owned, and operated by professionals from all racial backgrounds. Since the firm was founded in 1972, MEL has been soundly staffed and operated by professionals with proven experience and expertise in their respective disciplines. The quality of work produced by the firm has enabled it to expand from ten part-time engineers to a full-time organization of three principals and more than eighty technical, professional and management staff persons. Headquartered in Baton Rouge, Louisiana, the firm has branch offices in New Orleans and Shreveport, Louisiana, and has been able to undertake projects both regionally and nationally.

According to C. Maxwell Stanley [1]* MEL, Inc. is considered as a medium-size engineering firm (which comprises only 5.3 percent of all types of engineering firms).

CONSULTING SERVICES OFFERED

Major disciplines in which MEL, Inc. offers consulting services [2] are as follows:

1. Civil And Structural Engineering
   Urban and Rural Highways
   Elevated Highway and Expressway Systems
   Bridges (Fixed and Movable)
   Flood Control and Navigation Structures
   Industrial and Commercial Buildings
   Sidewalk and Street Improvements
   Port Facilities
   Industrial, Commercial and Residential Site Development
   Airport Runways
   Parks and Recreational Facilities
   Parking Facilities
   Water and Sewerage Treatment Facilities and Systems
   Pumping Stations (Sewerage, Drainage and Waste Water)

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*References and Bibliography follow the style of the Journal of Energy Resources Technology.

Surveying (Topographic, Hydrographic, and Cadastral)

Transportation Location Studies

Hydrological Studies

2. Construction Engineering Services

Value Engineering

Review of Shop, Working and Erection Drawings

Field Surveys

Resident Inspection

Construction Contract Administration

Coordination of Testing Program

3. Environmental Sciences

Coastal Zone Management Studies

Water, Air and Noise Abatement Programs

Environmental Impact Studies

Hazardous and Industrial Waste Analysis

Water Quality Evaluations

4. Mechanical Engineering

HVAC Systems

Plumbing and Process Piping

Heavy Machinery

Dust Collectors

Pneumatic Systems

Material Handling Systems (Conveyors)

Heat Transfer Systems

Solar Energy Systems

Energy Management

5. Planning and Technical Assistance
    Public Participation Programs
    Site Development Planning
    Applications for Project Funding (Government and Private)
    Project Administration
    Master Plan Studies
    Technical Assistance
    Business and Management Assistance

ORGANIZATION AND MANAGEMENT

The current organizational structure of MEL, Inc. reflects the development and adaptation to various work experiences. The company structure (See Figure 1) was designed with an emphasis on job specification, with definite segregation of responsibilities. The organizational chart of Figure 1 defines the formal channels which specify the order of authority, responsibility, and communication relationships from top to bottom. Essentially, there are three levels of operation in the firm. There is first the executive management level, followed by the operational management posts and the working engineer services. The principal function and responsibilities of key management position personnel are as follows:

Morgan M. Watson, M.S.M.E., P.E., President

The president is the chief executive officer of the corporation, responsible for coordinating the activities of all other officers. He is also responsible for marketing, planning, identifying, and pursuing new business opportunities. Mr. Watson has served in various technical and administrative capacities including research engineer

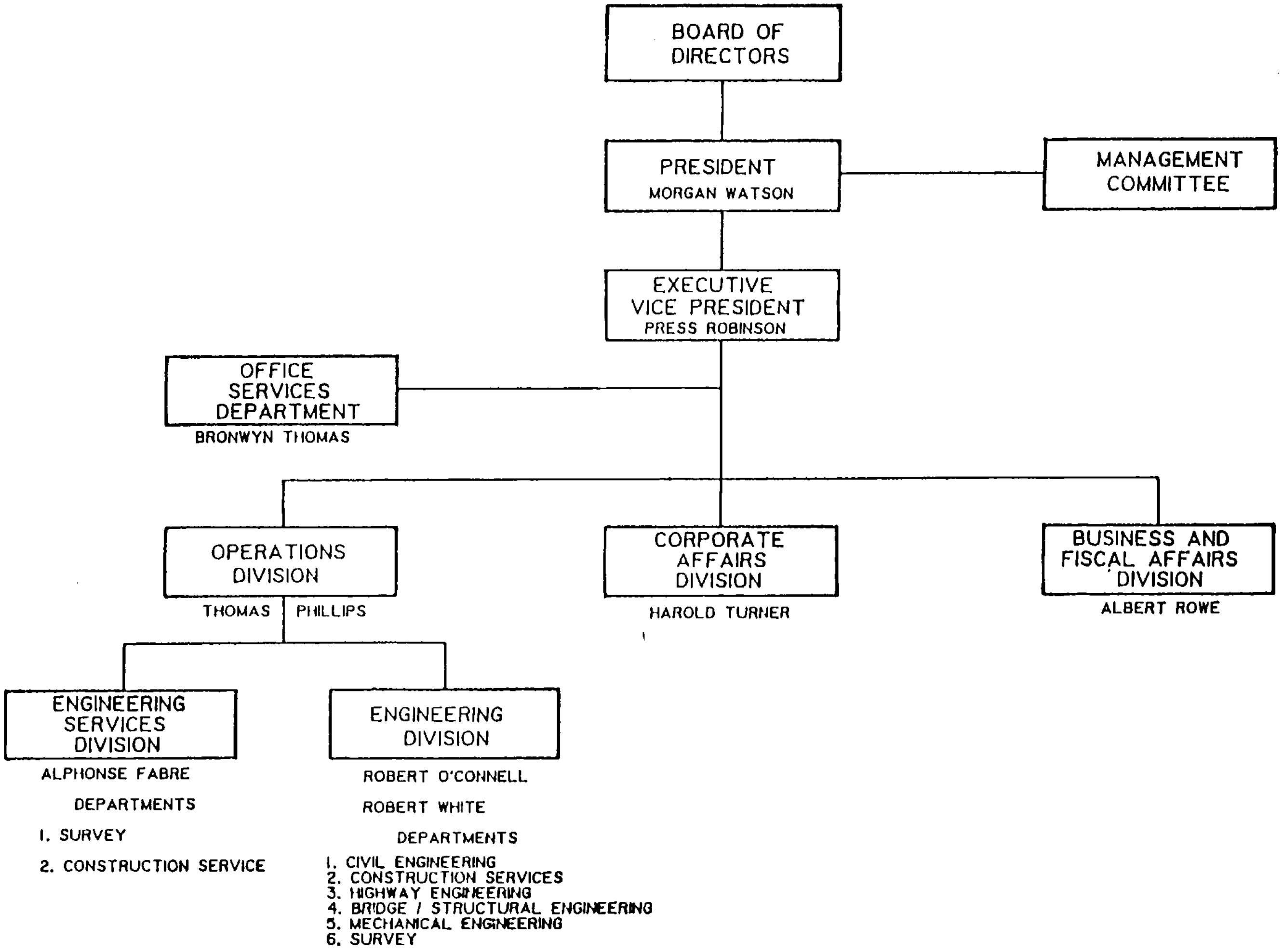

Figure 1

MEL, Inc. Current Organization Chart

with McDonnell Douglas, Chrysler, and NASA, and as Chairman of Mechanical Engineering and Assistant to the Dean of Engineering at Southern University. He is a registered professional engineer in the states of Arkansas, Georgia, Louisiana, and Mississippi.

Press L. Robinson, Ph.D., Executive Vice-President

The executive vice-president at MEL, Inc. is the chief fiscal officer. He is responsible for all business and financial affairs within the corporation. With a background as a research chemist with Dow Chemical, General Electric, Mound Laboratory, Los Alamos Laboratory and as a professor of Chemistry at Southern University, Dr. Robinson also serves as principal-in-charge of environmental projects. He is currently President of the School Board, in East Baton Rouge Parish, Baton Rouge, Louisiana.

Thomas F. Phillips, M.S.C.E., P.E., Manager of Operations

The manager of operations is the company's chief technical and professional officer. He is responsible for all production activities, including developing standards and quality control. He is also responsible for coordinating the branch offices in Baton Rouge, New Orleans, and in Shreveport. Mr. Phillips has had sixteen valuable years experience as a civil/structural engineer with the Corps of Engineers. He also serves as principal-in-charge of civil structural and surveying projects.

Albert B. Rowe, B.S., Manager of Business and Fiscal Affairs

The manager of business and fiscal affairs is responsible for the company financing, accounting and control. Other duties include maintaining the financial records, controlling financial activities, managing payroll, tax matters, inventories, and computer operations. Mr. Rowe formerly served as chief accountant for the Los Angeles County School Board Lunch Program for ten years.

Bronwyn R. Thomas, B.A., Manager of Office Services

The manager of office services is responsible for establishing systems and procedures to ensure the efficient and economical operation of administrative support services. Additional responsibilities include providing administrative assistance to the President and Vice-President of the firm, and serving as secretary of the corporation. Prior to joining the staff of MEL, Incorporated Ms. Thomas acquired eight years of administrative experience in the preparation of various reports, the analysis of reports with recommended actions, and the supervision and/or monitoring of personnel and work activities.

Harold Turner, M.S., Manager of Corporate Affairs

The manager of corporate affairs is the chief personnel officer at MEL, Inc. As personnel manager, Mr. Turner is responsible for the day-to-day management of personnel affairs and all related personnel matters. Mr. Turner has acquired more than twenty years of administrative and operations experience with the U.S. Army. Additionally, he has served as business manager for Southern

University and as a business management specialist with the Governor's Office of Minority Business Affairs, State of Louisiana.

Management Committee

The management committee of MEL, Inc. is a task group which functions at the executive level. This task group was established for the following purposes:

1. Exchanging views and information
2. Recommending action
3. Generating ideas
4. Making decisions

This top management body within the firm consists of the president, the executive vice-president, the manager of operations, the manager of corporate affairs, the manager of business and fiscal affairs, the manager of office services, and the author. Regularly scheduled meetings of this committee are held once a month. The executive vice-president serves as committee chairman which is a fixed position. Some example functions of the committee will be explained in the section on other management work.

MARKETING PRINCIPLE AND INTERACTION

The marketing principle at MEL, Inc. includes the business activities of a whole range of engineering services and work between MEL, Inc. and its clients. Markets are the source from which contracts are drawn and through which services are distributed. This interaction is the main means of circulating the services and the payments which keep the company functioning. Since September 1983, the overall marketing goal at MEL, Inc. has been to procure enough new projects for the company's total annual income (billings) to reach the $5,000,000 plateau. In order to achieve this goal, a reorganization (See Figure 2) of the firm's marketing effort was introduced on March 27, 1984. Mr. Watson, the president of MEL, Inc., now serves as principal-in-charge of marketing. The principals function within the marketing structure as follows:

1. Principal-In-Charge of Marketing:
   Responsible for creating the marketing plan, integrating marketing with overall business objectives, and as chief executive officer provides guidance to other corporate officials, to plan the company's future and look for new opportunities to develop.
2. Marketing Manager:
   Responsible for the development and execution of the marketing plan. With the management committee, he determines target markets, appropriate objectives, and tasks for achieving those objectives. He assigns responsibilities for implementation and monitors the achievement of the plan.
3. Business Development (Marketing) Representatives:
   Reporting to the marketing manager, they are primarily seeking prospects. They are responsible for the development of a continuing list of prospects large enough to ensure a steady volume of work, and identifying prospect needs which the firm is capable of satisfying.

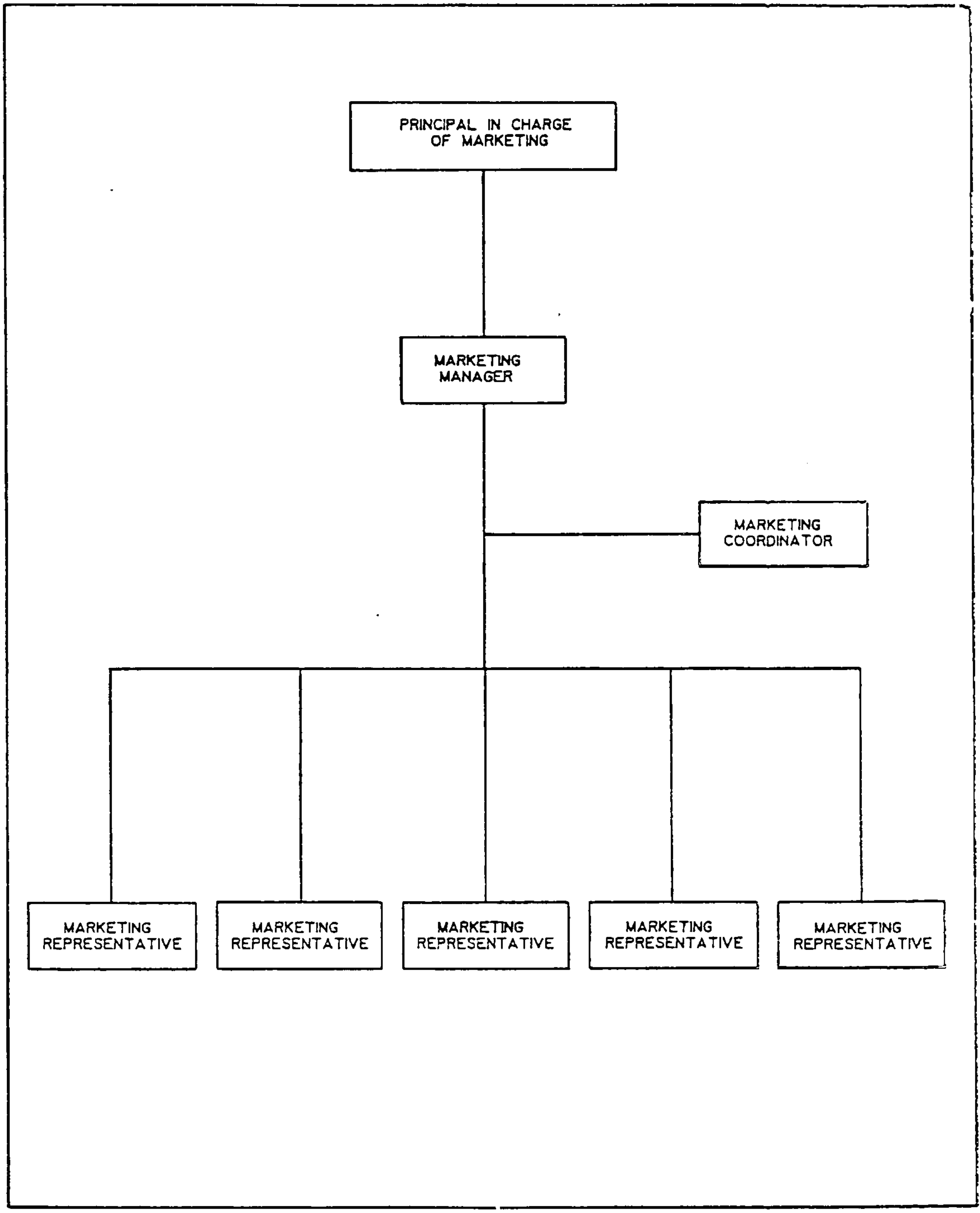

Figure 2

MEL, Inc. Marketing Reorganization Chart

4. Marketing Coordinator:

   An in-house, staff-level person responsible for creating and maintaining the marketing support system, including files, tickler systems, public relations materials, and other similar duties. This position will be filled based on the recommendation of the marketing manager.

The marketing activity of MEL, Inc. is primarily developed on the management level. Most managerial persons also serve as business development (marketing) representatives. The areas of business development (marketing) representatives' responsibilities are divided as follows:

1. All federal agencies, the city of New Orleans and the Louisiana Department of Transportation and Development (DOTD).
2. All state agencies except DOTD.
3. Baton Rouge city and parish, and all school boards in Louisiana except East Baton Rouge Parish.
4. National Park Service.
5. Towns and parishes in north Louisiana.
6. Towns and parishes in south Louisiana excluding New Orleans.
7. Other states where Corps of Engineers' transportation projects exist.

The primary market at MEL, Inc. has been and will continue to be federal, state and local governments, with the private sector receiving more attention in the future. There were many considerations involved in developing market entry into the private sector. The decision involved a commitment of MEL, Inc.'s resources and time. Most recently, industrial sector and design-construct are the two new marketing areas which were proposed by the president during the February 1985, management meeting. The author has been assigned as the coordinator to study the possibility of future expansion into the design-construct area. Detailed information will be presented later.

FINANCIAL STRUCTURE

The financial structure at MEL, Inc. is basically similar to other consulting engineering firms. The executive vice-president and manager of business and fiscal affairs play a central role in this area of the company. Their duties include financing of equipment, accounting and control, and long-range planning. The major problem faced by MEL, Inc. and other similar consulting engineering firms has been to obtain the cash flow to keep the company operating at all times. There are three major financing sources used by MEL, Inc.: debt, stock, and retained earnings. However, debt and retained earnings are the main sources of the company's financing. In the early stages of a project, a bank loan is secured by the signed contract. The main corporation account at the bank is utilized to deposit all income funds, whether from stock sales, lines of credit, loans, or fees from projects. Funds are then transferred to the operating account based on the monthly financial projection. Because of successful operations during the last few years, MEL, Inc. has been able to use internal funds instead of external funds. Engineering operations are financed by the retained earnings and fees from projects.

MEL, INC. CURRENT PROJECTS 1984-1985

During the fiscal year 1984 MEL, Inc. had many active projects. The total billings exceeded $4.6 million.

Based on updated (2/15/85) MEL active projects lists there were sixty-five projects in-house. However, most projects are slowly phased out as the billing fee cycle is exhausted. The new projects are then only slowly coming into their production. One typical example of the latter is the project which MEL, Inc. has contracted with Walk, Haydel & Associates to do facility work at six underground sites for strategic petroleum reserves (Louisiana and East Texas). From MEL, Inc. in-house calculations, the annual income of this project should be approximately $1.3 million per year. However, the project has yet to be contracted after six months of discussion.

PROJECT MANAGEMENT PROCEDURE

The present project management system took several years to develop. The current MEL, Inc. project management procedure flow chart (See Figure 3) was the result of a modification of the professional engineers in private practice guidelines [4] by Dr. James O. Morgan and Mr. Thomas F. Phillips, the Manager of Operations. MEL, Inc. has developed the project management guidelines as a means of planning for each individual and each design team to maximize their contributions to the overall performance of MEL, Inc. These project management guidelines [3] consist of ten major steps as follows:

1. Pre-project Scope Evaluation
2. Proper Contractual Agreement
3. Project Manager and Design Team System
4. Preparation of Work Program

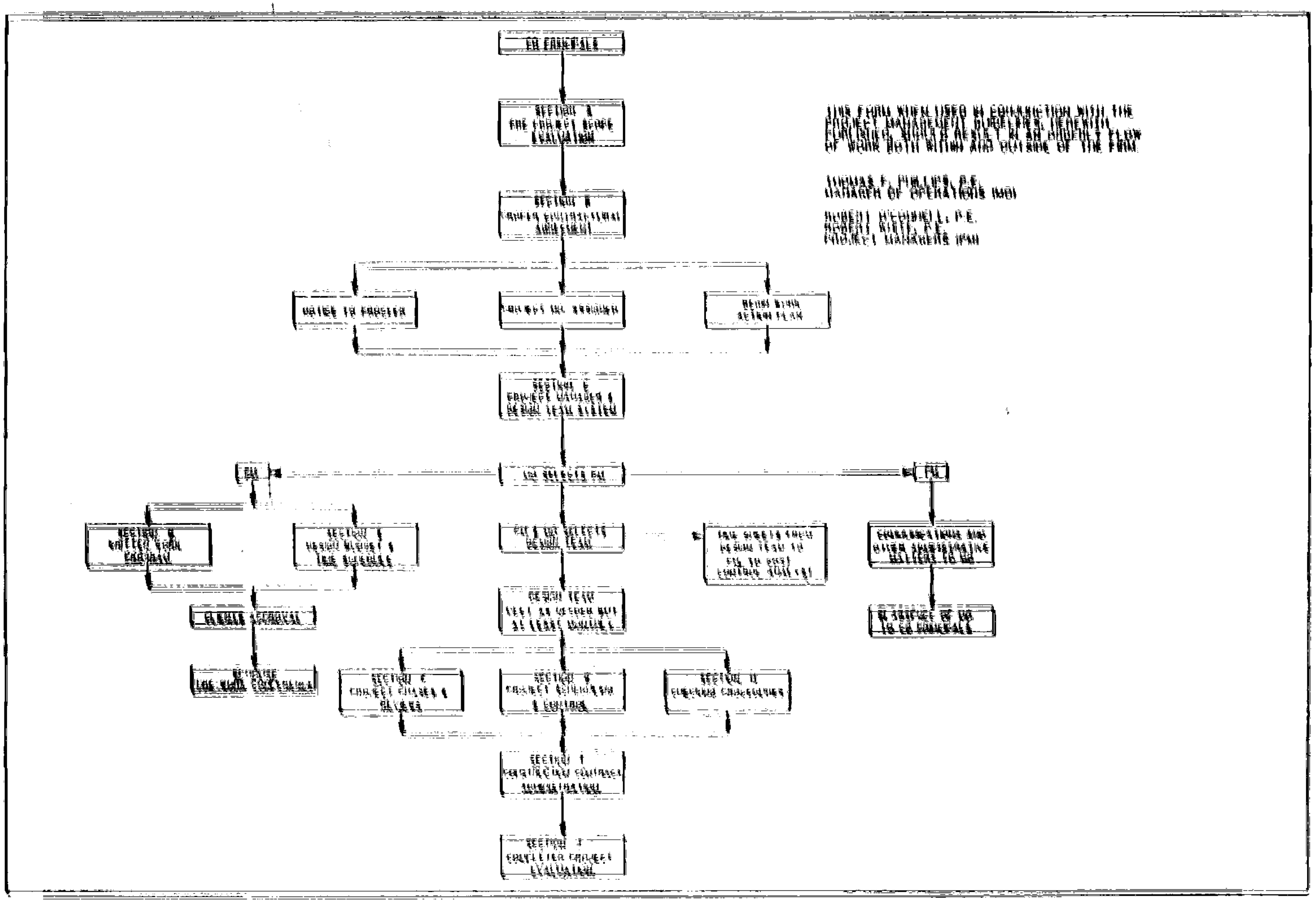

Figure 1

Project Management Flow Chart

5. Design Budget and Time Schedule
6. Project Phases and Reviews
7. Project Scheduling and Control
8. Checking Procedures
9. Construction Contract Administration
10. Completed Contract Evaluation

Project management begins as soon as MEL is awarded a project. A project number is assigned at the time of the receipt of notice to proceed. The manager of operations selects the project manager. The scope of the project, its location, client preference, and workload are the primary factors influencing the this selection.

Each project manager reports directly to the manager of operations on all project matters. The manager of operations has total responsibility and accountability for all projects in the firm. The technical and administrative efficiency of the project manager is the key to the success of the project team approach. He is responsible for productivity on his project from the standpoint of quality and quantity.

All communication with the client is channeled through the manager of operations and it is only with his approval that direct contact with the client may be made by personnel assigned to the project.

The cost accounting of the project is done by computer. The project manager is expected to maintain engineering cost control on his projects by comparing his records with the computer records. This controlling function involves comparing actual results with planned results and consequently making changes in individual and team behavior in this project management process. Those project management guidelines have been effectively interfaced with the new computerized accounting system which was introduced in the project cost control section in March 1985. The result has been overwhelmingly successful and will have a long-term impact on the success of MEL, Inc. in the future.

CHAPTER III

INTERNSHIP PARTICIPATION

INTRODUCTION

This chapter covers all aspects of internship participation during the year (July 1984-July 1985) with MEL, Inc. As a senior project engineer, this author began the internship by directly designing and supervising the engineering project "Air Conditioning and Heating of Eight (8) Dormitories" at the Louisiana Training Institute (L.T.I.) in Baton Rouge, Louisiana. This project has continued to be active throughout the internship. The author has also served in a review and advisory capacity for three other engineering projects.

Three topics within the management area which are discussed individually and in detail include: (1) The Practicalities of Implementation of a Computer Aided Design and Drafting System at MEL, Inc.; (2) Development of Project Cost Control Accounting System; and (3) The Entry of MEL, Inc. into the Design-Construct Market. Three project audit activities are combined with the Management Committee Meeting activities and reviewed within the topic of "Other Management Work". As part of the management at MEL, Inc., the author participated in the monthly management committee meetings and engaged in special assignments from the top management body which included the President, Executive Vice-President, Manager of Operations and Manager of Business and Fiscal Affairs.

AIR CONDITIONING AND HEATING SYSTEM DESIGN

Since July 16, 1984, the author has been assigned a project entitled, "Air Conditioning and Heating of Eight (8) Dormitories," at the Louisiana Training Institution (L.T.I.) in Baton Rouge, Louisiana. This project is supported by the State of Louisiana. The design work in the project initially consisted of providing an air conditioning and heating system with boiler replacement to eight buildings at L.T.I.

The dormitory buildings included in this project are:

1. Pinecrest Dormitory
2. Oakwood Dormitory
3. Willow Dormitory
4. Cedarcrest Dormitory
5. Elmwood Dormitory
6. Geranium Dormitory
7. Snapdragon Dormitory
8. Training Center (Lilac Dormitory)

Site locations of these eight dormitory buildings are shown cross hatched on Figure 4. Engineering responsibilities for the author are outlined as follows:

1. Review the scope of work
2. Engineering design and calculations
3. Equipment selection
4. System design and layout
5. Supervision and cooperation with other engineers and drafting personnel

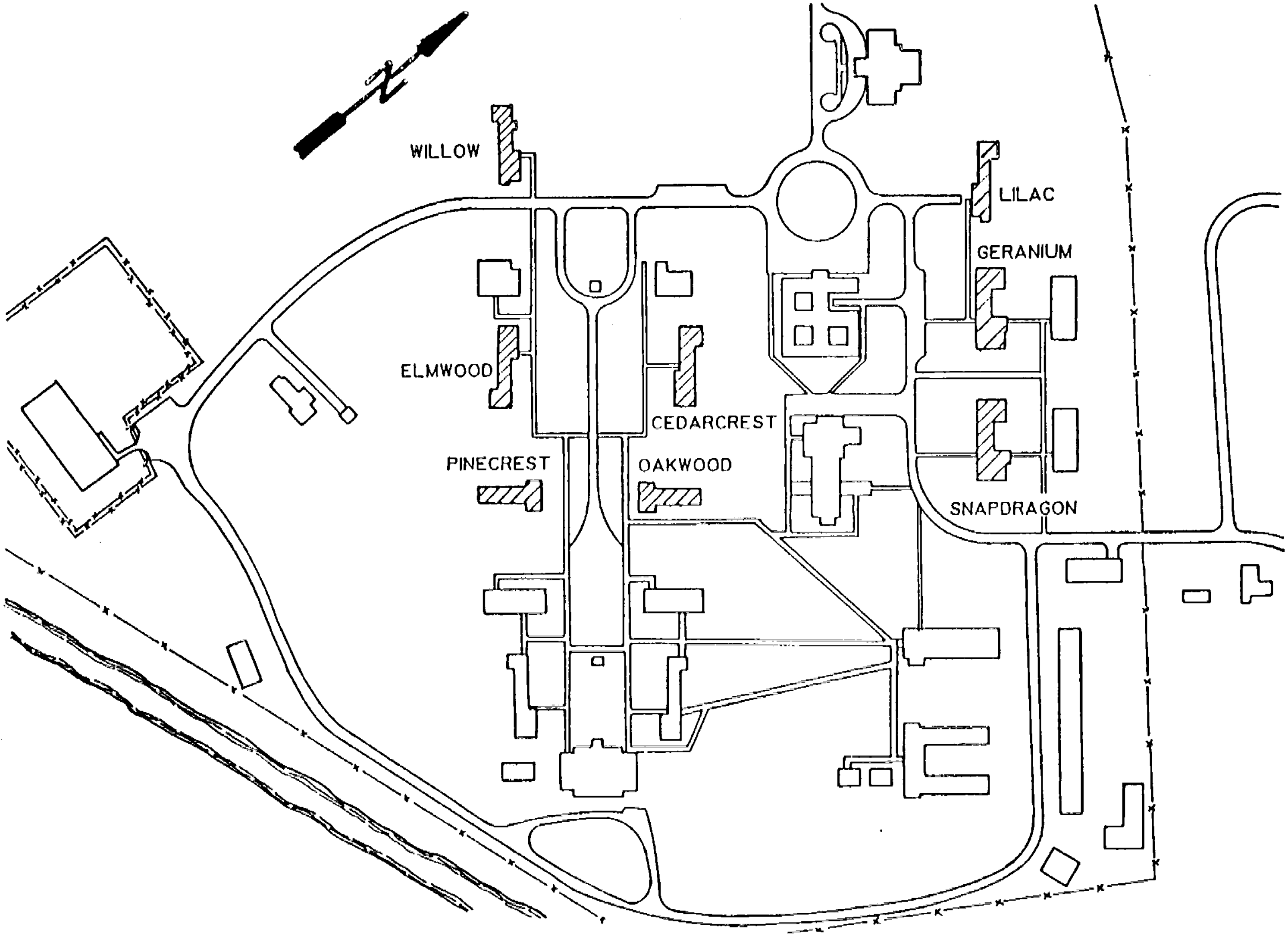

Figure 4
Dormitory Site Location For L.T.I. Project

6. Preparing engineering specifications
7. Assisting in the construction bidding process
8. Supervision of the project during the construction phase.

The preliminary study of the overall heating, ventilation, and air conditioning (HVAC) System at L.T.I. was awarded to MEL, Inc. in 1981. As part of the engineering design team at that time, the author suggested a central four pipe chilled water cooling and hot water heating system with fan-coil units to deliver and supply the heated and cooled air to different zone areas. From the energy conservation point of view, the long term net operation and maintenance savings from this system would off-set the initial extra capital expense in comparison with other types of systems. This four pipe system would provide a reliable system and savings in the long run. The State of Louisiana's Division of Administration Facility Planning and Control Office agreed with the author's preliminary energy saving design concept. However, due to budget difficulties, the project was divided into three phases. Each phase would be designed and constructed separately as independent units. In consideration of the construction budget's limitations, this centralized four pipe system was no longer feasible. An individualized zone operated concept was suggested. During my study at Texas A&M University, MEL, Inc. subsequently submitted a design with individually operated systems for each of the dormitories. The current scope of work is now based on this later submittal by MEL, Inc. This design was carefully examined by the author and other engineers (one mechanical and one electrical engineer). The author reexamined the original set of construction design concept for all of the buildings. The design work for each dormitory building is carefully outlined in the next few pages. The following design outline represents the check list used during the design process and submission process.

A. Pinecrest and Oakwood Dormitories

1.0 Install gas furnace with a direct expansion (DX) cooling coil in the attic for the sleeping area.
    1.1 Design new duct system for the sleeping area.
    1.2 Install exhaust fan with a timer in the open toilet area.
    1.3 Install thermostat in return system and control switch in the mechanical room.
2.0 Install new gas furnace with a DX cooling coil in the mechanical room on the second floor for the apartment.
    2.1. Replace existing duct system.
    2.2. Install an exhaust fan connected to light switch in the apartment restroom.
    2.3. Install a new thermostat with a control switch in the apartment.
    2.4. Remove the existing heating equipment in the apartment.
3.0 Install a window mounted heat pump in the night watchman area.
    3.1. Install an exhaust fan and heating strip in the toilet area.
4.0 Convert an existing storage closet into a mechanical room and install a split DX system for the first floor.
    4.1. Replace the existing duct system and provide a new duct system with furring for the day room and rest room area.

- 4.2. Install an exhaust fan in the restrooms.
  - 4.2.1. Add an exhaust system in the boy's toilet area to the air handler.
  - 4.2.2. Install a light, heat and exhaust fan with a 60-minute timer on the heat light in the officer toilet area.

5.0 Provide weather caulking on all windows.

6.0 Provide R-19 insulation and plywood walkways in the attic.

7.0 Remove suspended heating fans in the building.

8.0 Install condensers (2) and package HVAC unit outside on a concrete pad enclosed by a chain link fence with a locking gate.

9.0 Add a new distribution panel.

- 9.1. Provide power for new A/C System.

B. Elmwood Dormitory

1.0 Install a DX cooling coil fan with furring in the sleeping area and a duct system with furring.

- 1.1. Install an exhaust fan with a timer in the sleeping area and open toilet area.
- 1.2. Provide controls for heating and cooling in the return air duct in the mechanical room.

2.0 Existing boiler shall remain and new controls be installed.

- 2.1. Install hot water coil and piping.
- 2.2. Insulate all exposed piping.

3.0 Install a DX fan coil with furring in the first floor recreation room.

- 3.1. Locate thermostat in the return air duct and control switch in the writing room.

   3.2. Provide duct work to the writing room.

4.0 Install a hot water coil and DX cooling coil system in the apartment's corridor storage closet. Include modulating controls.

   4.1. Install a new thermostat.

   4.2. Provide an exhaust fan connected to the light switch in the apartment restrooms.

   4.3. Provide new piping to the hot water coils.

5.0 Provide weather caulking for all windows.

6.0 Condensing units for split system will be enclosed outside on a concrete pad.

7.0 No change to existing main panel.

   8.1. Existing panel is rated at 120/250 volts, 200 amp and has the following spare breakers which will be utilized for the new A/C load:

      1-20A 2P

      2-50A 2P (Ranges are not in service)

      4-30A 1P (Window units to be removed)

   8.2. Provide power to new A/C systems.

C. <u>Cedarcrest Dormitory</u>

1.0 Install a DX fan coil with furring in the sleeping area and a duct system with furring.

   1.1. Install an exhaust fan with a timer in the toilet area.

2.0 Replace existing boiler and controls.

   2.1. Install hot water coil in the duct for heating.

   2.2. Insulate all exposed piping.

3.0 Convert one half of an existing closet in the apartment to accommodate a DX cooling coil and hot water coil.

    3.1. New thermostat will be installed.

    3.2. Install an exhaust fan and heat lamp system in the apartment restrooms.

    3.3. Condensing units will be installed on the ground and enclosed with a chain link fence.

        3.3.1. Provide a roof access system for maintenance.

4.0 Install a DX cooling fan coil with furring in the recreation room.

    4.1. Provide a duct system to the writing room.

    4.2. All system controls will be installed in the writing room.

5.0 First floor heating will consist of a hot water coil in the duct.

    5.1. Design an exhaust system with air handler for the restroom.

6.0 The heating system control will be located in the mechanical room with the exception of the apartment.

7.0 Provide weather caulking on all windows in the building.

8.0 Add a new distribution panel.

    8.1. Provide power to new A/C systems.

D. <u>Willow Dormitory</u>

1.0 Install a DX fan coil system in the existing closet on the second floor in the sleeping area.

    1.1. Provide a duct system with furring for air distribution.

    1.2. Install an exhaust fan with a timer in the toilet area.

2.0 Provide a compartment in the foyer of the apartment to install a DX cooling coil and hot water coil system.

  2.1. Install filter grill and a duct system.

  2.2. Install an exhaust fan connected to the light switch in the restroom.

3.0 Replace the existing boiler and controls.

  3.1. Install a hot water coil heating system in the duct system.

  3.2. Provide an exhaust fan system in the air handler for the restroom on the first floor.

4.0 Install a DX cooling coil system with furring in the recreation room.

  4.1. Provide a duct system to the writing room.

  5.1. Provide weather caulking on all windows.

6.0 Insulate all exposed piping.

7.0 Install all condensing units on the ground with chain link fence enclosure.

8.0 No change to existing service drop or main panel.

  8.1. Existing panel is rated at 120/240 volts, 200 amp and has the following spare breakers which will be utilized for the new A/C load:

    1-50A 2P (range not in service.)
    1-20A 2P
    1-1P spare.

E. Snapdragon Dormitory

  1.0 Install a DX cooling coil with furring in the sleeping area.

  1.1. Install an exhaust fan with a timer in the toilet area.

1.2. Mount the DX condensing unit on the ground and enclose with a chain link fence.

2.0 Replace boiler and controls.

2.1. Replace floor heating system with a hot water coil system on both floors.

2.2. Provide new piping for new heating system.

2.3. Insulate all exposed piping.

3.0 Convert one half of an existing closet in the apartment to accommodate a DX cooling coil and hot water coil system.

1.1. Provide filter grill and a duct system.

1.2. Install an exhaust fan and heater strip in the restrooms.

4.0 Provide an exhaust system in the first floor toilet area. Tie exhaust system to air handler.

5.0 Provide a thermostat for heating and cooling.

6.0 Condensing units will be mounted on the ground and enclosed with a chain link fence.

7.0 Provide a new distribution panel.

7.1. Provide power for new A/C system.

F. Training Center (Lilac Dormitory)

1.0 Provide window or wall mounted heat pumps in the offices as designated by the user agency.

1.1. Provide 220 or 208 volt receptacle as required.

1.2. Provide a protective guard around system (outside).

For the first two weeks, the author made manual calculations and computer input data collections. All design data are based on ASHRAE data and specifications [5,6], and a commercial manufacturer's data [7].

MEL, Inc. is equipped with the IBM PC and Trane's computer programs [7]. This program is similar to the program provided by Carrier Corporation for use by ME664 and ME665 students at Texas A&M University, except that it goes into more depth in some areas. The computer calculations provide more detailed heating load and cooling load information. The result of both the manual and computer calculations have been compared in order to improve input data.

Some typical computer input and output data and manual calculation are included in Appendix A1. Before the equipment selection, a team of four members (two engineers, one designer and one L.T.I. representative) visited each building to verify the physical data and determine the possible site of equipment and duct layout.

In accord with energy management principles to effectively utilize energy, The author spent a great deal of time exchanging technical data with both Carrier [8] and Trane [9] engineers to verify the author's calculations.

In reality, HVAC manufacturers only manufacture a certain range of equipment. It is difficult to find the exact equipment capacity that matches the engineering calculations. A typical example are the units in Pinecrest and Oakwood Dormitories. The proper size gas furnace did not provide an adequate cooling load. Two design configurations were considered. Plan A was to use two normal size gas furnaces with an adequate cooling coil evaporator and to locate the whole unit completely inside the equipment room. Plan B was to use the correct size blower with cooling coils inside the equipment room. This plan will involve the addition of an adequate duct gas furnace unit in the attic.

However, plan B has some limitations to face. There is a special fire code regulation for having a duct gas furnace in the attic. Extra protection measurements need to be provided. The ceiling at Pinecrest and Oakwood consist of rigid, light-weight concrete deck. Also the current access door is not big enough for the required unit.

From the economic and maintenance view point, plan A with its over-sized gas furnace is still the better engineering choice. However, a two stage firing control system has been specified for the gas furnace in order to continue the implementation of energy saving principles.

The author has faced some other difficulties during the equipment selection and system layout. L.T.I. is a correctional institution for convicted young men under age eighteen. The buildings were not constructed to have an HVAC system. Instead, they were designed with security as one of the top priorities. The buildings also had new roofs installed recently and no units are permitted to be located on the rooftops. The electrical distribution panels are required to be located with the condensers inside enclosures. After careful investigation, the HVAC equipment was selected based on the author's final engineering analysis.

The equipment summary table is listed in Table A. The heating systems in both Geranium and Snapdragon buildings are old with hot water piping under the floor. A new hot water piping system with wall fin and hot water coils was designed. Specifications for equipment, such as boilers, pumps, exhaust fans, etc. have been calculated and selected according to the sample calculation shown in Appendix A1.

Table A

L.T.I. HVAC Equipment Summary

Location	Equipment	Manufacturer	Model
<u>Elmwood</u> (No Heating Coil)			
Sleeping Area (A)	Blower Coil	Trane	BACA - C10
	Condenser	Trane	RAVC - C106
Recreation Room (B)	Blower Coil	Trane	BACA - B75
	Condenser	Trane	RAVC - B626
Apartment (D)	Evaporator	Trane	EACF - B30C
	Condenser	Trane	RAUF - B302
Rest Room (E1)	Wall Exhaust with heater	Nutone	
Rest Room (E2)	Heat A Vent	Nutone	
Rest Room (E3)	Wall Exhaust with heater	Nutone	
<u>Cedarcrest</u> (with heating coil)			
Sleeping (A) Area	Blower Coil	Trane	BACA - C10
	Condenser		
Recreation (B) Room	Blower Coil	Trane	BACA - B75
	Condenser	Trane	BACA - B626
Apartment (D)	Evaporator	Trane	EACF - B25C
	Condenser	Trane	RAVF - B252
Rest Room (E1),(E2) (E5)	Same as Elmwood		

Table A "Continued"

Location	Equipment	Manufacturer	Model
Willow (No Heating Coil)			
Sleeping (A) (two)	Blower Coil	Trane	BACA - B75
Area (two)	Condenser	Trane	RAUC - B626
Recreation (B)	Blower Coil	Trane	BACA - B75
Room	Condenser	Trane	RAUC - B626
Apartment (D)	Evaporator	Trane	EAF - B306
Rest Room (E1), (E2) (E3) Same as Elmwood.			
Snapdragon/Geranium (With heating coil)			
Sleeping (A)	Blower Coil	Trane	BACA - C10
Area	Condenser	Trane	RAUC - C106
Recreation (B)	Blower Coil	Trane	BACA - B75
	Condenser	Trane	RAUC - B626
Apartment (D)	Evaporator	Trane	EACF - B256
	Condenser	Trane	RAUF - B252
Restroom (E1), (E2)	Same as Elmwood		
(E3)	Wall Exhaust with heater	Nutone	
Snapdragon 3rd Floor.			
	Gas Furnace	Carrier	58SS080-110BC
	Evaporator	Carrier	28AC048
	Condenser	Carrier	38ED048.
Pinecrest/Oakwood			
Sleeping (A)	Gas Furnace	Carrier	5855(2)080 CC
Area & Recreation Room	Cooling	Carrier	28L4012

Table A "Continued"

Location		Equipment	Manufacturer	Model
Apartment	(C)	Condenser	Carrier	38AZ012
	(B)	Gas Furnace	Carrier	5855-060-110CC
		Cooling Coil	Carrier	28AC042
	(C2)	Condenser	Carrier	38ED-42
Watchman Area	(D)	Heat Pump	Carrier	QFB3143
Lockers	(H)	Unit Gas Heater	Modine	PA75
Restroom	(E1) (E2)	Ceiling Exhaust	Nutone	
	(E3)	Heat A Vent	Nutone	
	(E2)	Wall Exhaust	Nutone	

The preliminary system design and layout were completed during the early term of the internship. All the equipment data and necessary layouts were forwarded to the electrical engineer. He later provided all necessary electrical power require- ment and electrical working drawings in order to complete the project. Production of the actual working drawing was a complex process. Much time was spent in day-by-day supervision of the design drafting personnel.

Finally, a set of engineering specifications for all equipment was compiled by the author as well as other engineers. These working drawings and specifications were used to direct the contractor in the construction of the design system. As a general practice in the consulting engineering business, the author started by gathering technical data from different manufacturers' catalogs. The equipment to be used was selected based on the author's design and calculations. Then installation requirements such as boiler and furnace data from the south region code, and the local design and construction codes were reviewed. This measure ensured agreement between equipment specifications and installment standards. Finally, the completed set of engineering specifications was assembled by combining the new design information with standard HVAC specifications generated by MEL, Inc. in the course of earlier projects. All of the specifications have been carefully checked with working drawings to assure their coordination and to reduce error and omissions.

The preliminary design and engineering specification (Appendix A2) was submitted to the State of Louisiana's Division of Administration Facility Planning and Control in December 1984. The estimated time schedule for completion of the project is shown in Figure 5. However, the estimated time schedule was not met. The review was not returned until February 1985. The comments and corrections have already been reviewed and resubmitted. This delay will cause the remainder of the bidding and construction to be delayed at least three or four months. The construction will not be completed before the end of the internship in July 1985. Considering the limitations of the construction budget, only six dormitories will be under construction during 1985.

OTHER ENGINEERING WORK

In addition to the main engineering design responsibility on the L.T.I. project, the author was assigned to serve as a project manager and senior project engineer to review and design all the mechanical HVAC and energy-related projects. Three projects are briefly discussed below:

1. Upgraded Silt Sluicing System Beneath Army Wharf. This is one of many minor projects MEL, Inc. had contracted with the Fort Worth District, Army Corps of Engineers. The scope of the work involved a determination of the condition of existing piping systems and developing the cost comparison of making repairs versus replacing the pipe system. The system has not been used for a long time. Minimum information was provided by the Army Corps of Engineers. The silt sluicing system helps to provide high pressure water through nozzles to clear the dirt along the river bank. In order to perform this work, the engineers had to design a pumping station on an Army barge to provide a working pressure of 170 to 200 psi at the nozzles throughout the entire system. The author served as the technical

AIR CONDITIONING AND HEATING OF EIGHT DORMITORIES

STATE PROJECT NO. 10-04-02-83B-4

PHASE	JAN 84	JUL 84	AUG 84	SEPT 84	OCT 84	NOV 84	DEC 84	JAN 85	MAY 85
PROGRAM COMPLETION PHASE			7/20/84						
PROGRAM COMPLETION REVIEW				8/3/84					
SCHEMATIC DESIGN & DESIGN DEVELOPMENT PHASE							11/27/84		
SCHEMATIC DESIGN & DESIGN DEVELOPMENT REVIEW							12/27/84		
CONSTRUCTION DOCUMENTS								1/9/85	
CONSTRUCTION DOCUMENTS REVIEW								1/25/85	
BIDDING AND CONTRACTING									1/20/85
CONSTRUCTION									90 days
				90 Day					

Figure 5

Estimated Time Schedule for L.T.I. Project advisory person on the project. Based on the author's design experience with fire hydraulic systems, a simple design approach was suggested to the project engineer which involved replacement of four nozzles. Design equations and experience data are based on the design books from Cameron Hydraulic Data [10] and Crane [11].

Based on the primary design calculations, the existing six-inch pipe was not adequate for four nozzles to operate at such high pressure. A diesel driven pump with an eight-inch main supply pipe system was suggested to replace the old system. The construction cost is well above the $180,000 cost limitation by the Corps of Engineers. After several discussions between the project engineer and Corps of Engineers the detailed design and cost proposal was submitted to the Corps of Engineers during March 1985. This project will be continued after the review and approval by the Corps of Engineers.

2. Air conditioning system for Fairview, North and Progress Hall (Lounge/Lobby) at Southern University.

This is a typical air conditioning system project. The design process started with cooling load calculations, equipment selection, duct system layout, and engineering specification. The author served as an in-house engineering reviewer. The load calculations and the duct system design layout were examined. Finally, the comments, suggestions and corrections were made prior to project submission.

3. Utility Cost and Energy Conservation at Southern University.

MEL, Inc. was requested to up-date a proposal to analyze utility costs and energy conservation at Southern University during March 1985. This project developed as a result of the previous MEL, Inc.'s Preliminary Energy Study at Southern University during 1980 in which the author was part of the study team. The scope of work included the following:

1. Monthly utility cost analysis and consultation on the operation of the air conditioning and heating systems.

2. Performed a detailed analysis of the timing of peak demands according to months, days and hours.

3. Determination of those factors that affected demand, such as building utilization, climate, scheduling of events, etc.

This project was recommended to begin on or about April 25, 1985, and proceed for a total one year cycle of utility billings. The author has been directly involved with this project from the beginning of the fee proposal and will analyze the demand history and the factors that affect demand as the project is in progress.

PRELIMINARY FEASIBILITY STUDY OF A COMPUTER AIDED DESIGN AND DRAFTING SYSTEM AT MEL, INC.

Introduction

Consulting engineers have a long history of achievement based on their ability to adapt and change, and to take advantage of new theories and technology. MEL, Inc., as well as other consulting engineering firms, is now faced with a challenge of the most important force affecting us today--"computerization." MEL already has an IBM-PC to handle engineering calculations and some accounting. MEL also has an IBM Displaywriter for word processing to handle all engineering reports and specifications. Until recently, computer-aided design and drafting has been generally limited to those larger engineering firms that had the financial resources to pioneer and implement the new technology. Now, with high power, moderately priced micro- and mini-computers, this situation is rapidly changing. The author was asked by the president of MEL to conduct research into the practicalities of the implementation of a computer aided design and drafting (CADD) system at MEL, Inc. for its engineering, accounting and management users.

After two weeks of extensive research of computer aided drafting (CAD) and computer aided design and drafting systems currently on the market, the wide range of price and functions available has led the author to the following approach. The author concludes that the best way to broaden MEL's perspectives on CADD system implementation is to learn from the experiences of other consulting firms and studies. Special issues focusing on CADD from journals such as Architectural

Technology [12], Civil Engineering [13]., Consulting Engineer [14], Computer [15], Heating, Piping, Air Conditioning [16], and Mechanical Engineering [17] have been examined. After analyzing all the data applying to the current MEL situation, a systematic approach was planned in my report. This report will include the following eight main items:

1. Basic CAD system
2. Both hardware and software cost
3. Major difference between $10,000/$80,000/$140,000 system
4. Best $10,000 and $80,000 system for MEL, Inc.
5. Systematic approach to acquire a CAD/CADD system
6. Training
7. Economic considerations and productivity
8. Why MEL needs a CAD/CADD system now.

Basic CAD System

Conventional engineering drawings consist primarily of pencil or ink on mylar film and are usually drawn by a skilled technician known as a draftsman or by a designer. The sheet of mylar and drawing pencil combine to form an input system. The sheet of mylar is the storage medium and a display device.

In a computer-aided drafting system (CAD), the input system consists of a computer (central processing unit), a CAD computer program package, and input devices. Designers use a drawing editor to create the electronic description of these objects that comprise a drawing. A drawing editor is a basic drawing function such as a line, circle, or angle, which is controlled by an input device. The drawing editor accepts input from the computer keyboard, a digitizer table, or a light pen, etc. In a CAD system, one cannot actually see the drawing that will be eventually stored. Instead, an image of the drawing is viewed on a display device. The designer can record the drawing on a magnetic tape or a disk. Since the CAD drawing is stored electronically, a computer control plotter is needed. A large, flat bed x-y plotter or a drum plotter is commonly used. The comparative data between the conventional drafting and CAD system is shown in Table B.

Table B

Comparison between Conventional Drafting and CAD Systems

Conventional Engineering Drafting		CAD* System
Input	1) Designer/Draftsman	1) Designer
	2) Pencil	2) Computer
	3) Mylar	3) Software package
		4) Keyboard/digitizer table/light pen Cursor
Display	1) Mylar	1) Display Monitor
Output	1) Mylar	1) Plotter
		2) Mylar
Storage	1) Mylar	1) Magnetic tape/disk
		2) Mylar

*CAD - Computer-Aided Drafting

A Computer aided drafting (CAD) system is an interactive computer graphic system for the generation of engineering documentation in a full production environment. A computer aided design and drafting (CADD) system or as it is called by some people computer aided design (CAD) system goes far beyond the simple reproduction of engineering documents. Computer aided design or computer aided design and drafting (CAD/CADD) has the ability to create different styles of drawings. CAD/CADD also has the capacity to automatically dimension and calculate configurations. Based on the design drawing, a CAD/CADD system can generate a listing of equipment from drawing and a complete bill of materials. A CAD/CADD system can create input for an analysis program, etc. However, the bottom line for implementing a CAD/CADD system at MEL, Inc. is dependent on two things: namely, the right hardware (computer and plotter, etc.) and the right software (computer program).

Hardware and Software Costs

One of the major problems with implementing a CAD/CADD system at MEL, Inc. has been the cost and design of the work station. Tonias [14] has listed a profile of some of the CAD and CAD/CADD systems exhibited at the "Systems '84 Show" in Baltimore, June 4-7, 1984. The prices vary widely from under two thousand up to a half-million dollars, a confusing array of prices reflecting different capabilities. The price also varies depending on hardware configurations such as the type of computer display, digitizer, and plotter, etc.

Based on the applications needed at MEL, Inc., only mini- and micro-computers were considered. There are many mini-computer, micro-computer and graphic components available on the market.

However, based on the maintenance service and software applications availability, only IBM, Digital Equipment, Hewlett-Packard, Wang and Apple Computer manufacturers are considered. The author began with evaluating hardware component costs and then comparing the minimum CAD/CADD system costs with different hardware configurations. In this range of computer systems, among the IBM System 138 series, Digital Equipment VAX-11 series, PDP-11 and Hewlett-Packard HP 3000 series, the DEC VAX 11-750 or PDP 11-73 was chosen as the mini-computer which is most suitable for MEL, Inc.

At the micro-computer level the IBM-PC has more software available on the market compared to Apple and Wang. The choices were evaluated on the basis of services and software availability. Other selection factors such as hardware components and minimum CAD/CADD costs are shown in Table C and Table D.

Software

Bernstein [18] states in his report that, "Unless engineering firms have unlimited funds, time and resources, they tend to buy readymade software rather than develop it themselves." Based on projections of available time and resources, it is the author's suggestion that MEL, Inc. should buy software and some databases from vendors.

Most CAD/CADD systems use two typical software packages. General software gives the computer its basic overall operation instruction. Special application software allows users to combine graphics-language commands into new customized applications providing expanded functionality.

Table C

Hardware Component Costs

Computer Components		Price in Thousands of Dollars
1. Mini (or Main Frame)		
DEC	PDP - 11/23+, 24, 44, 70, 73	10 - 90
DEC	VAX - 11/730, 750, 780	30 - 217
HP	3000 series	30 - 200
IBM	System 38 5381 Model, 4361	63 - 220
2. Micro		
IBM	PC	1 - 5
3. Graphics Display		1 - 30
4. Digitizer		1 - 60
5. Plotter		1 - 45
6. Work Station		
Intergraph	VAX - 730	180 - 250
	VAX - 750	275 - 310
	VAX - 780	395 - 450
Auto-trol	Apollo	150

TABLE D

Minimum CAD/CADD System Cost

System Hardware	Price in Thousands of Dollars
1. Microcomputer (PC)	
IBM PC	
Wang + storage device + plotter printer	10
Apple	
2. Mini-computer	
PDP 11/23+ 24, 44, 70, 73	
IBM Digitizer	45
5381 + 1 Station + Plotter	
Printer	
3. Mini-computers (IBM, Digital, H.P. etc.)	
VAX 11/725, 730, 750, 780, 785.	
+ 1 Station + Digitizer	
IBM 4361 Plotter	140+
4. Workstation (Hardware + Software)	
Intergraph VAX 750	275 - 310
Auto - Trol Apollo	150

Based on the latest data from Data Sources [19], PC World 1985 Annual Software Review [20], the costs of software vary greatly between mini-computer applications and micro-computer applications. Generally, the cost of PC software is under $4,000, and the cost of mini-computer software is are under $15,000. Some potential software packages for MEL, Inc. in the future are listed in Table E.

After carefully examining the hardware configuration and availability of software, three differently priced CAD/CADD systems can be reasonably applied to MEL, Inc. in the future. However, the costs are vary from $10,000 to $140,000 and there are major differences among the systems. A $10,000 CAD/CADD system basically consists of one micro-computer and other graphic components. An $80,000 CAD/CADD system is composed of one mini-computer with two working stations and other graphic components. A $140,000 CAD/CADD system consists of a mini-computer with one single working station. All the data in Tables C,D, and E are based on 1985 data [9,18] and were assembled by the author for MEL, Inc. Some of the major differences are listed in Table F.

Best $10,000 and $80,000 System for MEL, INC.

After examining the differences between these three CAD/CADD systems, this author concludes that cost should not be the primary issue. Instead, the basic functions most suitable and most needed by MEL, Inc. are the keys to selection. The author spent a great deal of time searching for suitable micro-CAD system software. With the help of the local Computerland dealer, this author was able to review some of the demonstration software for an analysis of the software quality.

Table E

Potential Software for MEL, Inc.

Vendor	System Name	Application	Price in Thousands of Dollars
1. Alpine Data System Roseburg, OR	Project time management	Project costs, accounting	5 - 25
2. Autodesk Inc. Mill Valley, CA	Auto CAD	A/E, general drafting	1.5
3. Carrier Syracuse, NY	E2000	General drafting, building system analysis	3.9
4. Concap Computing Systems Oakland, CA	Civil engineering Land surveying system	Land survey	7.5 - 30
5. Engineering Systems Baton Rouge, LA	Design Graphix 3-D Advanced	A/E, general design and drafting	20
6. Sargent Business Systems Oakland, CA	Job Cost Module	Job cost	0.6
7. The Civil Soft Anaheim, CA	COGO-PCIII Concrete	Survey mapping, structure design	1.52 0.925
8. Unix Computer System Weehawken, NJ	T.A.S	Financial report, accounting	6
9. VL Systems Inc. Irvine, CA	VANGO	Survey, mapping	20

Table F
CAD/CADD System Differences According to Cost

	(A) $10,000 CAD System	(B) $80,000$^+$ CADD System System	(C) $140,000 CADD
1.	Computer aided drafting, little computer aided design	Computer aided design and drafting	Computer aided design and drafting
2.	Micro computer based (IBMPC, Apple, Wang)	Mini computer based (Digital, HP, IBM)	Mini - (and Main frames) based (Digital, HP, IBM)
3.	Low capability a) No. of terminal or working station b) Speed and power c) Mathematics capability	Mid-range capability	High capability
4.	Average quality	Very good quality	Very good quality
5.	Save repeat drafting time	Save some design and drafting time	Save substantial engineers design and drafting time
6.	Little good software	Reasonably good software	Reasonably good software

Most of the software does not meet the engineering drafting standards. In addition, Architecture Technology [12] had a comprehensive investigation of PC computer applications. Six programs were identified as potentially suitable for professional use. Based on evaluator's experience and other reports [13, 21, 22] the Auto-CAD software is the most promising software with micro-CAD application. Three separate demonstration sessions were arranged by the author through Computerland Inc., to examine the Auto-CAD software related to MEL, Inc. highway and roadway design applications. Auto-CAD software indeed is the most economical and suitable choice for MEL, Inc. applications. However, to satisfy the full production needs, a more sizable CAD/CADD system is also needed. After much discussion with the vendor, it was found that Digital Equipment mini-computer VAX and PDP Series would provide a better service agreement. Most of the software listed in Table E are applicable to both VAX and PDP computers. Based on the author's specifications to use the VAX and PDP CAD/CADD system, a detailed proposal for software was requested and obtained from Engineering Systems, Alpine Data System, Inc., and VL Systems. This software can be implemented with MEL, Inc.'s civil structure, and highway applications, and its financial package.

Again, the costs still vary based on their configurations. However, Engineering Systems has a local area vendor which provides one of the most important factors--direct technical support, if needed. The systems will also allow MEL, Inc. to use third party software which is badly needed in job cost accounting, project management and other financial purposes. After visiting the Engineering Systems office twice, a sample drawing was carefully examined by the author. Based on my professional judgement, the quality of CADD drawings was more precise than a first class drafting product by a draftperson. A special demonstration was arranged for seven key production personnel and management members at MEL, Inc. After testing one of the MEL bridge design drawings from the Engineering System's software, the results were satisfying and accepted by all of the personnel members. The author concluded with an Engineering Systems proposal that has been projected as a mini-CAD system.

Systematic Implementation of CAD/CADD for MEL, Inc.

A timetable for implementation of the CAD/CADD system has been crucial to MEL, Inc. Currently MEL is in a transition stage. Most major projects have been close to completion, yet the new projects still are not concluded on time. Based on this circumstance, a systematic approach for MEL, Inc.'s CAD/CADD system has been proposed to MEL top management executives. This two-year proposal plan is shown in Table G.

The author suggests that the engineering work station and accounting/management function should be separated at this present time. The expensive VAX computer CAD/CADD system is not projected to be economically justified within the next two years, unless a very large project comes through. However, regardless of how sporadic the business may turn out to be in the future, MEL should start to establish one micro-CAD system within the next six months. This system should be fully equipped with an IBM-PC, D size (24" x 36") plotter, digitizer table, mouse and Auto-CAD software. The system

Table G
A Systematic Approach for MEL, Inc.'s
CAD/CADD System

Step One	Step Two	Step Three	Step Four
Within 6 Months	6 Months to 1 Years	6 Months to 2 Years	2 to 5 Years
Engineering			
A) Hardware a) One IBM-PC (512^{+} K RAM)	A) Hardware a) One IBM-PC (512^{+} K RAM)	A) Hardware a) PDP 11/73^{+} b) Two Working Stations	A) Hardware Need New Evaluation
b) Plotter Houston Instrument (DMP-42^{+} 24"x36")	b) -	c) E Size Plotter - d) RSX Operation System	
c) Digitizer Table (DTII AA H.I)	c) -	e) etc	
d) Mouse	d) Mouse/Pen		
B) Software a) Auto CAD (General)	B) Software a)	B) Software a) Design Graphix 3-D Advance (General)	B) Software a) Specialize Van-go CAD etc. (Survey)
b) Engineering calculation software (use current PC)	b) Specialized data bank		
	c) Other Software		b) Others
Costs $12,000 to $15,000	$6,400^{+}	$80,000^{+}	$25,000

Table G "Continued"

Step One	Step Two	Step Three	Step Four
Accounting/Management			
A) Hardware a) Current IBM-PC	A) Hardware a) to terminal to four terminal	-	A) Hardware a) One PDP $11/73^{+}$ b) Four
B) Software a) Current champion	B) Software a) Harvard project manager	B) Software a) project time management (Alpine)	B) Software -
b) Sargent business Cost Module Costs $600	b) Others $8,600	$15,000 to $20,000	$30,000

also can be tied to current coordinate geometry (COGO) software to provide the engineers hard copy in both roadway and structure design. After six months of training and learning, MEL should start to establish their mini-CAD system with two work stations. These two work stations will provide MEL, Inc. with the necessary design and drafting capacities. The functions of mini-CAD and micro-CAD systems are summarized in Table H.

Table H

Functions of MEL's Micro-CAD and Mini-CAD System

Engineering Function

Micro-CAD	Mini-CAD
1. Architectural design	1. Roadway/street/highway
2. HVAC	2. Concrete structure
3. Engineering calculation	3. Bridge design
4. Minor civil work, etc.	4. Other mechanical projects, industry piping, etc.

Accounting/Management Function

Micro-CAD	Mini-CAD
1. Accounting	1. Accounting
2. Project scheduling	2. Financial
	3. Management
	4. Word processing

Training

CAD/CADD does not give the designer the ability to push a button and automatically obtain the final design product. A CAD/CADD system is justifiable only if it is integrated into the entire design process, to be used by their designer or engineer in the design and layout of work as well as by the draftperson.

The key to the successful use of the computer by the MEL engineering staff and draftpersons necessitates an in-depth training program. This training program should include reviewing factors such as who will be trained, when the training will take place, and how the training sessions will be structured. The engineering body at MEL consists of some well educated and experienced older project managers and some young relatively recent college graduate junior engineers. This is an ideal design team. Experienced design managers should be aware of the impact of CAD/CADD and how it works, while fast-learning younger engineers will actually use the computer with some key input advice from the experienced design manager. Design teams in roadway, street, highway, sewage, structure, bridge, HVAC, and piping should be established. Engineering design teams will also train together. Only one out of eight draftpersons currently in MEL's drafting department have had CAD/CADD training. Groups of three persons should undergo extensive training during the first three months. Within the first month of installation of the second CAD/CADD system, a second group of three draftpersons will go through training. A suggested schedule of training is listed below.

Basic training involves becoming familiar with the CAD/CADD system operation. The new applications or advanced features used in

CAD/CADD are introduced during on-the-job training. A goal was set to achieve a greater production rate than the former system allowed. Auto-CAD system does not provide tutorial lessons. The author suggests himself to assume the responsibility of conducting the training providing personal one-on-one support.

MEL should structure the first CAD/CADD system into three- to four-hour shifts with two to four shifts during 8:00 a.m. to 12:00 noon, and 12:00 noon to 4:00 p.m. (for design and drafting), and a third four-hour shift from 4:00 to 8:00 p.m. primarily used for production drafting or training.

Roadway and HVAC will be the two types of projects to be first implemented with the CAD/CADD system. Highway Bridge Structure will be implemented during the second CAD/CADD system. MEL should have fully implemented all its projects with its CAD/CADD system within the next two years.

Table I
Suggested Training Timetable

A)	Drafting person	
	1) Basic training	2 days to 1 week
	2) On job training/with support*	one month
	3) Continue training/with support*	1 to 3 months
B)	Engineers/Designers	
	1) Basic training/with support*	2 days to 1 week
	2) On job training/with support*	Open (self study)

*technical support by author

Economic and Productivity Considerations

The CAD/CADD systems have a relatively high initial cost. Many engineering managers do not realize the long term expense of manpower. The cost of manpower is a continually escalating expense while a CAD/CADD system's cost is either sunk or static. Garret [23] did a five-year cash flow projection and five-year expense sheet with and without CAD. The result is favorable for a CAD/CADD system in the long run. Currently MEL's status is different from other firms in that MEL has already cut the engineering force to the low point. Economic considerations should be tied with productivity and future manpower. Studies [12], [13], and [24] show a productivity of 1:1 ratio can be reached within 20 - 120 hours with a micro-CAD system. A mini-CAD operator needs about 120 hours training to be a good designer. The projections of productivity at MEL are listed in Table J below:

Table J
Project Productivity at MEL

Ratio	Drafting	Engineering
1:1	1-3 months	1-6 months
2:1	6-12 months	After 12 months
3:1	After 12 months	

The productivity of 3:1 ratio in drafting and 2:1 ratio in engineering design should be achieved after one year of installation at MEL. The basic cost of a 5-year micro-CAD and mini-CAD as well as salaries for an average entering experienced drafting person and young engineer are listed and compared in Table K below.

Table K

Basic Economic Considerations for CAD/CADD

	Auto CAD	Design Graphix 3-DD Adv.
Hardware and Software	$12,950	$80,000
No. of Station	1	2
Work Station Costs	$12,950	$40,000
Yearly Amortization (1)	$ 2,587	$ 8,000
Yearly Maintenance (2)	$ 1,554	$ 4,850
Training (1st Year)	$ 900	$ 2,500
	$ 5,041/station	$15,350/station

(1) Assume 5 years straight-line depreciation. Does not consider the cost of money investment tax credit, depreciation, salvage value, etc.

(2) Based on Computer Land and Engineering Systems.

Experienced drafting person	$18,720/year
Junior Engineer	$21,000/year

With productivity at better than a 2:1 ratio, both the micro-CAD and the mini-CAD systems are less expensive than manpower. If workload is provided to fully utilize the micro-CAD and mini-CAD system, the payback period can be reached within one to three years.

Why MEL, Inc. Needs a CAD/CADD System Now

In answering this question, the author would like to quote some comments from engineering magazines, which are closely related to the consulting engineering business. These comments are as follows:

1. "The need for an affirmative answer is great. A small but growing number of design clients, led by some agencies of the federal government, are insisting on CAD capability. Other clients don't care how the design is produced as long as costs, including the designer's own fee, are cut to the bone. To prosper, or even survive, in this competitive environment requires that small firms have access to much the same kind of productive technology available to large firms."

   From Architectural Technology [24]

2. "Computers can help engineers and architects improve design quality, and decrease the costs of design and construction. . . . We will certainly not only live with the computer but also exploit its potential to our benefit. We must remain the master of the machine, and accept the responsibility to regulate its use."

   From Civil Engineering [25]

3. "It is easier, at times, to define what something is not rather than what it is. CADD (Computer-Aided Design and Drafting), in part because of technological advances and in part because of a tendency to use the term to describe only pieces of the design pie, falls into this nebulous category."

   From Consulting Engineer [14]

4. "Several recent" CAD studies sponsored by the design profession's trade magazines indicate that, to stay competitive, more and more companies will be forced to go

along with computerization, whether they like it or not. One survey noted that almost 50 percent of the engineers currently using computers and planning to buy new equipment expected to purchase a computer aided design system within the year.

> "A multitude of problems, both real and imagined, have to be experienced in integrating a CAD system into your firm. But don't let the magnitude of the task keep you from proceeding with CAD evaluation and implementation. You cannot sit on your laurels in this computerized high technology world; you will be left behind. You must continually evaluate: What do I need to do so the computer will make my job easier? What is it about my organization that could benefit from the successful implementation of a CAD system or in tackling a new application? The time to begin your involvement in CAD is today, not tomorrow, not next month, not next year."
>
> From Heating, Piping, Air-Conditioning [26]

This author believes that MEL will face great challenges in engineering production's cost and quality within the next two years. The author also believes MEL will benefit from the systematic approach presented herein for MEL's for successful implementation of a CAD/CADD system.

IMPLEMENTATION OF A COMPUTER AIDED DESIGN AND DRAFTING SYSTEM AT MEL, INC.

Since December 1984, the systematic approach for implementing a CAD/CADD System described in the previous section has been adopted as the company's master plan. One of the major problems with implementation of CAD/CADD system within MEL, Inc. has been financing such a system. The executive vice made funding available and as a result, more than $12,500 worth of hardware and software was purchased in May, 1985. This micro-CAD system is a fully equipped IBM micro-computer with 512k bytes of memory, dual floppy disks, a color monitor, 8087 co-processor chip, three button mouse, color/graphic adaptor card, Epson RX-80 printer, and Houston Instruments DMP-52 plotter. The software includes Auto-CAD, COGOACAD, Graplus, and EARTHWK-PC. The difference between the configuration and step one in the master plan are the plotter and digitizing table. The DMP-52 plotter has relatively better resolution and is an intelligent device which interacts with a large digitizing table while plotting. A small digitizing table will not service the production purpose at this time.

This micro-CAD system has several advantages over pocket programmable calculators MEL, Inc. engineers were using. Engineers can run much larger programs on this micro-CAD system and calculations can be done far more rapidly. Program editing and modification are much easier with this system than with programs for pocket programmable calculators. More importantly, this system can provide screen plotting which allows an engineer to explore many more options in design. Finally, the plotter can provide the design hard copy and a full size (24-inch by 36-inch) drawing.

During the implementation of this micro-CAD system, my responsibilities included the following:

1. Identifying (with others) and installing the new system software.
2. Setting the system function priorities.
3. Training and technical assistance to all project managers.

Identifying the "right" engineering software was not an easy task. Since 1984, the quantity and variety of software available for engineering applications has mushroomed. The quality has varied widely. The operations manager, project manager and author were responsible for selecting software for MEL, Inc. The author was also responsible for purchasing, installing, testing, and training. The EARTHWK-PC software has proven to be a successful example of this selection process.

Under the previously described plan, MEL, Inc. established priorities for computerizing various functions. Those priorities were: first, engineering calculation; second, computer aided design; and third, computer aided drafting. Computerizing engineering calculations has top priority at this time since it will save more time with only minor training requirements. Computer aided design is an extension of the engineering calculation. Because of the high cost of the hardware and training time requirements, computer aided drafting has the lowest priority at this time.

As previously stated, "The key to the success of the computer by MEL engineering staff and drafting persons necessitates an in-depth training program". Training sessions from 4:00 p.m. to 8:00 p.m. Monday through Friday have been established. Each engineer and project manager is required to attend two individual training sessions. One-to-one support is provided by the author during the training. The author also assists the project managers in developing the project data files system and will provide the technical support to implement this micro-CAD system during the project design process.

The result of the first three weeks of implementation of this micro-CAD system has been excellent. This system has been used to solve one engineering calculation within three hours, a problem that normally took two days and was done manually by the chief engineer. At present there are five engineers who sometimes need to use the computer at the same time. As mentioned, this micro-CAD system is now used exclusively for all engineering calculations. Computer aided design skills within the area of roadway intersection, cross section, and bridge structure design have been quickly acquired. This micro-CAD system is a relativey small CAD/CADD System. The next step is for MEL, Inc. to obtain the digitizing table and a second working station.

This system has been part of the production force since June 3, 1985. However, its full potential has not been realized, and probably will not be realized until three to six months from now. Many more hours of on-the-job training and development will be needed before the design and drafting process and the new system will develop a hand-in-glove relationship. It will probably take two full years before MEL, Inc. will reach full implementation of both the micro-and mini-CAD systems.

DEVELOPMENT OF A PROJECT COST CONTROL ACCOUNTING SYSTEM

The importance of efficiency in business organization has never been so generally recognized as at the present time. The use of budgetary control has become widespread in industry and commercial enterprises to achieve this goal. As a consulting engineering firm grows and as owners can no longer personally control all phases of its operation, an effective project cost accounting system and budgeting control become a necessity.

The project cost accounting system is the major quantitative information system in MEL, Inc. This project cost accounting system provides information for four broad purposes: internal reporting to project managers for use in planning and controlling current project operations; internal reporting to the operations manager, for use in strategic planning and formulation of overall policies; external reporting to clients for project support data; and payroll information during every two week period.

Since early 1984, MEL, Inc. has had a contract with Harper and Shuman in Cambridge, Massachusetts who developed a project financial management system (CFMS) that utilized input data taken directly from MEL, Inc. employees' daily time sheets. This data was sent to Harper and Shuman by mail once a month. After processing the data, the computer print-out was returned to MEL, Inc. However, this process was not effective nor successful. Communication became very difficult with some detailed information being transmitted by telephone line. Maintaining an in-house computer with time-sharing with the Harper Shuman mainframe or buying a mainframe computer for this purpose was also impractical and costly, running beyond the means of the MEL, Inc. budget.

During late 1984, the author was assigned to assist the Executive Vice-President and Manager of Business and Fiscal Affairs to develop a method of implementing the comprehensive project management cost control accounting system at MEL, Inc. with minimum cost. In Chapter III, "Preliminary Feasibility Study of a Computer Aided Design and Drafting System at MEL, Inc.", the author has identified software from both Champion Business Offices System and Alpine as the potential solution. The project time management software developed by Alpine from Beaverton, Oregon, has been successfully used by many middle size and large engineering firms across this country and its output has everything MEL, Inc. needs to achieve their project management goal. The disadvantage of its use, however, stems from the need to install a mini-computer system. Both the software and a four station system costs about 76,000 dollars. The Champion Business Accounting software has no project management output data directly available. However, there is a software "estimating job cost module" that has been developed by Sargent Business System from New Mexico, which can interact with Champion Software to prepare detailed estimates of cost by assembly. The costs can be broken down by labor, material, inventory, subcontract, equipment and other. It is an ideal output of detailed data for a construction firm. A demonstration disk was ordered and tested by Mr. Rowe, the manager of business and fiscal affairs and the author together. The process was difficult and disappointing due to an insufficient instruction manual. Finally after two weeks of re-examining the Champion operation manual the author was able to reconstruct a special code from Champion software to develop a code system that would cooperate with general ledger accounting numbers to produce the necessary output data and satisfy the management function. This project cost accounting system required an eight space or less code number during each transaction. The first five numbers are reserved for projects under different project numbers. The next three numbers are reserved for all the employee within MEL, Inc.

All in-house projects had a project code number which can be further divided by phase and level. Each employee also had an assigned code number with a defined discipline code (see table below).

Table L

MEL, Inc. Financial Code System

Code:

1	2	3	4	5	6	7	8
J		P	L		E		
O		H	E		M		
B		A	V		P		
#		S	E		#		
		E	L				
J		V	0				
K		W	1				
L		X	2				
		Y	3				
		Z	4				
			5				
			6				
			7				
			8				
			9				

Discipline:

Proj. Adm.	A
Civil Engr.	C
Mech. Engr.	M
Elec. Engr.	E
Arch.	B
Drafting	D
Clerical	T
Surveying	S
Inspection	I
D/L O/H	H

Simulated project budget and cost data were run successfully by Mr. Rowe and the author during January 1985. This sample computer print out is enclosed within Appendix A3 under project cost sample data.

By using this powerful code system, it is now possible to enter data into MEL, Inc's project cost system in such a way that specialized output can be produced as the following:

1. By searching for J11, J22, or J33 we can determine the individual cost group and total amount expended under project J11, J22 or J33. Cost groups are divided by administration, engineers, junior engineers, drafting personnel and clerk, etc.

2. By searching for J11 and T01, J22 and A05, J33 and A05, we can determine the total amount expended to employee T01 under project J11 or employee A05 under project J22 or employee A05 under project J33.

3. By searching for A05 only, we can determine the total amount expended by employee A05 under all projects or under overhead.

4. By searching for J only, we can determine the total amount expended under all the projects. The expense can be grouped with difference discipline.

5. By searching for H7020, we can determine the total amount expended charged to overhead.

The previous information contains some important internal reports which will provide the MEL, Inc. manager with the necessary budget control and planning data. Champion business accounting software consists of five stand alone modules. These include the general ledger module, accounts receivable order entry module, accounts payable purchase order module, inventory module, and payroll module. This system is a complete business financial accounting software package. As a result of this study, more than five thousand dollars worth of Champion software and an external hard disk were proposed and approved by the Management Committee on January 26, 1985. MEL, Inc's first completely computerized financial and project accounting system was successfully implemented in late April 1985. An up-to-date code system and project number sheet are listed under Appendix A3.

During early 1985, the author also assumed the responsibility of collecting and enforcing the manually projected cost accounting system which was developed by Mr. Phillips, the Manager of Operation. Under this system, all technical personnel submit daily time sheets which contain the hours charged under various projects. The daily time sheets are approved by their project manager and logged into the data book under each employee's name and project. This data will provide the biweekly payroll information to the Manager of Business and Fiscal Affairs. It also provides the project summary available to the Manager of Operations. This manual cost accounting system is slow but useful. The data will continue to be logged daily by hand until the comprehensive computer operated accounting system can take over.

OTHER MANAGEMENT WORK

In addition to the specific management task described above there are two activities that will be included within this section. These activities are the monthly management committee meetings and project audits. The project audit is a posting control measurement of the information which measures characteristics and qualities of actual project cost results and performance. Thus, it allows for corrective action on operations.

The author was assigned to audit three projects. These included project number 123 (Landscaping, Joint Use, Noise Abatement), project number 201 (Roadway Structure, Retaining Wall) and project number 253 (Broadway). The author reviewed the original contract contents, the award amounts, effective dates and lengths of the contracts. In particular, the billings have to be carefully compared with the project cost data. Several factors are taken into consideration. If there is a difference, what is the reason for the difference, and what action should be taken consequently? Table M below summarizes the overall project number 201 information. Both proposal and contract fees are listed. The large difference between the proposal and contract fees is due mainly to the scope of work. The total contract hours, billing hours and direct project cost hours from time sheets are compared. Table N shows the direct labor cost and fees calculations. Based on these reviews, there was a $19,107.42 difference between calculations and the total billing received. After discussion with the executive vice president of the firm on this matter, the project manager was requested to review the actual service performance by MEL, Inc. As a result, it was found that the original contract did not provide enough supervision hours to perform the actual work. Based on this data the State Department of Transportation and Development of Louisiana was requested to examine the facts and reimburse this difference to MEL, Inc.

TABLE M

Project Summary on Project 201

Contract Date	April 28, 1982
Effective Date	May 17, 1982

Proposal (Structure)		Contract on April 28, 1982	
Fixed	Maximum	Fixed	Maximum
$15,793.33	$140,597.06	$5,855.93	$44,754.03

Manpower in Proposal	Manpower in Contract
Principal - 23 hours	Principal - 12 hours
Supervision - 354 hours	Supervision - 98 hours
Engineering - 1420 hours	Engineering - 517 hours
Drafting - 1302 hours	Drafting - 678 hours

Roadway/Structure/Retaining Walls

Proposal		Contract on April 28, 1982	
Fixed	Maximum	Fixed	Maximum
$ 972.61	$ 8,658.44	$1276.42	$ 9,755.04
15,793.33	140,597.06	5855.93	44,754.03
74,441.96	66,250.60		
24,207.90	215,506.10	7,132.35	54,509.07

	Prin.	Supv.	Engr.	Jr. Engr.	Drafting	Tech.	Total
Contract hours	16	138	677		682		1513
Billing hours		363	1017	295.5	26.5	52.5	1754.5
Time Sheet hours	14	434	482	208.5	651.5	52.5	1842.5

Table N

Direct Labor Cost and Fee Calculation

for Project 201

Person	Hours	Rates	Total
M. Watson	14	$25.43	$ 356.02
J. Fink	354	25.00	8,850.00
B. O'Connel	366	17.50	6,405.00
W. Davenport	100	19.18	1,918.00
C. Alexander	454.5	12.02	5,463.09
K. Dickson	379	10.38	3,934.02
C. Lyn	96	15.50	1,488.00
E. Patel	24.5	8.00	196.00
A. Deconge	2	9.35	18.70
A. Corillo	52.5	5.00	262.50
			$28,891.33

Direct Payroll Cost	$28,891.33
Overhead (109.5%)	29,454.71
Direct Expenses	4,370.00
Total Costs	62,716.04
Fixed Costs	10,385.78
Maximum Fee (TC X 1.1 + Profit)	79,373.42
Total Phase I, Part 5	(60,266.00)
	$19,107.42

Management Committee Meeting

As stated earlier, the management committee of MEL, Inc. is the top management body. The committee focuses mainly upon overall organization planning, controlling, policy-decision making, and the selection of courses of action to solve all the problems existing within the engineering firm. The committee chairman serves to initiate action and to provide direction. A typical memorandum from the committee chairman is included in Appendix A-4. Other members focus on specific topics important to the firm. The author's area of concentration on the committee is concerned with long range planning and computer services within the firm.

At the December 1984 meeting, the author presented the report "The Practicalities of Implementation of a Computer Aided Design and Drafting System at MEL, Inc." This report was well accepted by the committee. The systematic approach for MEL, Inc. CAD/CADD system plan has been adopted as the company's future investment plan to up- date the overall computer capacities. In the January meeting, this committee accepted the proposal generated by Mr. Rowe and the author to establish a completely computerized financial and project accounting system. The outline for the new system is included in Appendix A-4 also. The assignment to make a design-construct market study was also a result of the committee meeting. With the approval and support of the committee, the author was able to suggest and complete an in-house computer application demonstration session for all civil engineers. The author also continued to up-date the software applications at MEL, Inc. throughout the internship. In general, these monthly management level meetings provided the author with an excellent chance to learn, observe and understand the consulting engineering firm's overall management and operation.

EXPANSION INTO THE DESIGN-CONSTRUCT MARKET

The timing of the entry of MEL, Inc. into the design-construct market is a strategic and critical decision. When an owner contracts with MEL, Inc. for both design and construction, this is referred to in-house as a "design-construct" project. Normally the MEL, Inc's engineer who has designed a project is responsible for representing the client in relations with contractors during the construcion period. However, MEL, Inc. has not been involved in the past with the construction management operation. Changing conditions such as price and economic environment place new demands on those involved in the implementation of construction projects.

During the past decade, the size and complexity of projects have grown substantially. With the growing complexity of the market, the requirements for effective project management as well as control of scheduling, cost and quality have also multiplied. Based upon the changes that have taken place in the project ownership, project management, and project financing, the one-stop engineering and construction firm has become the favorable response to entry.

During the 1984 regular session of the Louisiana Legislature, Senate Bill 726 was enacted and signed into law by Governor Edwards as Act 653. Act 653 provides for a ten percent (10%) set-aside of all the state's procurement of goods and services for minorities and women. Currently, there are six projects under this program. This legislation of such a guaranteed market provides MEL, Inc. with an excellent chance to enter the state construction market.

Early studies [27] show that there are very few minority owned contractors existing in the market and the figures have not changed significantly since then. Based on Mr. Shorters' [28] estimation, there are presently about sixty minority owned contractors in Louisiana.

The two critical factors that determine their existence are the issues of bonding and financial assistance. In addition, government construction is usually the only reliable market. With already established relations with various government agencies, MEL, Inc. holds some advantage to entry in this market. Most minority owned contractors were lacking interim financing and experienced difficulties in finding sufficient work. However, MEL, Inc. has established a stable relationship with the State Department of Transportation and Development and the Corps of Engineers. The remaining issue that MEL, Inc. needs to deal with is bonding which can be handled in two ways:

1. Set-aside a program fund which will provide the bond waiver program up to one hundred thousand dollars.

2. Use the Small Business Administration (SBA) Bond Guarantee Program to provide security bonds. Contracts to one million dollars may be 90 percent guaranteed by the SBA.

The formation of an effective organization at MEL, Inc. for entering the design-construct market requires a considerable amount of planning. Relationships must be established very carefully in order to integrate and coordinate the activities of all MEL, Inc. key individuals and divisions.

Basically there are six general types of design-construct arrangements:

1. Design-construct firm
2. Separate Architecture/Engineering (A/E) and contractor entities, but owned by the same firm
3. A/E firm as subcontractor to a contractor
4. A/E and constructor as subcontractor to a construction management firm
5. A/E and constructor joint venture
6. A/E firm with in-house design and constructor acting as a subcontractor.

Entry into the design-construct market requires both resources and time. In consideration of the MEL, Inc. personnel and their functions, a separate A/E and contractor entity owned by the same firm is ideal for MEL, Inc. (See Figure 6). Initially, these entities have separate engineering and construction divisions but will share the same support services such as accounting, marketing, etc. This organization can also function as a subcontractor to a contractor and joint venture if the opportunity is available.

In general, the construction industry may be divided into three major areas, they are:

1. Building or light construction
2. Engineering or heavy construction
3. Industrial construction.

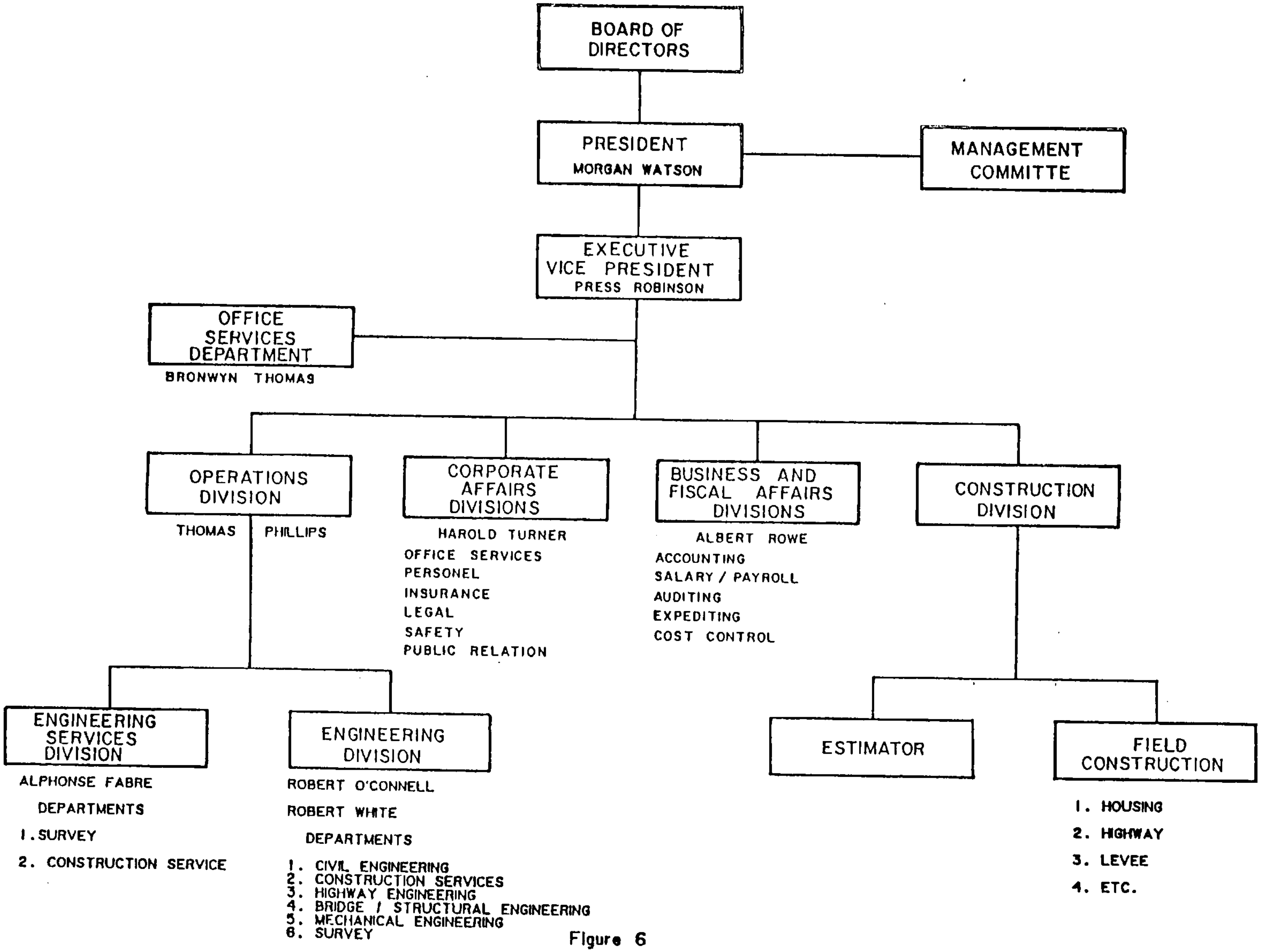

Figure 6

Proposed MEL, Inc. Reorganization Chart

Only selected projects within the first two areas should be considered for MEL, Inc. This company has both in-house architectural, engineering design and construction supervision experience with building construction. MEL, Inc. also has proven experience and expertise in highway design and supervision with river waterways, dams and levees. This remaining category of industrial construction involves a costly and complex process that is currently beyond the capabilities of MEL, Inc.

The construction of MEL, Inc's own company building and the church building where Mr. Watson attends can be a good starting point to establish the MEL-Construction, Inc. Mr. Phillips, the manager of operations is willing to spend his time and necessary efforts (such as contractor license, etc.) to form the new MEL-Construction, Inc. without an additional cost to the company. This procedure will reduce some of the major expenses to the minimum. However, the future percent of ownership of MEL-Construction, Inc. between Mr. Phillips and MEL, Inc. should be discussed by Mr. Phillips and the board of MEL, Inc. directly. Once the Church project has been awarded one estimator and one field project manager will be placed into key positions in the construction company. At that time, MEL, Inc. should establish their own work force or use the subcontractor's on the various projects.

To minimize the risk of entering into the highway construction and heavy construction market, most engineers suggested that concrete products and supply, parking lot and levee construction projects should be considered for entry at an early stage. Both Mr. Phillips and Mr. Fabre, the manager of the engineering services division, are ideal people to be in charge on highway construction and levee construction projects.

Based on this preliminary study of the feasibility of entrance of MEL, Inc. into the design-construct market, the author has recommended that the company pursue this further expansion. However, more planning is needed by the design-construct committee to achieve this goal.

CHAPTER IV

CONCLUSION

This chapter will summarize all internship activities in relation to the proposed internship objectives stated in the introduction and to the Doctor of Engineering objectives in general. In terms of the direction of the internship, the author was employed by MEL, Inc. as a senior project engineer in charge of technical design and supervision. The author also served as part of the MEL, Inc. management committee which directly dealt with daily project time activities, project audits and future planning. As a result of this orientation, it was possible to become exposed to a wide range of activities which not only required engineering knowledge but also expertise in managerial skills.

In the development of the internship, the author also served in different capacities varying from service on the management committee, involvement with the manual project cost system, to work on the project audit system. These internship activities provided the opportunity to directly contribute to discussions focusing upon the company's philosophy of management. The day-by-day and monthly activities also provided valuable information and experience on the overall operation of a consulting engineering firm. In addition to working in a review and advisory capacity, serving as a senior project engineer on the L.T.I. HVAC project and other projects allowed the author to participate in a technical role. The scope of these projects included the design, supervision, and coordination of engineering projects. In particular, the design and supervision of each project directly influenced the adherence to the project schedule and quality control. Thus, the interaction of the work in the firm provided the author with the chance to analyze and implement the overall managerial techniques utilized by MEL, Inc.

The author's contribution to the firm can be best understood from the context of the results of internship projects. On one level, such as L.T.I. and three other projects, technical ability and assistance were distributed. On the managerial level, direct input on the manual project cost control and project audit system helped to maintain the company's operation and production goals.

In addition, an important contribution was work on project cost control, which saved the company's resources and with minimum investment helped to develop the computerization of all financial and project cost accounting systems. The computer aided design and drafting project is a comprehensive master plan for MEL, Inc. which will help the company to make decisions for future adaptability. With up-to-date computerized assistance it is feasible to plan for expansion and increased production quality. Based on analysis of the systems available, the author identified and suggested the combination of the COGO software with the Auto CAD software as the best in civil engineering applications. This utilization was projected in my report almost two months before commercial packages of COGO Software and the Auto CAD software arrived on the market.

Finally, from work on the design and construction project, the author helped to develop the fundamental expansion plan for MEL, Inc. In general, the author's endeavors have contributed to the welfare of the company especially in management decisions to adapt policies or procedures that are more efficient or beneficial for the long term.

This would not have been possible without first being able to participate fully as a member of the management team, thus allowing me the chance to learn the overall functions of a consultant engineering firm. The interactions with people in different projects during my internship required my work not just as an engineer but also from the other important perspectives of management. In conclusion, the internship involvement at MEL, Inc. and the required course program at Texas A&M University have provided this author with the experience necessary to qualify for top management in the consulting business.

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APPENDIX A1

ENGINEERING DESIGN AND CALCULATION ON L.T.I. PROJECT

TABLE OF CONTENTS

I. DESIGN INFORMATION

Air Conditioning and Heating Eight (8) Dormitories at Louisiana Training Institute in Baton Rouge, Louisiana State Project No. 10-04-02-83B-4
MEL Inc. Baton Rouge, LA Project No. 173
Computer No. 81022.01

Design condition based on ASHRAE handbook

Location	Baton Rouge, Louisiana
Latitude	30°
Longitude	91°

	Outside		Inside	
Summer	93° FDB	80°FWB	78°FDB	50%RH
Winter	29°FDB			70°F

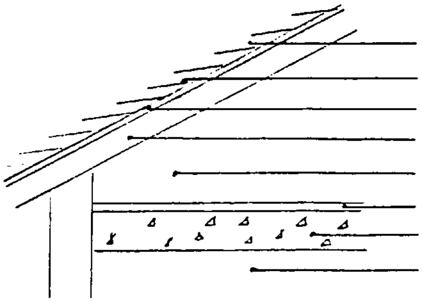
Summer Mean Daily Range 19°F

Elevation 64 Ft.

Number of people	65 per dormitory	
Sleeping area	230 BTUH Sensible	190 BTUH Latent
Other area	255 BTUH	255 BTUH
Ventilation	7 cfm/person with return air	
Lighting	1.5W/ft^2	Sleeping area
	2W/ft^2	Others

(I) U - Value For Pinecrest and Oakwood Dormitory all data is based on ASHRAE Handbook

(A) Roof (Pitched Roof)

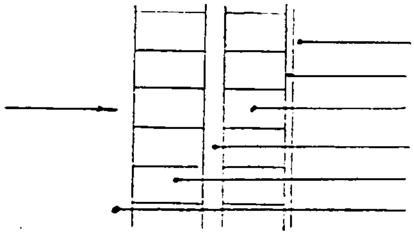


	R-Value between Rafters	R-Value at Rafters
Outside Surface	0.17	0.17
Shingle Roof	0.44	0.44
Plywood Sheathing	0.78	0.78
2" x 8" Rafter	-	9.06
Air Space	0.91	0.91
Metal Lath	0.47	0.47
Concrete 4 in.	4.44	4.44
Inside Surface	0.61	0.61
	7.82	16.88

Assume 10% Framing
(1/7.82)(0.9) + (1/(16.88)(0.1) = 0.121 BTU/hr-ft^2 - °F

With new R-19 Insulation
[1/(7.82+19)](0.9) +[(1/16.88+19)](0.1) = 0.0399 Use 0.05 BTU/hr-ft^2 - °F for calculation

(B) Wall



	R-Value
Inside Surface	0.68
Plaster 0.625 in	0.39
Stacked Brick 4"	0.80
Air Space	1.1
4" Face Brick	0.44
Outside Air	0.17
	3.58

$$U = \frac{1}{3.58} = 0.28 \text{ BTU/hr - ft}^2\text{-°F}$$

(C) Window

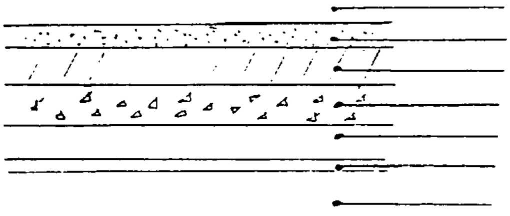
Single glass	Summer	1.04 BTU/ft^2-hr-°F
	Winter	1.10 BTU/ft^2-hr-°F

(d) Doors

Wood	0.43	BTU/ft^2-hr-°F
Steel	0.59	BTU/ft^2-hr-°F

(II) U-Value for Willow/Cedarcrest/Elmwood/Geranium/Snapdragon/Lilac

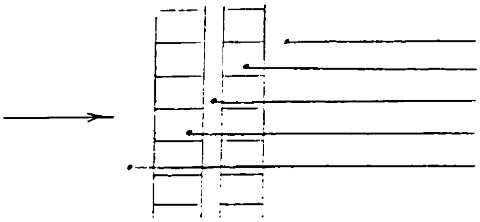
(A) Roof (Flat Roof)



	R - Value
Outside Surface	0.17
Built-up Roof	0.33
2" Rigid Insulation	2.78
2½ in Concrete	2.75
Air Space	0.93
Gypsum 3/8"	0.33
Inside Surface	0.61
	7.90

U = 1/7.9 = 0.127 BTU/ft^2-hr - °F

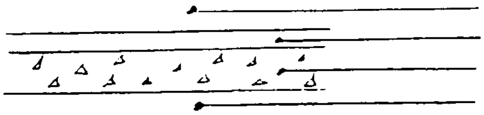
(B) Wall



	R - Value
Inside Surface	0.68
Stacked Brick	0.80
Air Space	1.10
4" Face Brick	0.44
Outside Surface	0.17
	3.19

$$U = \frac{1}{3.19} = 0.314 \text{ BTU/hr-ft}^2\text{-°F}$$

(C) Outside Floor



	R - Value
Inside Surface	0.21
Floor Plaster*	0.47
Concrete	4.44
Outside Surface	0.17
	5.69

$$U = \frac{1}{5.69} = 0.176 \text{ BTU/hr-ft}^2 \text{ - °F}$$

(D) Window

Single glass Summer 1.04 BTU/ft^2-hr - °F
U - Valve Winter 1.10 BTU/ft^2-hr - °F

(E) Doors U - Value

Wood 0.43 BTU/ft^2-hr - °F
Steel 0.59 BTU/ft^2-hr - °F

*Metal Lath and Lightweight aggregate plaster, 0.75 in

(III) Infiltration (General) Based on ASHRAE GRP 158

Assume 15 MPH. Pw/Cp = 0.105
Cp = 1 Pw = 0.105 in of H_2O

For Average Fitting K = 2.0

Q/P = 0.5 in CFM/ft^2 For window and residential type door.

(IV) Miscellaneous (General)

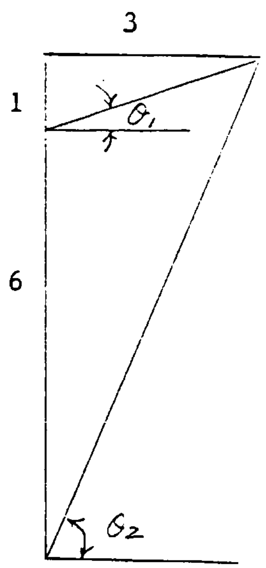
Sensible	3200 BTUH	Only apply to apartment with kitchen stove
Latent	1800 BTUH	

(V) Overhang Angle (General)

Type one

$\theta_1 = \tan^{-1}(1/3) = 18.42°$

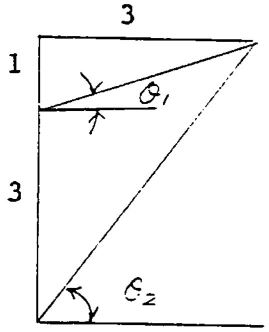
$\theta_2 = \tan^{-1}(7/3) = 66.8°$

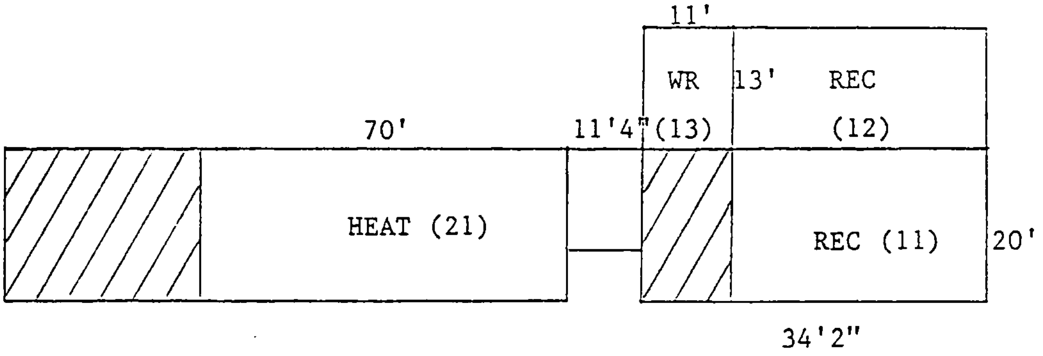


Type two

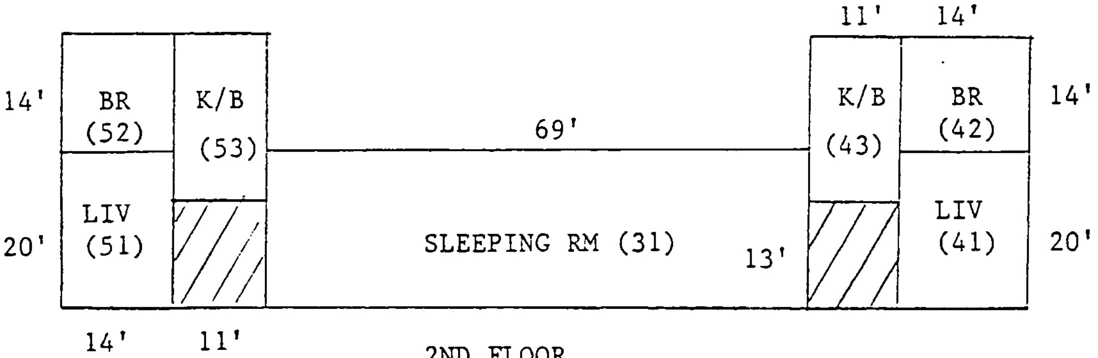
$\theta_1 = \tan^{-1}(1/3) = 18.42°$

$\theta_2 = \tan^{-1}(4/3) = 53.13°$

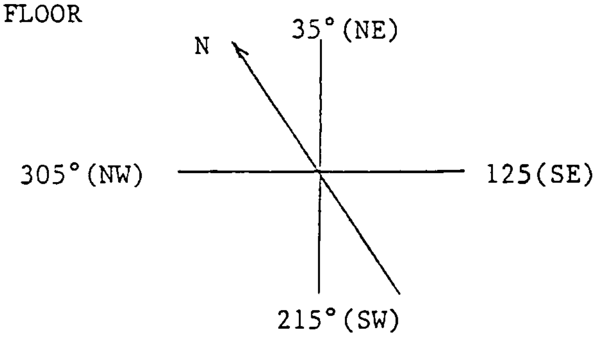


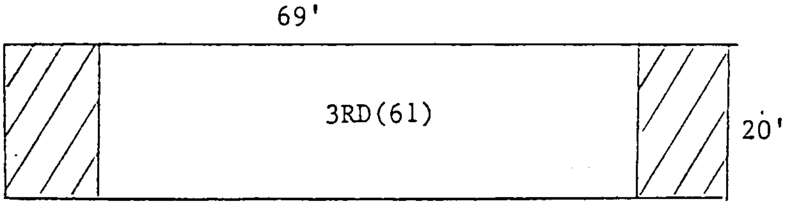


1ST FLOOR



2ND FLOOR





3RD FLOOR

SNAPDRAGON/GERANIUM FLOOR PLAN

II COMPUTER INPUT INFORMATION (Typical Example Snapdragon/Geranium)

(I) Recreation Area (See Snapdragon/Geranium Floor Plan)

01 (11) REC (1)
Floor Area A = 682 ft^2
Wall (1) 215° (34.1)(9) = 307 ft^2
Window (1) (9)(9) = 81 ft^2 81/307 = 0.264
Roof = (20.1)(20) = 402 ft^2
Wall (2) 125° (20)(9) = 180 ft^2
Window (2)
(12)(9)(0.5) = 54CFM [(54/307) + 180]/2 = 0.55
CFM/ft^2
Exp = (19)(9) = 171 ft^2

02 2W/ft^2 Mis = 0
People Sen = 255 Lat = 255 682/15 = 45 ft^2
people
Roof U = 0.127 Roof Type J Floor U = 0.176

03 Wall (1) .264 Wall (2) 0
Uglass 1.04 SC = 0.98 U = 0.314
Wall Type L Angle 0

04 Top Angle θ_1 = 18.42°
Bottom Angle θ_2 = 53.13°

01 (12) REC (2)
Floor Area 34.1 x 13 = 444 ft^2
Wall (1) 125° 13 x 9 = 117 ft^2
Window (1)
Wall (2) (34.1)(9) = 307 ft^2 35°
Window (2) (8)(18) = 162 ft^2 162/307 = 0.527
Roof 20.1 x 13 = 262 ft^2 Exp = 0
(24)(9)(0.5) = 108 CFM 108/(117 + 307)/2 = 0.125CFM/ft^2

02 Same as Master 444/10 = 44.4 Use 45 ft/people
03 Same as Master Bottom Angle 66.8°

01 (13) WR
Floor Area 13 x 11 = 143 ft^2
Wall(1) 35° 11 x 9 = 99 ft^2
Window (1) (3)(18) = 54 ft^2 54/99 = 0.545
Roof = 0
Wall (2) 13 x 9 = 117 ft^2 305°
Window (2) 0
(24)(3)(0.5) = 36CFM [36/(99 + 117]/2 = 0.08 CFM/ft^2
Exp = 11 x 9 = 99 ft^2

02 Same as Master 143/5 = 28.6 ft^2/people

(II) (21) HEAT
Floor Area 60 x 20 + 55 = 1255 ft^2
01 Wall (1) 215° (70)(9) = 630 ft^2
Window = (1)
Roof = 0 15(9) = 135 ft^2 135/630 = 0.24
Wall (2) 35° 630 ft^2
Window 135 ft^2 0.214
$\frac{(28)(12) + 2\ (20\ )}{2}$ = 188 CFM 188/(630)(2)(2) = 0.0746 CFM/ft^2

02 1.5W/ft^2 1626/30 = 54.3 Exp = 2(20)(9) = 360 ft^2

(III) (31) Sleeping Area

01 Floor Area 69 x 20 = 1380 ft^2
Wall(1) 215° 69x9 = 621 ft^2
Window (1) (18)(18) = 324 ft^2 324/621 = 0.52
Roof 1380
Wall(2) 35° 621 0.52
(24)(18)(0.5) = 216 CFM
Exp = (13x9)(2) = 234 ft^2 216/621(2)(2)= 0.087 CFM/ft^2

02 Sen (210) Lat (140) 1380/65 = 21.2 ft^2/people

(IV) Rightside Apartment

01 (41) LIV
Floor Area 14 x 20 = 280 ft^2
Wall (1) 215° 14 x 9 = 126 ft^2
Window (1) 3(18) = 54 ft^2 54/126 = 0.428
Roof = 280 ft^2
Wall(2) 125° 20 x 9 = 180 ft^2
Window (2) 0
3(24)(0.5) = 36 CFM 36/(126 + 180)(2) = 0.059
CFM/ft^2

Exp 13 x 9 = 117 ft^2

02 2W/ft^2 210 (Sen) 140 (Lat) 280/2 = 140 ft^2/people

01 (42) BR
Floor Area 14 x 14 = 196 ft^2
Wall (1) 125° 14 x 9 = 126 ft^2
Window (1) 0
Roof 196 ft^2
Wall (2) 14 x 9 = 126 ft^2 35°
Window (2) 3(18) = 54 ft^2 54/126 = 0.428
3(24)(0.5) = 36 CFM [36/(126 + 126)]/2 =
0.072 CFM/ft^2

02 196

01 (43) K/B
Floor Area 11 x 21 = 231 ft^2
Wall (1) 35° 11 x 9 = 99 ft^2
Window 0
Roof 231 ft^2
Wall(1) 305 13 x 9 = 117 ft^2
Window (2) 2(9) = 18 18/117 = 0.154
2(12)(0.5) = 12CFM 12/(99 + 117) = 0.056
CFM/ft^2

Exp 11 X 9 = 99 ft^2
Use 3200/231 = 13.8
02 (S) 9930/231 = 43 1800/321 = 7.8 231/2 = 116 ft^2/People

(V) Left Side Apartment (Same As Right Side Apartment)
01 (51) LIV
Floor Area 14 x 20 = 280 ft^2

(VI) (61) 3rd
01 61 Floor Area = 69(20) = 1380 ft^2
Wall(1) 215° 69(8) = 621 ft^2
Window(1) 6(9) = 54 ft^2 54/621 = 0.087
Roof 1380 ft^2
Window(2) 54 ft^2
12(12)(0.5) = 72CFM 72/621(2) = 0.058 CFM/ft^2

Exp 20(9)(2) = 360 ft^2

02 115/ft^2 210(S) 140(L) 621/12 = 51 ft^2/Person

III HEATING AND COOLING LOAD CALCULATION

Typical Computer Calculation

GENERAL JOB INPUT

JOB SNAPDRAGON/GERANIUM 34

PROJECT: 01 L.T.L.

LOCATION: 01 BATON ROUGE, LOUISIANA

BUILDING OWNER: 01 F.D.A.C.

PROGRAM USER: 01 C.C. CHEN

COMMENTS: 01 SNA/GER

	Latitude 8	Longitude 16	Time Zone Number 24	Clearness Number Summer 32	Clearness Number Winter 40	Atmospheric Pressure 40	Altitude 50	Weather Tape Code 64
02	30	91	6	0.90	0.95	-	64	BATONROU

	Summer Design Dry Bulb 8	Summer Design Wet Bulb 16	Summer Design Design Month 24	Summer Design Daily Range 32	Winter Design Dry Bulb 40	Ground Reflectance 48	Roof Alpha 56
03	93	80	8	19	29	0.20	0.56

ROOM DESIGN

	Cooling Dry Bulb 8	Relative Humidity 16	Heating Dry Bulb 24	Ventilation (Outside Air) CFM/ Person 32	Ventilation (Outside Air) CFM/ Sq. Ft. 40
04	78	50	70	7	-

GENERAL ZONE INPUT

NOTE: Up To 700 "01" Cards May Be Input

LOAD

	Zone Number 8		Description 16	Floor Area 24	Wall Direction 1 32	Wall Area 1 40	Roof Area 48	Wall Direction 2 56	Wall Area 2 64	Infiltration CFM/Gross Wall (Sq Ft) 72	Exposed Floor Area 80
01	11	1	REC 1	682	215	307	402	125	180	0.055	171
01	12	2	REC 2	444	125	117	262	35	307	0.125	0
01	13	3	WR	143	35	99	0	305	117	0.08	99
01	21	4	HEAT	1255	215	630	0	35	630	0.064	360
01	31	5	SLEEP	1380	215	621	1380	35	621	0.087	234
01	41	6	RAPT	280	215	126	280	125	180	0.059	117
01	42	7	BR	196	125	126	196	35	126	0.073	
01	61	8	3RD	1380	215	621	1380	315	621	0.058	360
01		9									
01		10									
01		11									
01		12									
01		13									
01		14									
01		15									
01		16									
01		17									
01		18									
01		19									
01		20									
01		21									
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01		23									
01		24									
01		25									
01		26									
01		27									
01		28									
01		29									
01		30									

ZONE INPUT INTERNAL

NOTE: Up To 700 "02" Cards May Be Input

	Zone Number 8	Lights 16	Miscellaneous		People			Roof "U" Value 64	Roof Type 72	Floor "U" Value 80
			Sensible 24	Latent 32	Sensible 40	Latent 48	Density 56			
02	M	2	0	0	255	255	45	0.127	J	0.176
02	11	-	-	-	-	-	-	-	-	-
02	12	-	-	-	-	-	-	-	-	-
02	13	-	-	-	-	-	28.6	-	-	-
02	21	1.5	-	-	-	-	54.3	-	-	-
02	31	1.5	-	-	210	140	21.2	-	-	-
02	41	1.5	-	-	210	140	140	-	-	-
02	42	1.5	-	-	210	140	196	-	-	-
02	43	1.5	13.5	7.8	210	140	150	-	-	-
02	61	1.5	-	-	210	140	51	-	-	-
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ZONE INPUT EXTERNAL

NOTE: Up To 700 "03" Cards May Be Input

	Zone Number 8	Wall One or Two 16	Percent Glass 24	Glass "U" Value 32	Shade Coefficient 40	Wall "U" Value 48	Wall Type 56	Wall Tilt Angle 64	
03	M	1	0.264	1.04	0.98	0.314	L	0	
03	11	1	-	-	-	-	-	-	
03	11	2	0	-	-	-	-	-	
03	12	1	0	-	-	-	-	-	
03	12	2	52.7	-	-	-	-	-	
03	13	1	54.5	-	-	-	-	-	
03	13	2	0	-	-	-	-	-	
03	21	1	21.1	-	-	-	-	-	
03	21	2	21.1	-	-	-	-	-	
03	31	1	52.0	-	-	-	-	-	
03	31	2	52.0	-	-	-	-	-	
03	41	1	42.8	-	-	-	-	-	
03	41	2	0	-	-	-	-	-	
03	42	1	42.8	-	-	-	-	-	
03	42	2	0	-	-	-	-	-	
03	43	1	0	-	-	-	-	-	
03	43	2	15.4	-	-	-	-	-	
03	61	1	8.7	-	-	-	-	-	
03	61	2	8.7	-	-	-	-	-	
03									
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03									
03									

OPTIONAL EXTERIOR SHADING

NOTE: Up To 700 "04" Cards May Be Input

	Zone Number 8	Wall One or Two 16	Top Overhang Angle 24	Bottom Overhang Angle 32	Left Near Side Angle 40	Left Far Side Angle 48	Right Near Side Angle 56	Right Far Side Angle 64	Adjacent Building 72	Wall Alpha 80
04	M	1	18.42	51.13						0.45
04	11	1								
04	11	2								
04	12	1								
04	12	2		66.8						
04	13	1		66.8						
04	13	2								
04	21	1								
04	21	2								
04	31	1	18.42	66.8						
04	31	2		66.8						
04	41	1		66.8						
04	41	2								
04	42	1								
04	42	2		66.8						
04	43	1								
04	43	2								
04	61	1	18.42	51.3						
04	61	2								
04										
04										
04										
04										
04										
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04										
04										

SYSTEM

PRIMARY SYSTEM

	Percent Roof To RA 8	Percent Lights To RA 16	Percent Wall To RA 24	
01	5	5	20	

	System Type 8	System Supply Fan SP 16	System Return Fan SP 24	Fan Motor Efficiency 32	Cooling Supply Air Dry Bulb 40	Heating Supply Air Dry Bulb 48	Tonnage Block or Peak 56	Fan Configuration 64	Omit Fan Motor Heat 72	Economizer 80
02	SZ	1.2	0.5	80	56	100	PEAK	DRAW	1	0

SKIN SYSTEM

	System Type 8	System Supply Fan SP 16	Fan Motor Efficiency 24	Omit Fan Motor Heat 32	Cooling Supply Air Dry Bulb 40	Heating Supply Air Dry Bulb 48	Heating Only 56	
03	RAD	1.2	80	1	56	100		

Typical Manual Calculation

SNA/GER (SLEEPING AREA) project name — B.R.La. location — 1380 floor area — C.C. by — Aug.84 date

Design Conditions:
Winter: outdoor 29 °F, indoor 70 °F.
Summer: outdoor 93 $°F_{db}$ & 80 $°F_{wb}$. indoor 78°F & 50 % R.H.
peak heat gain, time 4:00PM, date Aug.21.

Building Conditions:
Fresh Air 7 CFM/person or ___ air changes = ___ CFM.
Glass U 1.04 ; SC 0.41, 0.32 ; notes combine value
Lighting watts 1.5-2W/Ft^2 People, (maximum #) 65.
Ceiling-Roof U 0.127 : color light : weight Med.
Walls U 0.314. Floor U 0.32 or factor ___.
Door U 0.43. Equipment, watts ___ or hp ___.
Appliances & Other ___.

Item	Quantity	Winter Heat Loss = BTUH	Summer Heat Gain = BTUH
Fresh Air: winter	671 CFM	(1.08)(41 TD) = 29.72	
summer	671 CFM		(1.08)(15 TD) = 10870 (.68)(63 $G_{dif.}$) = 28760
Glass total	648 sqft	(1.04U)(41 TD) = 27630	(1.04 U)(15 TD) = 10,110
N.E	324 sqft		(79SF)(0.41SC) = 10,500
E.	sqft		(SF)(SC) =
S.W	324 sqft		(181SF)(0.41SC) = 24,050
W.	sqft		(SF)(SC) =
horiz.	sqft		(SF)(SC) =
Lighting total	2070 watts		(3.4) = 7,040
People	65 # 65 #		(210 sensible) = 13650 (140 latent) = 9100
Ceiling-Roof 1	1380 sqft	(.127U)(41 TD) = 7,190	(.314U)(43.5ETD) = 7630
2	sqft	(U)(TD) =	(U)(ETD) =
Walls N.E 1	297 sqft	(.314U)(41 TD) = 3830	(.314U)(13 ETD) = 1220
S.W 2	297 sqft	(.314U)(41 TD) =	(.314U)(28 ETD) = 2620
P 3	234 sqft	(.32 U)(41 TD) = 3070	(.32 U)(10 ETD) = ,750
Floors basement	sqft	(factor) =	
above grade	sqft	(U)(TD) =	
Slab Edge	linft	(U)(TD) =	
Doors	sqft	(U)(TD) =	(U)(TD) =
Equipment	watts hp		(3.4) = (2500) =
Appliances			(sensible) = (latent) =
Other			
		subtotal 71440	subtotal 126,300

add 10% for ducts outside conditioned space 78584

Total BTUH; PEAK HEAT LOSS 85728 PEAK HEAT GAIN 145,250

```
Typical Computer Calculation Data Summary
SNAPDRAGON/GERANIUM (SLEEPING ROOM)

SYSTEM AIR QUANTITIES

-----------MAIN COOLING-----------
      OA          CFM/          BTU/
ZN   CFM    CFM   SQ FT   MBH   SQ FT
 1   444.   3810.  2.76   94.8  68.69
TOT  444.   3810.  2.76   94.8  68.69


-----------MAIN HEATING-----------
                                SKIN
      CFM/             BTU/   CFM OR
CFM   SQ FT    MBH    SQ FT    MBH
 0.     .00   70.5    51.12   -11.6
 0.     .00   70.5    51.12


     INDICATED DESIGN VALUES

     CFM COOLING - TOTAL................MAIN       3810.1
                                        SKIN          .0
     CFM HEATING - TOTAL................MAIN          .0
     CFM - OUTSIDE AIR..................MAIN        444.2
     COOLING TONS.......................MAIN         10.5
     COOLING SUPPLY AIR DRY BULB........MAIN          .0
     HEATING MBH........................MAIN         59.3
                                        SKIN          .0
     HEATING MBH........................MAIN         32.3
                                        SKIN         38.3
     HEATING SUPPLY AIR DRY BULB........MAIN        125.0
                                        SKIN          .0


PSYCHROMETRIC STATE POINTS
      COIL   DRY   WET               DRY   WET                DRY   WET
SYST   CFM   BULB  BULB  ENTHALPY   BULB  BULB  ENTHALPY    BULB  BULB
MAIN  3908.  80.4  67.2      31.7   58.7  57.1      24.6    78.0  65.0
SKIN    0.    .0    .0        .0     .0    .0        .0      .0    .0


      COOL        SFAN   VENT   SQ FT     CFM    CFM/   HTG BTU   FLOOR
 SYS  TONS         CFM    CFM    /TON    /TON   SQ FT    /SQ FT   SQ FT
MAIN  10.5       3810.   11.7   131.6   363.4   2.76       23.4   1380.
```

```
SNAPDRAGON/GERANIUM (RECREATION ROOM)


SYSTEM AIR QUANTITIES


---------MAIN COOLING---------   ---------MAIN HEATING--------- SKIN
      OA         CFM/          BTU/        CFM/         BTU/  CFM OR
ZN   CFM   CFM   SQ FT   MBH   SQ FT  CFM  SQ FT   MBH  SQ FT   MBH
 1   103.  909.   1.33  26.4   38.71   0.   .00  17.9  26.22   -3.2
 2    67.  744.   1.68  22.4   50.43   0.   .00  17.1  38.50   -3.7
 3    34.  274.   1.92   8.6   60.24   0.   .00   7.4  51.83    -.8
TOT  205. 1927.   1.52  57.4   45.24   0.   .00  42.4  33.41


     INDICATED DESIGN VALUES

     CFM COOLING - TOTAL. . . . .  MAIN      1927.2
                                   SKIN          .0
     CFM HEATING - TOTAL. . . . .  MAIN          .0
     CFM - OUTSIDE AIR. . . . . .  MAIN       204.9
     COOLING TONS . . . . . . . .  MAIN         6.0
                                   SKIN          .0
     COOLING SUPPLY AIR DRY BULB.  MAIN        57.4
                                   SKIN          .0
     HEATING MBH. . . . . . . . .  MAIN        17.1
                                   SKIN        25.3
     HEATING SUPPLY AIR DRY BULB.  MAIN       125.0
                                   SKIN          .0

PSYCHROMETRIC STATE POINTS

           -RETURN/OUTSIDE AIR-- ----COIL LEAVING----- ---BUILDING--
      COOL  DRY   WET             DRY   WET             DRY   WET
SYST   CFM  BULB  BULB  ENTHALPY  BULB  BULB  ENTHALPY  BULB  BULB
MAIN 1977.  80.7  67.2      31.7  56.8  55.5      23.6  78.0  65.0
SKIN    0.    .0    .0        .0    .0    .0        .0    .0    .0


                        RULE OF THUMB CHECKS
                        PCT
       COOL   SFAN    VENT  SQ FT     CFM     CFM/  HTG BTU  FLOOR
 SYS   TONS    CFM    CFM    /TON    /TON    SQ FT   /SQ FT  SQ FT
MAIN    6.0   1927.   10.6  210.7   320.0     1.52     13.5  1269.
```

IV. HVAC EQUIPMENT SELECTION

Typical Blower Coil and Condensing Unit

Use Trane Split System Air Conditioners

Based on Ambient Dry Bulb Temperature 95°F
indoor 80°F DB 67°F WB

1) From table 20.1
Blower Coil RAUC - C10
Condensing Unit BACA - C10
Normal at 3500 CFM
TC = 122 MBH

2) From chart 21.1, sensible heat ratio is 0.72 (adequate)

3) $\frac{3810\text{ CFM}-3500\text{ CFM}}{3500\text{ CFM}} = 8.9\%$

From table 22.1 Correction factor 1.015

4) Refrigerant Line of 60 ft
From table 22-2 Reduction of 2450 BTUH
Corrected Gross Cooling Capacity

$$\left[122\text{ MBH} - \frac{2450\text{ BTUH X MBH}}{1000\text{ BTUH}}\right](1.015) = 121.34\text{ MBH}$$

5) Supply Air at 4000 CFM a 0.8 in H_2O External pressure
rpm = 874 BHP = 1.46

From chart 23-1 Fan Motor Heat (MBH) = 5.8MBH

6) Net System Cooling Capacity
121.34 - 5.8 = 115.5 MBH
115.5 MBH big than 94.8 MBH is good enough.
Other model is too small or too high.

Hot Water Coil

From Trane table 26-1
at Entering Air Temperature 60°F
Water Temperature Drop 20°F
Entering Water Temperature 190°F
BACA - C10 Blower Coil has Hot Water Heating
Coil Capacity up to TH = 159 MBH @ 16 gpm

The Standard Hot Water Coil as shown in table 14-1

Coil Dimension	12"x57"
Face Area	4.75 Ft^2
Coil Type	WC

However, the computer coil selection data show a relatively high water velocity at 737 ft/min to 842 ft/min

A Coil	Coil Dimension	18"X47"
	Face Area	7.13 ft^2
	Coil Type	WC
	FV = 561 ft/min	
	TH = 108.9 MBH	@ 11.2 gpm

This is the better coil selection

A summary of the hot water coil computer calculation follows:

Hot Water Coil Computer Calculation Summary

INPUT DATA

TAG	SCFM	EAT	EWT	WIDTH	LENGTH	FA	FV
HC-1	1000.	70.0	180.0	18.	24.	3.00	333.
HC-2	4000.	65.0	180.0	12.	57.	4.75	842.
HC-3	4000.	65.0	180.0	18.	57.	7.13	561.
HC-4	2100.	65.0	180.0	12.	46.	3.83	548.

LAT	MBH	GPM	WTD	COIL TYPE	ROW	FIN TYPE*	FPG	WPD
.0	29.9	.0	20.0	ST	0.		0.	0.
.0	100.0	.0	20.0	WC	0.		0.	0.
.0	100.0	.0	20.0	WC	0.		0.	0.
.0	73.0	.0	20.0	WC	0.		0.	0.

TAG	COIL TYPE	ROW	FIN TYP	FPF	TURB	OUTPUT DATA MBH	LAT	APD	GPM	WTD	WPD
HC-1	ST	1.	SF	80.	YES	35.0	102.4	.06	3.1	23.4	7.1
HC-2	WC	1.	SF	84.	YES	100.0	88.1	.29	10.3	20.0	1.1
HC-3	WC	1.	SF	80.	NO	108.9	90.2	.14	11.2	20.0	.3
HC-4	WC	1.	SF	103.	YES	73.0	97.1	.14	7.5	20.0	.5

HC-1	Apartment Hot Water Coil
HC-2	Sleeping Room
HC-3	Sleeping Room
HC-4	Recreation Room

---

*Fin type input left open for selection by computer program during the calculation process.

Furnace, Evaporators, and Condensing Units
Gas Fired Furnaces
For Pinecrest/Oakwood Computer Data

Sleeping Area TC = 98.4 MBH TH= 69.7 MBH
CONF/LIV/RUM TC = 87.4 MBH TH = 63.2 MBH1

Based on Carrier Twinning Kit for Up flow Gas - fired Furnaces Model 58SS Super Saver is the New deluxe gas - fired induced -draft furnace with high efficiency .

On P.3 Carrier Twinning kit
Model 58SS (2) 080CC
TH = 190 MBH input
TH = 158 MBH output
On. P.4 Cooling CFM = 3500
at External Static pressure about 0.25" in water

On P.5 Combining Evaporator Coil &
Condensing unit
Carrier Direct - Expansion Evaporator Coil
Model #28LA012 and
Carrier Air-Cooled Condensing Unit
Model #38AE012
at 95°F Ambient Temperature
at 67°F Wet Bulb Evaporator Temperature
TC = 113 MBH
SHC = 80 MBH
ST = 41° F

Unit Gas Heater (PIN/OAK Locker Area)
TH = 46.47 MBH
USE Modine propeller unit heater (10)
Model # PA 75
TH = 75 MBH input TH = 60 MBH output

Exhaust Fan Data from Nutone Catalog

Use Nutone suggest ventilation guide

Kitchen	15 Air Changes/hour
Bathroom	8 Air Changes/hour

Noise Level   Comfort Zone at 0-8.0 Zones

(a) Toilet Area   (SNA/GER)

$$\frac{11 \times 14 \times 8x8}{60} = 164.3 \text{ CFM}$$

Use Nutone Model   8070
Wall-Impeller   160 CFM   4.5 Sones

(b) Sleeping Area Toilet (All Buildings)

$$\frac{4 \times 11 \times 8 \times 8}{60} = 47 \text{ CFM}$$

Use Nutone Model #8870
Wall-Impeller   80 CFM   6.0 Sones

(c) Apartment Bathroom (All Buildings)

$$\frac{8 \times 7 \times 8 \times 8}{60} = 60 \text{ CFM}$$

Use Nutone Model #9605N
Heat - A - Vent   70 CFM   5.0 Sones
Heating at 5118 BTU

(d) First Floor Toilet Area (All the Buildings)

$$\frac{22 \times 14 \times 8 \times 8}{60} = 328 \text{ CFM}$$

Use Nutone Model #8170
Wall - Impeller   270 CFM   6.0 Sones

V. SUMMARY OF HEATING AND COOLING LOAD, AND EQUIPMENT DATA

Building Name	Computer MBH	Manual MBH	Manual ADj. MBH	Equipment MBH	Total Tons CFM
			Pinecrest/Oakwood		
Sleeping	TC = 98.4	TC = 104.8	TC = 120.5	TC = 117.3	10 Tons
Area	TH = 69.7	TH = 68.62	TH = 75.1	TH = 158	3505 CFM
APT	TC = 43.7	TC = 32.94	TC = 37.89	TC = 43.7	4 Tons
2nd Fl	TH = 32.3	TH = 21.1	TH = 25.32	TH = 59	1325 CFM
Watchman	TC = 14	TC = 10.45	TC = 12.02	TC = 14	1.2 Ton
Room	TH = 11.3	TH = 9.28	TH = 11.13	TH = 11.9	500 CFM
CONF/LIV	TC = 87.4	TC = 109.8	TC = 126.2	TC = 117.3	10 Tons
Run	TH = 63.2	TH = 62.4	TH = 74.87	TH = 158	3505 CFM
Locker					
etc.		TH = 35.2	TH = 46.47	TH = 60	
			Cedarcrest/Snapdragon/Geranium		
Sleeping	TC = 94.8	TC = 126.3	TC = 145.25	TC = 122	10.5 Tons
Area	TH = 70.5	TH = 76.45	TH = 83.4	TH = 109.15	4000 CFM
APT (R)	TC = 31.7	TC = 30.93	TC = 35.57	TC = 31.7	3 Tons
	TH = 22.5	TH = 22.47	TH = 27.00	TH = 35	1000 CFM
APT (L)	Same	Same	Same	TC = 31.7	3 Tons
				TH = 35	1000 CFM
Recrea-	TC = 57.4	TC = 81.1	TC = 93.17	TC = 34.9	7 Tons
tion	TH = 42.4	TH = 52.37	TH = 57.13	TH = 77.3	2100 CFM
Heating				(Total = 298.8)	
Area		TH = 42.12	TH = 45.95	TH = 51.5	
			Elmwood		
Sleeping	TC = 85.4	TC = 102.35	TC = 117.7	TC = 122	9.5 Tons
Area	TH = 67.8	TH = 62.34	TH = 68.1	TH = 0	3400 CFM
APT (R)		TC = 25.57	TC = 29.4	TC = 34.9	3.3 Tons
		TH = 22.12	TH = 24.2	TH = 0	1180 CFM
APT (L)	Same	Same	Same	TC = 34.9	3.3 Tons
				TH = 0	1180 CFM
Rec	TC = 51.6	TC = 65,23	TC = 75.02	TC = 81	7 Tons
Room	TH = 36.8	TH = 40.8	TH = 44.5	TH = 0	2100 CFM
Heating					
Air		TH = 35.2	TH = 46.47	TH = 51.5	

Building Name	Computer MBH	Manual MBH	Manual Adj. MBH	Equipment MBH	Total Tons CFM
Willow					
Sleeping	TC = 135.5	-	-	TC = 170.	14.2 Tons
Area	TH = 96.3	-	-	TH = -	5000 CFM
APT	TC = 31.71	-	-	TC = 34.9	3.3 Tons
	TH = 22.5	-	-	TH = -	1180 CFM
REC	TC = 27.4	-	-	TC = 81	7 Tons
Room	TH = 42.4	-	-	TH = -	2100 CFM
HEAT		TH=42.12	TH=45.95	TH=51.5	
Typical Building					
Whole Building	TH = 243.1 (355.8)	TH = 260.63	TH = 284.4	TC = 400	
3rd	TC = 40.5	TC = 38.02	TC = 43.73		
Floor	TH = 38.9	TH = 35.1	TH = 38.3	TH = 51.4	

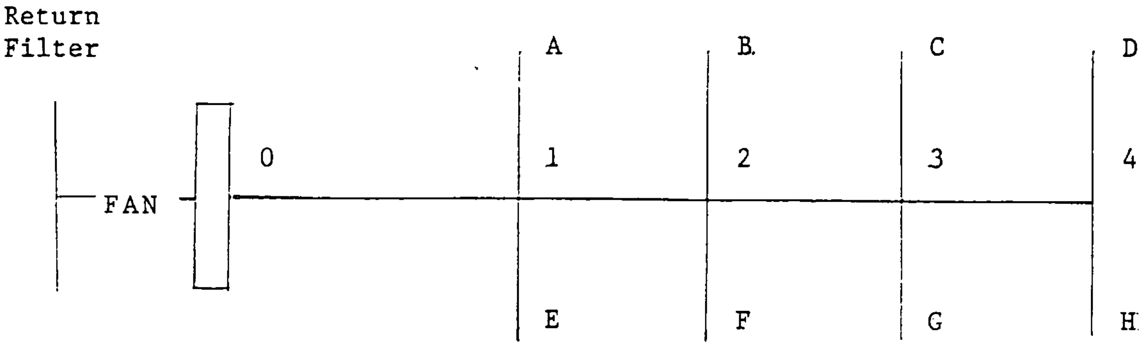
VI. DUCT DESIGN AND LAYOUT

Typical Example Sleeping Area of
Snapdragon/Geranium/Cedarcrest

TC = 122 MBH
TH = 109.15 MBH

CFM = 4000

USE Equal Friction Method and (TRANE Ductulator)
P = 0.082 in H_2O/100 ft
V = 1230 ft/min
Main Duct Size 46" x 12"



V=1230 ft/min

Q=4000 CFM

500 CFM each

Supply Grille

0 - 1	4000 CFM		46" x 12"
1 - 2	3000 CFM		44" x 10"
2 - 3	2000 CFM		32" x 10"
3 - 4	1000 CFM		24" x 8"
1 - A	500	CFM	18" x 6"
:	:		:
4 - H	500 CFM		18" x 6"

Section Elbow	Capacity CFM	Velocity FPM	Duct Size	$\frac{H}{W}$	$\frac{L}{W}$	L(ft)
FAN	4000	1230	46"x12"	0.261		
Section 1	4000	1230	46"x12"	0.261		
Section 2	3000	1150	44"x10"	0.227		
Section 3	2000	1030	32"x10"	0.313		
Section 4	1000	910	24"x8"	0.333	20	40
Section H	500	750	18"x6"	0.333		
Equivalent Length for Elbows						40 ft

Sections 1, 2, 3, 4 Wide Side become narrow use 15°
Losses = C_1 x hv. $C_1 = 0.15$

Section H Grille Loss = C_1 x hv $C_1 = 1.25$

Fan Entrance Louvers Loss = C_1 hv $C_1 = 0.5$

$$hv = \frac{(V)^2}{(4005)^2}$$

All Section Losses
$$0.15\ \frac{(1230)^2}{(4005)^2} + 0.15\ \frac{(1150)^2}{(4005)^2} + 0.15\ \frac{(1030)^2}{(4005)^2}$$
$$+ 0.15\ \frac{(910)^2}{(4005)^2} + 1.25\ \frac{(750)^2}{(4005)^2} + 0.8\ \frac{(500)^2}{(4005)^2} = 0.0573 \text{ in } H_2O$$

Length 0 - 4 = 60 ft
Total Length 60 + 40 = 100 ft
Losses = $(100)(1.1)\ \frac{(0.082)}{100} = 0.1396$ in H_2O

SPR = $0.5 \times \frac{(1230 - 750)(1230 + 750)}{16040000} = 0.0296$ in H_2O

Net Losses 0.0573+0.1396 - 0.0296 = 0.167 in H_2O

Blown Coil Unit 0.8 in H_2O

Total Pressure Drop 0.8 + 0.167 = 0.967 in H_2O Use 1.0 in H_2O

Supply Registers

CFM = 500 Velocity 540 ft/min

D = 13"

$A = 3.14 \times D^2/4 = 3.14 \times (13/12)^2/4 = 0.92$

Use 0.92 Free Area/ft^2

CFM	Velocity	Free Area/ft^2
540	560	0.95
500	540	0.92
450	560	0.785
415	540	0.772
335	520	0.64
300	520	0.567
280	500	0.56
250	500	0.50
200	500	0.40
100	500	0.196
20	500	0.196

Use Grillmaster Double Deflection Register
Series S4 - OB

- Return Grille

Use Grillmaster Filter Back
Model RAHFB

VII HOT WATER PIPING SYSTEM DESIGN AND LAYOUT

Typical Example Snapdragon/Geranium

Use 0.40 in/ft as Design Friction Value

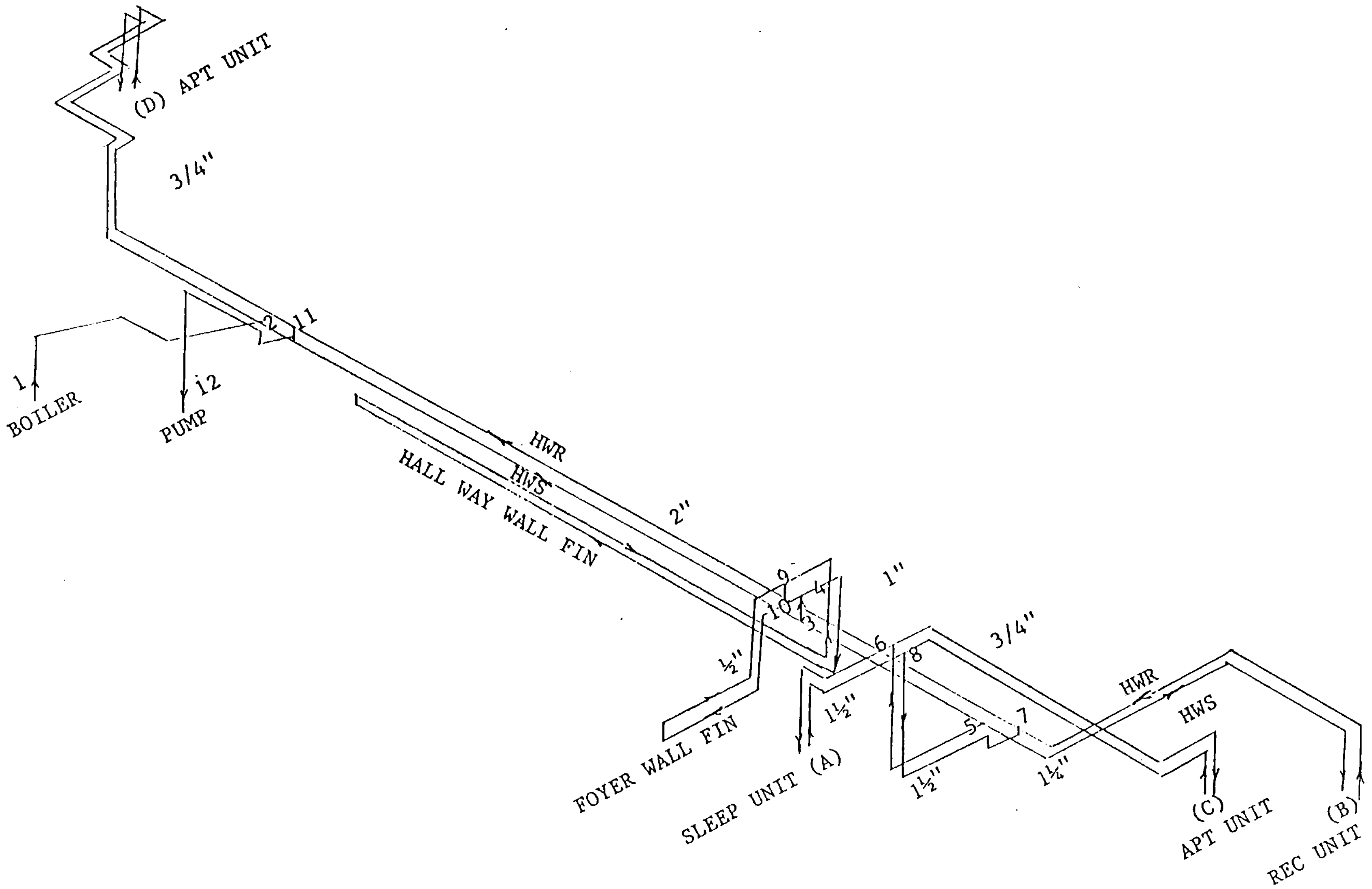
Based on Hot Water Coil Computer Selected Data

				Use
a)	Apartment	35 MBH	31 gpm	3.5 gpm
b)	Recreation	77.3 MBH	8 gpm	8.5 gpm
c)	Sleeping Area	108.9 MBH	11.2 gpm	12 gpm
d)	Hallway	51.1 MBH	5.2 gpm	5.6 gpm

Use B/G System Syzer Calculator

Supply/Return Pipe

1-2/11-12	33.1 gpm	2"	40 Wt Std. Iron Pipe
2-3/10-11	29.6 gpm	2"	40 Wt Std. Iron Pipe
3-4/9-10	5.6 gpm	1"	40 Wt Std. Iron Pipe
3-5/7-10	24 gpm	2"	40 Wt Std. Iron Pipe
5-6/8-7	15.5 gpm	1½"	40 Wt Std. Iron Pipe
6-A/A-8	12 gpm	1¼"	40 Wt Std. Iron Pipe
6-B/B-7	8.5 gpm	1¼"	40 Wt Std. Iron Pipe
5-C/C-7	3.5 gpm	3/4"	40 Wt Std. Iron Pipe
2-D/D-11	3.5 gpm	3/4"	40 Wt Std. Iron Pipe
4-9	0.86 gpm	½"	40 Wt Std. Iron Pipe
4-10	4.74 gpm	1"	40 Wt Std. Iron Pipe



SNAPDNAGON/GERANIUM PIPING FLOW DIAGRAM

VIII OTHER EQUIPMENT SELECTION

Boilers and Pumps (CED/SNA/GER)
Based on Computer Load Calculation and
Equipment Selection

Sleeping Area	TH = 108.9 MBH
APT (R)	35 MBH
APT (L)	35 MBH
REC Room	77.3 MBH
Hall Way etc	53.53 MBH
	309.73 MBH use 310 MBH

Boiler Capacity Larger than 310 MBH
at efficiency 80% 310 MBH/0.8 = 387.5 MBH
After a few years, boiler efficiency will drop.
at efficiency 65% $\frac{310 \text{ MBH}}{0.65} = 476.93$ MBH

Suggest Use Teledyne Laurs Model 500
500 MBH input
400 MBH output at 80% efficiency
1st Stage for Normal Heating
2nd Stage for Extremely Cold Weather
gpm = 38 gpm T = 20°F

Pipe use 0.40 in/ft pipe losses.

HWS/HWR use 2" Ø Std Wt Steel Sch 40
Pump (CED/SNA/GER)

Longest Run (4+4+5+2+78+2+8+78)(2)(1.5)(1.2) = 652 ft
50% Valve, Tee, Elbow, etc
20% Correction factor

$$\frac{652\ (400)}{1{,}200} = 21.73 \text{ ft of Head losses.}$$

at Head = 21.73 ft
Q = 38 gpm

Use B & G Series 1531
Unit No. 311 T   Sec 2   Dis 1½ AB.
1750 rpm
1 HP

Boiler (ELM/WIL)
No Heating is provided

Existing Boiler   input 760,000 BTUH
output 603,000 BTUH

Replace with Teledyne Loars   Model 750
input 750,000 BTUH
output 600,000 BTUH

Pump (ELM/WIL)
Existing pump

gpm = 70 gpm
Head = 40 ft
HP = 1½ HP.   1750 rpm

Replace with   B & G Series 1531
Unit No. 312T   Sec 2
1750 rpm   Dis 1½ AB
1½ HP

Boiler Control use Honeywell Industrial Risk Insurance

Wall Fin Use Trane's Wall Fin Catalog

Based on two pipe
t = 20° F
t = 180° F Hotwater temperature
TH = 51.5 - 55 MBH
Q = 5.6 gpm
t air = 65°F

Use 1¼" Steel Element Series 52 type 12S (TRANE)
Velocity Correction factor 0.962 (P.12. Chart 1. Trane)
51.5/0.962 = 53.53 MBH at 990 BTU/hr/ft

$$\frac{53.53 \text{ MBH}}{0.99 \text{ MBH/ft}} = \underline{56 \text{ ft}}$$

For all CED/GER/SAN Hall Wall

Use Trane's Wall Fin
Series 52
Type 12S
1¼" Ø Steel
6" Cabinets
20" high
56 ft Long
Sloping top

Compression Tanks

Based on B & G Compression Tank Selection Method

$$Vt = \frac{(EW - EP)\ Vs}{\frac{Pa}{PS} - \frac{Pa}{Po}} - 0.2\ Vs$$

Where
Vt - Compression tank size in gallons
Vs - Volume of System in gallons
EW - Unit expansion of water
EP- Ep - Unit expansion of system
Pa - atmospheric pressure, psi absolute
Pj - initial pressure in tank psi absolute
Po - final pressure (relief valve setting) Psi absolute
0.0 Vs - Approximate amount of air released from new system water upon heating - 2% of System Water Volume

Based on 180° F Hot water temperature
t = 20°F
(a) Boiler at 400 MBH
2 pipe system
Tank size is over 20 gl
(b) Boiler at 600 MBH
2 Pipe System
Tank Size is 30 gl

Detail Calculation

Pipe 2"	(0.17)(200)	=	3.5 gl
1½"	(0.105)(30)	=	3.18 gl
1¼"	(0.078)(250)	=	20.28 gl
1"	(0.045)(30)	=	1.35 gl
3/4"	(0.028)(160)	=	4.48 gl
			66.47 gl

Total volume in pipe etc (66.47)(1.2) = 79.76 gl Use 80 gl
in Boiler 95 gl
175 gl

$$Vt = \frac{(0.028)\ (175)}{\frac{14.7}{26.7} - \frac{14.7}{64.7}} - 0.02(175) = 17.6 \text{ gl}$$

Use 20 gl size tank (CED/GER/SAN)

For 600 MBH Boiler

$$VT = \frac{(0.028)\ (240)}{\frac{14.7}{26.7} \quad \frac{14.7}{44.7}} = 27.78 \text{ gl}$$

Use 30 gl size tank (ELM/WIL)

This sample of design and calculation work represents only about one quarter of overall design and calculation work on the L.T.I. project. However, most of the other design and calculation work is of the same nature.

IX NOTATION

SYMBOL	SPACE NUMBER	Code Number
REC (1)	Recreation Room	11
REC (2)	Recreation Room	12
WR	Writing Room	13
HEAT	Shower/Toilet/Locker Room	21
SLEEP	Sleeping Room	31
LIV	Living Room (right side)	41
BR	Bed Room (right side)	42
K/B	Kitchen/Bath (right side)	43
LIV	Living Room (Left Side)	51
BR	Bed Room (Left Side)	52
K/B	Kitchen/Bath (Left Side)	53
3rd	Third FLoor	61
APT	Apartment	
CED	Cedarcrest Dormitory	
CONF.	Conference Room	
ELM	Elmwood Dormitory	
GER	Geranium Dormitory	
LIL	Training Center (Lilac)	
OAK	Oakwood Dormitory	
PIN	Pinecrest Dormitory	
RUM	Rumper Room	
SNA	Snapdragon Dormitory	
WIL	Willow Dormitory	
NE	North East	
NW	North West	
SE	South East	
SW	South West	

SYMBOL	SPACE NAME
SYMBOL	Quality
B or BTU	British Thermal Unit
BTUH	British Thermal Unit Per Hour
CFM	Cube Feet Per Minute
DB	Dry-Bulb Temperature
Exp	Exposed Wall Area Feet Square
Ft	Feet
Ft^2	Square Feet
°F	Degree Fahrenheit
IN or "	Inch
Lat	Latent Heat
0°	Degree of Angle
Mis	Miscellaneous Heat
R-Valve	Resistant
RH	Relative Humidity
Sen	Sensible Heat
TC	Total Cooling
TH	Total Heating
U - Valve	Over-All Conductivity
W	Watts
WB	Wet-Bulb Temperature
gl	Gallons
GPM or gpm	Gallons Per Minute
MPH	Mile Per Hour
RPM or rpm	Revolution Per Minute

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APPENDIX A2

ENGINEERING SPECIFICATION

ON

L.T.I.

This document is part of the overall engineering specification submitted with the design calculation and construction drawings to the state of Louisiana's Division of Admission Facility Planning and Control. The equipment to be used was selected based on the author's design and calculations. This author was responsible for gathering and summarizing the technical data which was derived from various sources of manufacturer's data. About thirty percent of the specification is the result of the author's original work. The remainder of the document was extracted from standard HVAC specifications in use at MEL, Inc., and was assembled by the author at another engineer's direction. What follows is a reproduction of an actual document used by MEL, Inc.

15.01 HEATING, VENTILATING AND AIR CONDITIONING

A. GENERAL CONDITIONS

1. Mention herein or indication on the Drawings of articles, materials, operation, or methods requires that the Contractor provide each item mentioned or indicated of quality or subject to qualification noted; perform according to conditions stated each operation prescribed; and provide therefore all necessary labor, equipment, and incidentals.

2. All material shall be new and shall be installed in accordance with manufacturer's recommendations.

B. SCOPE OF WORK

1. Furnish all labor, materials, and equipment necessary to provide complete and proper operation, Heating, Ventilating, and Air Conditioning systems, all as specified herein and shown on the accompanying Drawings.

2. All materials and construction shall conform to the requirements of all building codes and laws in force in the locality in which the work is to be done, and to regulations of the National Board of Fire Underwriters.

3. Include all necessary piping to and from services provided under the Plumbing Section.

4. All electrical work, including wiring in connection with temperature control and power wiring to motors and motor controls, is included under the Electrical Section.

5. Touch-up Painting, shall be provided as necessary with similiar paint.

C. DRAWINGS

1. Submit for approval of the Designer, five (5) copies of drawings of all equipment to be furnished, and of such shop or setting Drawings as may be necessary to clarify the work intended, or to show the relation of this Contractor to adjacent work or to the work of other Contractors. Submit such drawings, dimensioned and to correct scale, with such promptness as to cause no delay in the work of this or other Contractors.

2. Clearly mark or show the name of the project and the item to which the Drawing applies.

D. STARTING, TESTING AND INSTRUCTIONS

1. Furnish a competent Engineer to start and test the installation, and to train the Owner's operator in operation of the system.

2. Post written operating instructions at convenient points throughout the system.

3. At completion of the work, furnish three (3) sets of written operating instructions, manufacturer's descriptive bulletins, operating and maintenance manuals and parts lists on all equipment installed.

E. GUARANTEE

1. Furnish written guarantee of all materials and workmanship under this Contract for a period of one (1) year from date of final acceptance of the building. Repair or replace and defective materials and workmanship without cost to the Owner.

2. Guarantee all equipment to be of quality and capacity specified, and further guarantee specified portions of the installation, such as sheet metal work, etc., as specified herein.

F. OPENINGS, CUTTING AND PATHING

1. Ascertain that all openings, shafts, chases, furred spaces, etc. required for or to conceal any of this work in any part of the structure are properly located and of ample size.

2. Furnish and install, during progress of construction, all necessary sleeves, thimles, hangers, inserts, etc., at such times and in such a manner as not to delay or interfere with the work of the other Contractors. Where any such work has not been done and where the proper installation of all materials and equipment included in these specifications or governed thereby requires cutting, drilling, chipping or fitting, do such necessary work at Contractor's expense and also perform in a manner approved by the Designer, such pathing and repairing as necessary to restore the construction to a condition existing at the time of commencement of such cutting, drilling, etc. Before doing any cutting and pathing, obtain permission of the Designer and follow his instructions as to how such proposed work shall be done, and if the Designer deems it of sufficient importance the work shall be done by others at the expense of the Contractor.

3. Fill in, cover, caulk, flash or otherwise weatherproof, as required, all opening left in the structure for this work.

4. A jack hammer or any other chipping equipment shall not be used to provide opening in the precast concrete roof existing in the buildings where heating and air-conditioning systems are being installed.

G. COORDINATION OF TRADES

Perform all work at such times and in such manner as to avoid interference with work of other Contractors. Confer with and co-operate with other Contractors on the project to insure proper completion of the work with a minimum amount of interference between this.work and that of other Contractors, such conference and cooperation shall be established before fabrication and erection of work.

H. SHEET METAL WORK

1. GENERAL. Furnish and erect in a neat, workmanlike manner all sheet metal work shown on the Drawings. Verify all dimensions at the site, making all field measurements and shop Drawings necessary for fabrication and erection of sheet metal work. Obtain approval of the Designer on all deviations from Contract plans and specifications, as may be necessitated by mob conditions or otherwise

2: OBSTRUCTIONS. Make allowances for beams, pipes or other obstructions in the construction of the buildings, and for work of other Contractors, whether or not these are shown on the Drawings. Transform, divide or offset ducts, as required, in such a manner as to maintain the same cross-sectional area of duct as indicated on Drawings. Where necessary to take pipes or similar obstructions into ducts, the ducts need not be enlarged if the decrease in area does not exceed 10%, and such decrease is approved in writing by the Designer. If the decrease in area would exceed 10% enlarge the duct to maintain duct area not less than 90% of that indicated on the Drawings. In either case provide a stream-lined easement or collar or approved design.

I. MATERIAL AND GAUGES

1. Except as otherwise specified herein or on Drawings, construct all sheet metal work of galvanized steel. Sheet metal exposed to the weather shall be galvanized Armco Zonc-Grip, Wheeling Softite, or approved equal.

2. Use U. S. Standard Gage #24 for all ducts up to 30 inches wide, and U. S. Standard gage #22 for all ducts between 31 and 60 inches wide. #20 Gage for ducts larger than 60" wide.

J. JOINTS AND BRACING

Joints and bracing shall be in according with Detail No. 1. All angles shall be hot rolled galvanized steel. Provide additional angles as necessary to prevent vibration, chatter or pulsations of any sheet metal work.

K. CROSS BREAKS

Provide cross breaks on all ducts except those which are to be acoustically lined. On ducts where cross breaks are to be provided, apply cross breaks to all flat surfaces over 8 in. width, also to all elbows and offsets, centers of cross breaks to be of sufficient height to assure rigidity of the sheet metal. For 7"'-10" joints, provide two sets of cross breaks per joint.

L. ELBOWS AND OFFSETS

Provide elbows in all duct work with turning vanes in accordance with Detail Nos. 2 and 3. Provide offsets having offset angle greater than 30 degrees with turning vanes.

M. ACOUSTIC LINING

1. Owens-Corning Fiberglass Coated Duct Insulation, or approved equal, 6 lb. density board type lining, 1" thickness.

2. Apply acoustic lining with waterproof cement, and secure to sheet metal with sheet metal screws and 1-1/2 in. diameter sheet metal washers, one for each two square feet of lining. Use bolts and nuts instead of screws for ducts into which access must be made for adjustment of dampers, etc. Paint joints and edges of acoustic lining with waterproof cement to a smooth finish.

N. DUCT SUPPORTS

1. Securely fasten ducts to walls and ceiling.

2. Hangers for horizontal ducts shall be 1 x 1/8 in. flat galvanized ban iron for ducts up to 48 in. width, and 1 x 1/8 in. galvanized angles for ducts wider than 48 in. Angles iron hangers shall have an end turned at 90 degrees to receive hanger bolt.

3. Provide hangers for each section, located adjacent to duct joints, extending full height of duct side.

4. Fasten hangers overhead bar joist construction with suitable clip angles welded to joists chords.

O. FLEXIBLE CONNECTIONS

Wherever a duct is to be fastened to the intake or discharge of a fan, or where it goes between new and existing buildings provide a flexible connection between duct and fan, of "Ventfab", as manufactured by Iden Associates, or approved equal, waterproof and fireproof fabric. Flexible connections shall be at least 4 in. long, securely fastened with galvanized band iron hoops.

P. ACCESS PANELS

Where required for ocassional repair or adjustment of equipment such as fire dampers or thermostats provide access panels in ducts of 20 gauge galvanized steel, with edges turned to prevent their being sharp and for stiffness.

Q. FLASHING

1. Wherever sheet metal work or piping under this Contract passes through exposed walls, or roof, furnish and install flashing an counter-flashing necessary for weather-proofing.

2. Flashing and counter-flashing shall be 16oz. sheet copper, securely soldered and fitted, except that cap flashing for ducts, hoods, etc., shall be same material as duct and isolated from dissimilar metal base flashing with roofing felt. Turn flashing out at least 10 in. all round on the roof and up at least 10 in. on ducts and pipes.

R. GUARANTEE, ADJUSTMENT AND TESTS

1. Guarantee all sheet metal work to be free of all vibration, chatter, or objectionable pulsations under all conditions of operations.

2. All ducts in non-heated spaces shall be airtight, with seams caulked wherever necessary with suitable caulking compound.

3. Air-System-Balancing: The balancing, testing and adjusting of the heating, ventilating and air condition system shall be performed by an independent balancing company possessing calibrated instruments, qualified engineers and skilled technicians to perform the tests. This agency shall be hired by the mechanical or sheet metal subcontractor. The balancing agency shall be responsible for inspecting, adjusting and balancing and logging the data of performance of fans, drives,

drive motors, dampers and all air distribution devices and the flows of air through the system. The mechanical subcontractor and the suppliers of the equipment installed shall cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components and shall furnish all labor, materials, additional dampers, balancing, etc., required to eliminate any deficiencies.

Before final acceptance of the system is made, the balancing agency shall furnish to Engineer the following data in five copies:

a. A tabulation of simultaneous temperatures of all spaces and equipment entering and leaving conditions on each separately controlled zone.

b. A listing of measured air quantities at each outlet.

c. Air quantities, at all return, outside air intakes and exhaust devices.

d. Pressure readings, entering and leaving from each supply, return and exhaust fan, air handling unit, filter, coil, balancing damper and other components of the system.

e. A tabulation of all electrical data including starter type, size, heater rating, amperage and voltage rated and running.

The test and balancing agency selected shall make an inspectionof the building during the opposite season from when the balance was performed to insure optimum operation conditions. All space temperatures shall be balanced for both summer and winter to within 1-1/2 degrees F.

All work performed by the balancing agency shall be done in accordance with "National Standards for Field Measurements and Instrumentation, Total System Balance Colume 1, Number 81266," published by the Associated Air Balance Council.

4. Contractor shall install a smoke detector where indicated on the drawings shut down the duct system blower when activated.

S. EQUIPMENT

S-1 DIRECT EXPANSION SPLIT SYSTEM

The Contractor shall install as indicated on the drawings twenty (20) upflow discharge air handling unit floor mounted type with a hot water coil in the following dormitories:

Dormitory	No. of Units
-Elmwood	4
-Willow	4
-Cedarcrest	4
-Geranium	4
-Snapdragon	4

AIR HANDLING AND CONDENSING UNITS:

The contractor shall furnish and install, as shown on the plans, air conditioning units of the type, size and capacity set forth in the schedule.

Casing shall consist of fan section, coil section and drain pan. Removable panels in fan and coil sections shall be furnished to provide access to all internal parts.

All fans and fan shafts in the central station air conditioning units shall be manufactured by the unit manufacturer. FAns shall be double width, double inlet, multi-blade type. All fans shall be statically and dynamically balanced and tested after being installed in factory assembled fan sections. Fans shall be installed on property sized solid shafts as designed and required by the unit manufacturer. Fan tables shall be based on unit performance with fans tested and rated in the unit. The fan shall be supplied with 208 volts, 3 phase 60 hertz motors.

All unit panels shall be insulated with 1" thick coated blanket fiberglass type insulatin securely fastened to panels with approved adhesive. Filter boxes shall be furnished. Filter area shall be such that filter velocity is in accordance with the filter manufacturer's recommendation.

Casing and all accessories with the exception of the coils shall be given a protective enamel paint finish. All metal parts, prior to final assembly of the units, shall be chemically cleaned, phosphatized, hot air blast dried, automatically controlled pressure paint sprayed, and coated with baked enamel primer finisher. An additional coat of air dried enamel shall be applied on all exterior surfaces after final assembly and before shipment.

Coils shall be a product of the unit manufacturer and be certified in accordance with PRI Standard 410. They shall be the continuous aluminum plate fin and copper tube type. Fins shall have collars drawn and belled and shall be firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing no lighter than 16 gauge. Coils shall be mounted in the coil casing to be accessible for service. Coils shall have same end connections. Fin thickness shall be not less than 0.0075 and tube wall thickness shall not be less than 0.020.

Each air handling unit shall be mounted on rubber-N-shear isolators.

The condensing unit shall be an air-cooled unit and located as indicated on the drawing. The unit shall be properly assembled and tested at the factory. It shall be designed for use with Refrigerant 22.

The Condenser coil shall be of nonferrous construction. Coil shall have aluminum plate fins, mechanically bonded to seamless copper tubes. Coil shall be circulated for subcooling.

The unit shall be equipped with direct-driven, propeller-type fans arranged for vertical discharge. The fan motor shall have inherent protection, and shall be of permanently lubricated type, resiliently mounted. Each fan shall have a safety guard. Control shall be included for cycling fans for intermediate season operation.

Where refrigerant lines exceed 60 lineal feet additional refrigerant oil shall be added by contractor per manufacturer's recommendations.

Units shall be furnished with a five (5) year compressor warranty.

The Compressor shall be of serviceable hermetic design with external spring isolators and shall have an automatically reversible oil pump. Maximum power input to the compressor shall not exceed 27 KW at conditions specified. The compressor shall be located in a section separated from condenser fans and coil.

The Controls shall be factory wired and located in a separate enclosure within the unit. Safety devices shall consist of high and low pressure switches and Compressor overload devices. Unit wiring shall incorporate a positive acting timer to prevent short cycling and restarting for approximately 5 minutes after shutoff.

The Condensing unit casing shall be fully weatherproof for outdoor installation. Casing shall be of galvanned steel zinc phosphatized and finished with baked enamel. Panel openigns shall be provided for power refrigerant and connections. Panel shall be removable to provide access for servicing.

S-2 GAS-FIRED FURNACE

1.) The unit A as indicated on the drawings shall be a dual or twinning upflow type natural gas-fired furnace. The unit shall be designed to mount an encased cooling coil in the supply air stream of the furnace. The unit shall be constructed of one piece with a finished baked enamel coating. The unit shall have an internal factory-wired control box with a two (2) manual reset limit controls to prevent reverse air circulation. A built-in transformer shall be provided to operate unit with cooling coil condenser as required by N.E.C. The unit shall be rated for 115v/1ph/60 Hz

2.) The unit B as indicated on the drawing shall be a upflow type natural gas-fired furnace. The unit shall have solid-state blower control and electronic ignition. The unit shall have an induced-draft blower. As an added feature, the unit shall have redundant gas valves. The burner shall be constructed of aluminized steel. Electrical service shall be 120V/1 ph/60Hz

S-3 DIRECT EXPANSION ENCASED EVAPORATOR COIL

The Contractor shall install as indicated on the drawings seven (7) direct expansion coils to be installed in the discharge duct of gas-fired furnace units as follow:

Dormitory	No. of Units
Snapdragon	1 (Alternate bid)
Oakwood	3
Pinecrest	3

The coils shall be seamless copper tubes mechanically bonded with heavy aluminum fins complete with male couplers valve, expansion devices and fully charge with R-22. The cooling coils shall have a minimum face area 9.79, 5.1 and 4.2 square feet in accordance to the units specified on the drawings.

The casing of the encased coil shall be insulated and constructed of galvanneal steel. The finish shall be a baked enamel.

The condensing unit shall be air-cooled type factory assembled and designed for standard operating temperature range. The unit shall be CSA and UL approved and comply with ARI Standard 210, national rating standard of the Air Conditioning Refrigeration Institute.

The Condenser Coil shall have seamless aluminum tubes. Heavy aluminum fins mechanically bonded to tubes.

The Compressor shall be - Hermetic - welded shell-type with internal spring isolation. Winding thermostat and current overload device coupled with pressure-limiting valve. Internal protection devices provided protection for motor overload, locked rotor, extreme voltage supply, excessive winding temperatures, extreme pressures, loss of refrigerant charge and compressor cycling.

The Condenser Fan shall be - Aluminum - aerodynamic design, statically balanced. Direct-driven, heavy-duty, permanently lubricated motors with built-in thermo-overload protection. Fan/motor support mounted to cabinet top with a rugged grille to protect fan.

S-4 HEATING SYSTEM

1. GAS FIRED PROPELLER UNIT HEATER

The unit heater shall be a propeller type in accordance with the design indicated in the Heating Unit Design Schedule on Sheet No. M-1

The unit shall be provided with an electronic ignition pilot. The unit gas controls, motor and electrical junction box shall be exposed and readily accessible for servicing. Safety fan guard shall be provided. The unit shall be thermostatically control. Contractor shall furnish and install a manufacturer recommended thermostat. The Contractor shall reuse vent and reconnect existing gas line and support.

2. BOILER

The boiler shall be as specified and scheduled on plans and shall be an atmospheric, natural gas-fired type design certified and tested by AGA. The boiler shall be complete with 13 gauge 90-10 copper nickel tube, glass lined cast iron headers and Magnesium Anode, 3" insulation on refactory, titanium stabilized stainless steel burners. Three (3) staged firing entering water can be as low as 60°F, with factory install flow switch. The controls and trim shall consist of operating aquastat, manual reset high limit control, low-water cut-off, electric gas valve, safety pilot burner, gas pressure regulator, manual gas shut-off valve, ASME relief valve factory mounted and set (30 psi), pressure - temperature gauge and draft diverter for indoors. The boiler shall have an approved AGA gas train and shall be shock proof. Conform to "IRI Regulation." The boiler shall be shock proof.

System Pumps

The Contractor shall furnish and install, as shown on the plans two pad mounted centrifugal circulating pumps capable of delivering 38 and 70 GPM @ 25 and 40 Feet of head, respectively. The pump shall be single stage, vertical split case design, in cast iron bronze fitted construction. The pump internals shall be capable of being serviced without distrubing piping connections. The pumps motor enclosure shall be dripped proof and the motor shall be copper wound. Motor RPM shall be 1750 @ 208 volts and three phases. The pump impeller shall be enclosed type, hydraulically and dynamically balanced and keyed to the shaft and secured with a suitable locknut. The pump shall employ a mechanical seal, with a carbon seal ring and ceramic seat. A shaft sleeve shall be furnished under the complete wetted area of the mechanical seal. The bearing frame assembly of the pump shall be fitted with oil lubricated, bronze journal bearings and a hardened alloy steel shaft. A flexible coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor.

Built-In Pumps

The boiler built-in pump shall be supplied by the boiler manufacturer. The pump shall be an integral part of the heat exchanger, mounted and wired at the factory - no external piping. The pump shall be sized to match heater capacity and water hardness. The pump shall be bronze fitted in a cast iron porcelain lined volute. The pump shall be wired for 115 volts, single phase, 60 cycles, capable of delivering 50 GPM against 10 T.D.H.

Boiler Stack

Boiler shall be vented as shown on the drawing reusing the existing stack.

Expansion Tank

Expansion tank shall be galvanized steel having a capacity of 20 and 30 gallons with 125 psi working pressure as indicated on the drawing No. M-9. Compression tank shall be installed where shown on plans and connected as shown on plans. Provide a glass gauge and air charging and tank draining valve. Also provide and install an automatic float operated air vent valve with manual cock on tank and pipe to drain. Tank shall be in accordance with ASME construction. Provide shutoff valves and drain cocks for gauge glass removal. Tank shall be insulated in accordance with paragraph No. 2 in the piping and plumbing section of this specification.

The sight level gage on the expansion tank shall be stainless steel type with 1/2 inch sight glass and fitting. The sight glass shall extend a minimum of 6". The gage shall have a valve on lower end and mounted 2 inches from bottom of tank.

Air Separator

Air separator shall be equipped to handle a flowrate of 57 GPM, and have 2" N.P.T. tangential inlet and outlet connections. The unit shall have an internal perforated stainless steel air collector tube designed to direct and release air into the compression tank. The unit shall have a removable galvanized steel strainer. Unit must be constructed in accordance with ASME Boiler and Pressure Vessels Code and stamped 125 PSIG design pressure. A blowdown connection shall be provided for routine cleaning. The separator shall contain an automatic float type drain valve with an operating pressure of 30 psig. The valve shall be field piped to the nearest floor drain.

Pressure & Temperature Gages

All dial sizes shall be a minimum of 3½ inch in diameter. Pressure gages shall be pipe mounted drawn steel case type with bronze bourdon tube and brass movement, ¼ inch NPT male bottom fitting. Range shall be 0-100 PSIG with 2% or less accuracy.

Temperature gage (thermometers) shall be constructed of stainless steel with standard ¼ inch stem and fitting for pipe mounting. Range shall be to 250°F with 2% or less error.

Thermometers

Furnish and install where shown on the drawing, red reading mercury thermometer with 6 inches extruded brass. Case, black lines and numbers, magnified lense and glass shield, straight or angle as required.

Chemical Feed

Furnish and install a Pot Feeder as indicated on the drawing. The pot feeder shall have an operating temperature of 250°F and a maximum operating pressure of 120 psi.

The pot shall be employed with an inlet, outlet & drain line connection.

The pot feeder shall contain chemical for treatment of boiler and coils in a closed hot water system. Also shall contain corrosion inhibitors for both iron and copper metals plus antifoulants to maintain a clear system.

S-5 HOT WATER FIN - TUBE RADIATION

Furnish and install fin-tube radiation as indicated and scheduled on the plans. All ratings shall be IBR approved. Units shall be installed in a neat and workmanlike manner in accordance with this specification and with the manufacturer's recommendations.

Heating elements shall be 1-1/4 inch steel tube with aluminum fins. Elements shall have integral fin collars which space the fins. Tubes shall be mechanically expanded into fin collars to eliminate noise and insure durability and performance at specified ratings.

Enclosures for heating elements shall be wall hung, type constructed of 16 gauge steel, and mount into a continuous roll formed captive channel mounting strip which permits hinge type mounting and access at the top and onto 14 gauge steel rigidized closure brackets on not more than 4' centers at the bottom without visible fasteners. Enclosures shall have baked enamel finish.

The front panels shall be individually removable to facilitate cleaning, servicing or replacement. All accessories shall fasten to the enclosure assembly in a manner which prevents contact with the back wall during installation.

Sheet metal cabinet air outlets shall be recessed and framed.

Provide end panels, inside and outside corners, enclosure extensions and access panels.

The contractor shall furnish and install control valves and piping accessories as specified.

S-6 HOT WATER COIL

Hot water coils shall be furnished for mounting inside limit housing where indicated on plans.

Coil capacities, pressure drops and selection procedures certified in accordance with ARI Standard 410-81.

The tubes shall be round seamless copper tubes expanded into full fin collars for permanent fin-tube bond and expanded into cast iron headers for permanent leaktight joint.

The fins shall be configurated, plate-type aluminum or copper fins with full fin collars for maximum fin-tube contact and accurate spacing, mechanical bonded to tubes for permanent fin-tube bond.

The casings shall be galvanized steel, 16-gauge casings on coils with headers 33-inches or less galvanized steel, 16-gauge channels with 14-gauge center and end supports on coils with 36, 42 and 48-inch headers up through 120 inches. Galvanized steel, 14-gauge casings on coils with 36, 42 and 48-inch headers and greater than 120 inches in length. One or more galvanized steel center tube supports on lengths over 42 inches.

The headers shall be gray cast iron (finely dispersed graphite, peralitic) for 12 through 33-inch header heights. Round seamless copper tubes with an internal threaded adapter for direct pipe connection for 36, 42, and 48-inch header heights.

All coils shall be proof tested at 1.4 times maximum working pressure, then leak tested at maximum working pressure. Minimum test pressures are 300 psig proof test and 200 psig leak test.

Heating System Controls

The A/C thermostat cycles the air handler fan motor during heating season to maintain the predetermined setting.

The boiler system is activated manual by the Owner. The Fan cycle "OFF" AND ON" while the circulating pump operates constantly.

All boiler control and system devices shall be recommended by boiler manufacturer and furnished by the Mechanical Contractor.

S-7 NEW FLAME SAFEGUARD CONTROL SYSTEM

The Contractor shall furnish and install new boiler controls for Elmwood and Willow Dormitory boilers. The control shall comply to boiler Group "B" in the Southern Building Standard Mechanical Code. The control shall conform to "I.R.I. Regulation" (formerly F.I.A.) for single burner with inputs over 400,000 BTU/HR. The control schematic is shown on drawing no. M-9 with listed parts

S-8 BATHROOM EXHAUST FANS AND HEATER UNITS

1. Furnish and install exhaust fans and electric heating units drawings. Fans and heater shall be of the type, size, and capacity indicated in plans.

2. Standard centrifugal fan located on the wall shall be provided with heavy gauge all welded steel fan housing mounted upon a rigid support and entire unit shall be treated for outside installation. The motor and drive housing shall be mounted on vibration isolators and shall be completely sealed from the exhausted air and fumes. The motor cooling completely sealed from the exhausted air and fumes. The motor cooling air shall be taken into the chamber from a location free of discharge contaminates. Units shall be direct driven. Bearings shall be designed for 100,000 hours operating life. All single phase motors shall have built-in thermal overload protection. Fans shall e equipped with the accessories listed in the schedule on drawings

- Centrifugal ceiling exhaust fans shall be provided, direct driven blower type with aluminum forward curved blower wheel. Fan housing shall be of baked enamel steel with integral wiring junction box and outlets for fan motor hookup. The interior of the housing shall be lined with sound deadening insulation. Motor shall be quiet shaded pole type lubricated for life. Fan shall have backdraft damper mounted in throat of discharge outlet adjustable to either horizontal or vertical position. Fan inlet shall be provided with extruded a aluminum ceiling grille with adjustable blades and anodized finish. Extend duct thru roof to approved vent cap.

All fans shall have been statically and dynamically balanced prior to leaving factory. Fans found vibrating noticeably in the field due to damage to shipment, improper handling, etc., will be removed and replaced at no additional cost to the Owner. All fans shall be AMCA rated and tested and shall bear the AMCA Seal.

The exhaust system with the exception of the Apartments shall be installed and interlock with light switch as indicated in the Exhaust/Ventilation Schedule on the drawings. As noted therein, the exhaust system shall contain as a integral part of the control switch a 60 minute timer mounted in the mechanical room. The timer shall be designed to cycle every other hour as long as the light switch is in the "ON" position. The Fan is "OFF" when the light switch is in the "Off" position.

Wall mounted apartment exhaust fans shall be activated manually.

The controls shall be suitable for 120 volt, single phase, 60 Hz electrical service.

Roof cap shall be of aluminum construction with weather louver or as specified by the manufacturer. A metal mesh bird screen shall be provided. All roofing flashing shall be of standard type and watertight with proper sealant.

Ductwork, duct accessories, and duct systems both conventional and special, apparatus casing, and all hangers and supports for the duct systems shall be provided. All ductwork and duct systems shall be fabricated and installed in accordance with the drawings and these specificatiosn and shall be tested, adjusted, and demonstrated ready for operation as specified.

In addition to the requirements of the drawings and these specifications, the duct systems shall be fabricated and installed in accordance with SMACNA standards.

The bathroom heaters shall be of the radiant fan-forced ceiling type with a downflow warm air stream.

The unit shall be rate for a 1500 watts output. Electric service is 120V/60 Hz. The heater shall have its own operating switch.

T-1 AIR DISTRIBUTION

Furnish and erect in neat and workmanlike manner all ducts and sheet metal shown on plans, or specified, or required to provide complete air conditioning and ventilating systems.

Ducts shall be constructed of galvanized steel sheets in accordance with National Board of Fire Underwriters pamphlet #90A, Table 1, and according to the Sheet Metal and Air Conditioning Contractors' national Association (S.M.A.C.N.A.) Low Velocity Duct Manual, latest edition, complete with necessary elbows, dampers, etc. Support and anchor to building in an approved manner completely free from vibration under operating conditions.

Provide flexible fan connections of two layers of glass cloth, U.L. approved, air tight, at least two inches long.

Provide necessary access doors to provide entry to enclosed spaces or ducts, to service dampers of equipment. Doors shall have non-corrosive hinges, brass latches, and insulation where necessary.

Provide in ductwork, dampers, vanes, splitters, etc., as shown on drawings or that may be necessary to make system complete. Dampers constructed of 14 gauge galvanized steel.

Provide quadrants on adjustable splitters, mark shaft to give splitter dampers position in duct. Where square turns are shown, install Tuttle and Bailey "Ducturn" or Kureger Turning Vanes, or approved equal, to deflect air through turns.

Longitudinal duct seams shall be snap-lock or pittsburg type; corner seams shall be double seams or Pittsburg; transverse joints shall be made drive slips and S-slips. Where drive slips are used, they shall be driven across the duct side having smaller dimension, with S-slips or pocket lock securing the longer sides. Hemmed or bar slips shall be used in accordance with duct size.

Ducts shall be constructed of galvanized steel sheets in accordance with National Board of Fire Underwriters pamphlet #90A, Table 1, and according to the Sheet Metal and Air Conditioning Contractors' National Association (S.M.A.C.N.A.) Low Velocity Duct Manual, latest edition, complete with necessary elbows, dampers, etc. Support and anchor to building in an approved manner completely free from vibration under operating conditions.

Provide flexible fan connections of two layers of glass cloth, U.L. approved, air tight, at least two inches long.

Provide necessary access doors to provide entry to enclosed spaces or ducts, to service dampers of equipment. Doors shall have non-corrosive hinges, brass latches, and insulation where necessary.

Provide in ductwork, dampers, vanes, splitters, etc., as shown on drawings or that may be necessary to make system complete. Dampers constructed of 14 gauge galvanized steel.

Provide quadrants on adjustable splitters, mark shaft to give splitter dampers position in duct. Where square turns are shown, install Tuttle and Bailey "Ducturn" or Krueger Turning Vanes, or approved equal, to deflect air through turns.

Longitudinal duct seams shall be snap-lock or pittsburg type; corner seams shall be double seam or Pittsburg; transverse joints shall be made drive slips and S-slips. Where drive slips are used, they shall be driven across the duct side having smaller dimension, with S-slips or pocket lock securing the longer sides. Hemmed or bar slips shall be used in accordance with duct size.

Hangers shall be provided and spaced as required by duct size and weight, but not more than 8'-0" apart in any case. Ducts less than 36" wide and not over 40" in semiperimeter may be hung by galvanized strap hangers 12-gauge or heavier. Strap hangers shall be mill-cut band iron or squarely trimmed, flat field - cut material.

ALL DUCT SIZES SHOWN ON PLANS ARE CLEAR INSIDE DIMENSIONS.

T-2 GRILLES, DIFFUSERS, AND REGISTERS:

All wall grilles, and registers, unless otherwise specified, shall be Krueger, Titus, Tuttle-Bailey, or Agitair, Metal-Aire, furnished with sponge rubber mounting gaskets, with mounting screws finished same as grille and opposed blade volume dampers.

Wall supply registers shall be of aluminum construction, with double deflection, and with integrally attached opposed blade volume control, key operated through the grille face.

Return air and exhaust grilles to be non-vision, aluminum construction, fixed horizontal fin, with opposed blade dampers.

Door grilles (louvers) were called for in plans, shall have free area as indicated in the schedule on the drawings. Contractor to turn grilles over to millwork contractor for installation.

Arrows registers indicate direction of air flow, provide proper throw and flow.

T-3 PIPING - REFRIGERANT

The Contractor shall furnish and install the completed piping system as illustrated on the drawing. All piping must follow standard refrigerant piping techniques. Piping details and specifics shall be as recommended by the manufacturer. The piping schematic diagram on the drawing contains filter, sight glass, strainer, isolators and supports. The Contractor shall provide and install these minimum requirements:

REFRIGERANT PIPING SHALL BE AS FOLLOWS:

Line Service	Pipe	Fittings
Suction	Hard Copper Tubing Type L	Wrought Copper or Brass
Liquid	Hard Copper Tubing Type L	Wrought Copper or Brass
Hot gas line	Hard Copper Tubing Type L	Wrought Copper or Brass
Condensate	Hard Copper Tubing	Wrought Copper or Brass
	or	
	PVC, Schedule 40	PVC, Socket Joint

PIPE SIZE SHALL BE AS SPECIFIED AND RECOMMENDED BY EQUIPMENT MANUFACTURER AND SHALL BE SIZED IN ACCORDANCE WITH THE DISTANCE BETWEEN THE COOLING COIL AND THE CONDENSING UNIT.

Refrigerant relief valves shall be piped to outside the building, terminating high through sidewall. VAlve all equipment on both terminating high through sidewall. Valve all equipment on both inlet and outlet. Provide unions on each side of all items of equipment pipe all vent valves and relief valves on the systems. Run condensate drain lines from air conditioning equipment to drains, as noted. Contractor shall provide drain line to existing drainage system installing trap, etc., in accordance with all standard Local codes.

The maximum spacing of supports of hangers for horizontal runnings of piping shall be as follows:

Size of Pipe	PVC	Copper
½" - 1"	8' - 0"	6' - 0"
1-¼" - 1-½"	10' - 0"	6' - 0"
2" - 3"	12' - 0"	10' - 0"

Sleeves of No. 16 gauge galvanized iron shall be installed for pipes passing through walls above ground. Where pipes pass through waterproofing membranes, flashing sleeves shall be installed. Weatherproof opening for pipes passing through exterior walls.

For copper piping, all valves and unions to be as follows: Gate valves 2 inch and smaller shall be Crane no. 1310; Fairbanks No. 0582; Jenkins No. 1200. Unions shall be Nibco No., 633; ITT Grinnell No. 9133; Chase No. 402. Unions shall be 300 pounds non-shock, malleable iron screwed type. "DIELECTRIC" Union shall be used at any connection from ferrous to non-ferrous piping or equipment. Check Valves shall be "swing check" type and manufactured by Crane No. 37; Fairbanks No. 0640, Power No. 578 or approved equal.

Hangers, Escutcheons, etc. shall be provided and installed with chrome plated brass escutcheons wherever pipes pass through ceilings and masonry walls exposed in finished areas. Escutcheons not required on fan coil unit, hanger rods, or where piping passes through new wood or masonite panels, at individual rooms. Where piping penetrates new wood panels the Contractor shall maintain proper spacing between the-different lines and holes shall be be neatly cut to receive insulated lines.

T-4 PIPING AND PLUMBING SYSTEM - HOT AND COLD WATER

1. Plan and arrange piping to insure good appearance and good operation. At equipment, provide service valve and union; other unions as required to facilitate maintenance.

   As indicated, provide the hot water system. Relief valves shall be a half size larger than the pipe which is to be full-sized-vented to outside, or floor drain. (Do not rise into attic). Use insulating "dielectric" union at any connection or transition from ferrous to non-ferrous piping or equipment. Insulation: Insulation as required herein shall not be applied until all work has been tested and inspected by Engineer.

The Contractor shall furnish and install the completed piping system as illustrated on the drawing. Piping details and specifics shall be as recommended by the manufacturer. The Contractor shall provide and install these minimum requirements:

COLD & HOT WATER PIPING SHALL BE AS FOLLOWS:

Pipe	Size	Fittings	Horizontal Runs Max. Spacing For Support
"L" hard Copper	1/2"-2"	Wrought	6'
"L" hard Copper	1/2"-2"	Wrought	6'
Schedule 40 Galvanized Steel	1/2"-2"	Malleable Screw Type	8' 8'
Schedule 40 Galvanized Steel	1¼"-2	Malleable Screw Type	10'
Schedule 40 Galvanized Steel	1¼-2"	Screw Type Malleable Screw Type	10'
Schedule 40 Galvanized Steel	1¼"-2	Screw Type	10'

2. All hotwater lines shall be insulated with foamglass or equal molded pipe covering 1" thick, with factory applied vapor barrier jacket. Exterior water lines, valves and fittings, and drain lines shall be insulated with 1" insulation of the same type. Longitudinal lap of vapor barrier jacket shall be sealed with the white vapor barrier lap cement. End joints shall be sealed with 3" vapor barrier strips applied with lap cement.

3. All flanges, strainers, valves and fittings shall be insulated with fabricated fitting covers of material and thickness equal to that of the insulation of the adjoining pipe and securely fastened in place. Insulation on flanges, strainers valves and fittings shall be finished with a coating of white vinyl plastic paint or white lagging adhesive followed by an application of white adhesive.

4. All valves, strainers, etc., shall be covered and the covering shall extend all the way up to the equipment.

5. Insulate flexible pipe with 1" fiberglass with vapor barrier jacket.

6. Provide 16 gauge insulation Shield at each support point in the Mechanical room. Shields to be minimum 8" long and cover bottom 120° of insulation Donot provide shields on piping inside the building.

7. Piping Installation: Furnish and install complete piping systems as shown on plans of materials specified. Valve all equipment on both inlet and outlet. Provide unions on each side of all items of equipment. Pipe all vent valves and relief valves on water systems to drains. Where noted Contractor shall provide drain line to existing vent system installing trap, etc., in accordance with all codes.

8. Furnish and install all gate valves, check valves, balancing valves, air relief valves, hangers, floor and ceiling plates, etc. to make complete system. Screw joints shall be made up with graphite and oil or other approve compound for a water system. Make all piping offsets, etc. to meet conditions at building and to make a neat workable system.

9. Provide manual air vent valves at high points for quick venting of fill and where air might be trapped.

10. Pump connections shall be flanged and piping shall be adequately supported so there is no strain on pump casings. Furnish and install a strainer, in each system with 20 mesh stainless steel screens and blow down connections with valves on strainers.

11. Furnish and install an automatic fill valve in cold water fill line to each water system. Connect water from nearest water service. Provide quick-fill bypass around automatic fill valve.

12. Valves and Unions: Furnish and install all valves that are shown on plans or that are necessary to make this system complete. All valves, stop cocks, waste cocks, connections, etc., shall be provided and installed where necessary and required for controlling different parts of the work. VAlves shall be provided on all inlet and outlet connections of all items of apparatus and fixtures, on all branch lines near supply of groups of fixtures, bypasses, etc. Provide valves in main lines and also on supplies to equipment. At fixtures and equipment, provide unions in water lines connected thereto.

    For copper piping, all valves and unions to be as follows: Gate valves 2 inch and smaller shall be Crane No. 1310;

Fairbanks no. 0582; Jenkins No. 1200. Unions shall be Nibco no., 633; ITT Grinnell No. 9133; Chase No. 402. All valves and unions for steel piping to be as follows: Gate valves 2 inches and less shall be Crane No. 440; Jenkins No. 62 and Powell No. 500. Unions shall be 300 pounds non-shock, malleable iron screwed type. "DIELECTRIC" Union shall be used at any connection from ferrous to non-ferrous piping or equipment. Check Valves shall be "swing check" type and manufactured Crane No. 37; Fairbanks No. 0640, Power No. 578 or approved equal.

13. Furnish and install where shown B&G, Thrush, Griswold and Watts circuit setters; provide removable type molded insulation cover over these devices.

14. Hangers, Escutcheons, etc shall be provided and installed with chrome plated brass escutcheons, wherever pipes pass through floors, ceilings and masonry walls exposed in finished areas. Escutcheons not required on fan coil unit, hanger rods, or where piping passes through new wood or masonite panels, at individual rooms. Where piping penetrates new wood panels the Contractor shall maintain proper spacing between the different lines and holes shall be neatly cut to receive insulated lines.

15. Contractor shall furnish and installed thimbles, inserts and other requirements necessary for support of his equipment and piping. Assist and cooperate with other trades in locating and placing these items.

16. Furnish and install Grinnel, Fee and Mason, A.O. Smith, Tyler or equal malleable iron split ring hangers and supports throughout unless otherwise shown on the drawings. Use rods for hangers supports. No strap hangers acceptable.

T-5 GAS PIPING SYSTEM

Gas piping within the building shall be black steel schedule 40 and run exposedin ventilated spaces. Routing shall be run close to and parallel to the wall. Leave enough space for convenient working of fittings. Provide a shut-off valve at each building entry. At each item of appliance of equipment, provide a gas-cock for shut-off and a union between valve and appliance.

The gas piping system shall be installed in strict accordance with NFPA 54, 1980.

T-6 TEST FOR PIPING SYSTEMS

Water piping shall be tested in accordance to standard AWWA test including the chlorination of new portable water supply as per AWWA standard.

Gas system shall be tested as per AGA standard of gas pipe construction.

How water/cold water piping for heating will be tested 150 pounds water pressure for a period of twelve (12) hours and shall not loose more than one (1) pound of pressure over that period of time.

APPENDIX A3

SAMPLE PROJECT COST DATA

MEL,INC. FINANCIAL CODE SYSTEM

Code:

```
____________________
 1 2 3  1  1  1 2 3
____________________

  J     P  L   E
  O     H  E   M
  B     A  V   P
  #     S  E   #
        E  L

  J     V  0
  K     W  1
  L     X  2
        Y  3
        Z  4
           5
           6
           7
           8
           9
```

Discipline:

Proj. Adm.	A
Civil Engr.	C
Mech. Engr.	M
Elec. Engr.	E
Arch.	B
Drafting	D
Clerical	T
Surveying	S
Inspection	I
D/L O/H	H

Reg O/H	7020
Vacation	7030
Sick Leave	7040
Holiday	7050
Time of W/Pay	7060

Employee #'s:

Supervision: (Proj. Adm.)

M. Watson	01
T. Phillips	02
A. Fabre	03
J, Fink	04
R. O'Connell	05
R. White	06
U. Penalosa	07

Civil Engr:

T. Phillips	02
A. Fabre	03
J. Fink	04
R. O'Connell	05
R. White	06
U. Penalosa	07
C. Alexander	19

Clerical:

L. Short	01
C. Williams	02
R. Moton	03

Draftspersons:

M. Lawrence	11
B. Carriere	12
L. Lively	13
J. Tate	14
A. Deconge	18
C. Alexander	19

Mech. Engr:

M. Watson	01
E. Wilson	15
J. Morgan	16
R. Wilson	17
A. Deconge	18

Construction Supv. & Inspect:

J. Peronne	I01
J. Hurst	I02
R. Rutledge	I03
J. Barr	I04
W. Normand	I05
R. Leblanc	I06
J. Tessier	I07
M. Rabalais	I08
S. Anderson	I09
W. Love	I10
M. Eggart	I11
F. Hardin	I12
W. Nealy	I13
J. Garces	I14
K. Powell	I15
J. Lunan	I16
N. Rider	I17
H. Odom	I18
W. Woods	I19
K. Thompson	I20
D. Burley	I21
M. Paradin	I22
G. Linton	I23
	I24
	I25
	I26
	I27
	I28
	I29
	I30
	I31
	I32
	I33
	I34
	I35

SURVEYING:

E. Smith	S01
H. Oliver	S02
D. Travasos	S03
W. Hames	S04
M. Travasos	S05
J. Banks	S06
M. Gauthier	S07
R. Putfork	S08
B. Deck	S09
C. Guidry	S10
S. Sundy	S11
N. Jones	S12
L. Williams	S13
K. Johnson	S14
D. Dauzat	S15
J. Richardson	S16
W. Jones	S17
T. Johnson	S18
S. Hebert	S19
I. Netidire	S20
	S21
	S22
	S23
	S24
	S25
	S26
	S27
	S28
	S29
	S30
	S31
	S32
	S33
	S34
	S35

MEL,INC. PROJECT CODE

PROJECT NAME	PROJECT NUMBER				DESCRIPTION
	Old #	Old G/L#	New G/L#	Computer #	
Install Roof-Build T-3	279	X/6010	5010	J1000CXX	Civil Engr.
	279	X/6030	5040	J1000BXX	Arch. Engr.
	279	X/6020	5020	J1000MXX	Mech. Engr.
	279	X/6013	5100	J1000DXX	Drafting
	279	X/6016	5130	J1000TXX	Typing
Reinforce/Modify Carport Roofs	280	X/6010	5010	J1100CXX	Civil Engr.
	280	X/6020	5020	J1100MXX	Mech. Engr.
	280	X/6013	5100	J1100DXX	Drafting
	280	X/6016	5130	J1100TXX	Typing
A/C Lobby-Fairview & Progress	281	X/6020	5020	J1200MXX	Mech. Engr.
	281	X/6000	5030	J1200EXX	Elec. Engr.
	281	X/6013	5100	J1200DXX	Drafting
	281	X/6016	5130	J1200TXX	Typing
N.O. Streets 9th	282	X/6010	5010	J13V0CXX	Civil Engr. PH.1
	282	X/6015	5110	J13V0SXX	Surveying PH.1
	282	X/6016	5130	J13V0TXX	Typing PH.1
	282	X/6008	5200	J13V0AXX	Proj. Adm. PH.1
	282	X/6013	5100	J13V0DXX	Drafting PH.1
	282	X/6010	5010	J13W0CXX	Civil Engr. PH.2
	282	X/6013	5100	J13W0DXX	Drafting PH.2
	282	X/6016	5130	J13W0TXX	Typing PH.2
	282	X/6008	5200	J13W0AXX	Proj. Adm. PH.2
	282	X/6010	5010	J13X0CXX	Civil Engr. PH.3
	282	X/6013	5100	J13X0DXX	Drafting PH.3
	282	X/6016	5130	J13X0TXX	Typing PH.3
	282	X/6008	5200	J13X0AXX	Proj. Adm. PH.3
Survey Gulf Outport	283	X/6010	5010	J1400CXX	Civil Engr.
	283	X/6015	5100	J1400SXX	Surveying
	283	X/6008	5200	J1400AXX	Proj. Adm.
LCIS New Year	284	X/6008	5200	J1500AXX	Proj. Adm.
	284	X/6020	5020	J1500MXX	Mech. Engr.
	284	X/6013	5100	J1500DXX	Drafting
Balar Assoc. 173/171/LA1	285	X/6008	5200	J16Y0AXX	Proj. Adm. PH.1
	285	X/6010	5010	J16V0CXX	Civil Engr. PH.1
	285	X/6013	5100	J16V0DXX	Drafting PH.1

PROJECT NAME	PROJECT NUMBER				DESCRIPTION
I-49 Extra Work Order #24	286	X/6008	5200	J1700AXX	Proj. Adm.
	286	X/6010	5010	J1700CXX	Civil Engr.
	286	X/6013	5100	J1700DXX	Drafting
I-49 Extra Work Order #25	287	X/6008	5200	J1800AXX	Proj. Adm.
	287	X/6010	5010	J1800CXX	Civil Engr.
	287	X/6013	5100	J1800DXX	Drafting

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                                       MEL, INC.
                                REPORT OF ACTIVITY BY CODE
USING CODE(S):  J11                                     ACCT#          5000  TO       7030
DATE:__06/30/84_______BEGINNING MO/YR:__09/84_______ENDING MO/YR:__09/84__________PAGE________1_______
ACCOUNT#          DATE          JRNL CK#/REF        DESCRIPTION            AMOUNT

    5010          09/30/84      CD       3          CASSIE ALEXANDER       225.00
    5010          09/30/84      CD       3          CASSIE ALEXANDER       162.50
    5010          09/30/84      CD       3          CASSIE ALEXANDER        50.00
    5010          09/30/84      CD       3          CASSIE ALEXANDER        50.00
    5010          09/30/84      CD       5          ROBERT EARL WHITE      330.72
    5010          09/30/84      CD       5          ROBERT EARL WHITE      248.04
    5010          09/30/84      CD       5          ROBERT EARL WHITE      332.16
                                TOTAL THIS ACCOUNT:                           1398.42

    5010          09/30/84      CD    0001          BEVERLY CARRIERE        84.20
    5010          09/30/84      CD    0001          BEVERLY CARRIERE       336.80
    5010          09/30/84      CD    0001          BEVERLY CARRIERE       336.80
                                TOTAL THIS ACCOUNT:                            757.80

    5130          09/30/84      CD       2          LINDA SHORT             13.94
    5130          09/30/84      CD       2          LINDA SHORT             13.94
    5130          09/30/84      CD       2          LINDA SHORT              6.97
                                TOTAL THIS ACCOUNT:                             34.85

    5200          09/30/84      CD       4          ROBERT O'CONNELL        66.00
    5200          09/30/84      CD       4          ROBERT O'CONNELL        66.00
    5200          09/30/84      CD       4          ROBERT O'CONNELL        44.00
    5200          09/30/84      CD       4          ROBERT O'CONNELL        44.00
                                TOTAL THIS ACCOUNT:                            220.00

                                TOTAL ACTIVITY LISTED:                        2411.07
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                                   MEL, INC.
                         REPORT OF ACTIVITY BY CODE
USING CODE(S):  J22                                         ACCT#      5000  TO  7030
DATE:__06/30/84_______BEGINNING MO/YR:_______09/84__________ENDING MO/YR:__09/84_______PAGE____1____
ACCOUNT#            DATE          JRNL CK#/REF       DESCRIPTION              AMOUNT

    5010            09/30/84      CD      3          CASSIE ALEXANDER         112.50
    5010            09/30/84      CD      3          CASSIE ALEXANDER         112.50
    5010            09/30/84      CD      3          CASSIE ALEXANDER         100.00
    5010            09/30/84      CD      5          ROBERT EARL WHITE         82.68
    5010            09/30/84      CD      5          ROBERT EARL WHITE         82.68
    5010            09/30/84      CD      5          ROBERT EARL WHITE        581.28
                                        TOTAL THIS ACCOUNT:                       1071.64

    5100            09/30/84      CD   0001          BEVERLY CARRIERE         101.04
    5100            09/30/84      CD   0001          BEVERLY CARRIERE         151.56
                                        TOTAL THIS ACCOUNT                         252.60

    5130            09/30/84      CD      2          LINDA SHORT               13.94
                                      TOTAL THIS ACCOUNT:                           13.94
    5200            09/30/84      CD      4          ROBERT O'CONNELL          66.00
    5200            09/30/84      CD      4          ROBERT O'CONNELL          66.00
    5200            09/30/84      CD      4          ROBERT O'CONNELL          44.00
    5200            09/30/84      CD      4          ROBERT O'CONNELL          44.00
                                        TOTAL THIS ACCOUNT:                        220.00

                                      TOTAL ACTIVITY LISTED:                      1558.18
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                                         MEL, INC.
                                  REPORT OF ACTIVITY BY CODE
USING CODE (S):  J11     AND:  T01                   ACCT#     5000   TO  7030
DATE: 06/30/84_____BEGINNING MO/YR:  09/84  ENDING-MO/YR: - 09/84      PAGE_____1_______

ACCOUNT#            DATE          JRNL  CK#/REF        DESCRIPTION           AMOUNT
     5130            09/30/84       CD     2           LINDA SHORT           13.94
     5130            09/30/84       CD     2           LINDA SHORT           13.94
     5130            09/30/84       CD     2           LINDA SHORT            6.97
                                             TOTAL THIS ACCOUNT:                    34.85
                                          TOTAL ACTIVITY LISTED:                    34.85
```

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                                         MEL, INC.
                                  REPORT OF ACTIVITY BY CODE
USING CODE (S):  J22     AND:  A05      ACCT#     5000    TO      7020
DATE 06/30/84______BEGINNING_MO/YR:_09/84_____ENDING MO/YR:_09/84_____PAGE_____1____

ACCOUNT#            DATE          JRNL  CK#/REF        DESCRIPTION           AMOUNT
     5200            09/30/84      CD      4           ROBERT O'CONNELL      66.00
     5200            09/30/84      CD      4           ROBERT O'CONNELL      66.00
     5200            09/30/84      CD      4           ROBERT O'CONNELL      44.00
     5200            09/30/84      CD      4           ROBERT O'CONNELL      44.00
                                                       TOTAL THIS ACCOUNT:          220.00
                                          TOTAL ACTIVITY LISTED:                    220.00
```

TIME SHEET – SEMI-MONTHLY

MEL INC.

EMPLOYEE NAME. ____________

EMPLOYEE SIGNATURE ____________ SSN ____ – – ____

EMPLOYEE NO. ____________

PAYROLL ENDING ____________

CODE PROJECT NO.			PHASE	LEVEL	EMP. NO.		
TOTALS							

REG. HRS.	O/T HRS.	HOLI WKD. 1.8	SHT DIFF 1.1	NEW GENERAL LEDGER NO.	PROJECT NAME	OLD PROJECT NO.	OLD GENERAL LEDGER NO.
				7030	VACATION		6211
				7040	SICK PAY		6212
				7050	HOLIDAY PAY (NO WORK)		6213
				7060	TIME OFF WITH PAY		6214
				7020	O/H		6230

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		TOTAL
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	

FIELD	PAYOFF
REG. PAY	
O.T. PAY	
FED. WH.	
FICA	
ST. WH.	
HOSP. INS.	
LIFE INS.	
CONTRIB.	
TRAVEL ADV.	
GROSS PAY	
DEDUCTIONS	
NET PAY	
CHECK NO.	

REMARKS: ____________

____

____

APPROVED BY: ____________

APPENDIX A4

SAMPLE MANAGEMENT COMMITTEE DOCUMENTS

MEMORANDUM

TO: Morgan Watson
Thomas Phillips
Mitchell Albert
Albert Rowe
Bronwyn Thomas
C. C. Chen

FROM: Press L. Robinson

DATE: January 10, 1985

RE: Management Committee Meeting

The Management Committee Meeting will be held on Tuesday, January 29th at 10:00 a.m. Please be prepared to make reports (inclusive of Action Plan) on your respective division/department. Written reports are to be turned in to me by close of business on Wednesday, January 23rd, and to members of the management committee by close of business on January 25th. A report format is attached.

PLR/clh

MEL-3

AGENDA

MANAGEMENT COMMITTEE MEETING

January 29, 1985

I. Call to Order

II. Minutes of November 27, 1984

III. Old Business

IV. Division Reports

A.	Finance	Rowe
B.	Operations	Phillips
C.	Marketing	Watson
D.	Corporate Affairs/Planning and Technical Assistance	Albert
E.	Office Services	Thomas
F.	Computer Services	Chen

V. Other Business

PLR/clh

MEL-3

MANAGEMENT COMMITTEE MEETING REPORT

January 29, 1985

MEL Current IBM-PC Up-Grade

A) Use Current IBM-PC		
1) Add one Color/Graphic Adaptor	$250 or $400	For CoGo Screen Plotting and Hard Copy
2) Up Grade CoGo New Version	95	More Capacity and fast to existing CoGo programs
	$345 - $495	
B) Add IBM-PC		
1) New IBM - PC .Color Monitor .Graphic Capacity .256K^{+} .2 disk drives	$2600 (On Sale)	.Engineering Dept. have their Own Computer .Current Computer can be used between Financial and Engineering
2) Epson FX-80 Printer	$595	
3) Civil Soft Project	$225	Project Schedule & Costs
4) Other Software	Open	

(C) I-Omega (See Financial - Al Rowe)

TO: Press L. Robinson

FROM: Finance Division AR

DATE: 1/25/85

RE: Report for Management Meeting 1/25/85

A. Computer Status

B. Personnel Changes

C. Workload

D. Cash Flow

E. Budget

F. Problems for Discussion by Team

A. Through research and outside assistance C. Chen has concluded that we do not need an outside Job Costing Progeam but our Champion Software can provide the same output. I set up 3 demo projects and time sheets to go along with projects and we preceded to run job costing program. After discussion with T. Phillips and Press we have agreed that this will be adequate. We have ordered the A/P and A/R Modules and are now assigning new project numbers and revising time sheets to accompany, however the purchase of the I Omega is inevitable. Total costs are $4,500.

$3,500	I Omega
500	A/P
500	A/R

B. We are all aware that H. Turner is no longer in my Department and V. Ani is responsible for some of his duties and other have been shifted to Accounting. A job description for her will be available at next meeting.

C. Workload in the Finance Division does not change because of a staff reduction for several months and by that time we will probable have new projects and additional direct labor staff. In addition to that V. Ani has been assigned to a temporary survey crew and is practically unavailable in this Division. W-2 statements and payroll were released on schedule due to the fact that S. Wilson and myself have taken work home to assure that things proceed as normal. We are also preparing special reports for SBA which are to be ready for Monday January 28, 1985.

Vita

Name:	Chu-Chen (C.C.) Chen, P.E.
Address:	7925 Meadow Ave. Baton Rouge, LA 70811 Home (504)775-0988 Office (504) 927-7240
Citizenship:	Born in China in 1937; now a permanent U.S. citizen
Education: 1982-Present	Doctor of Engineering degree program. Texas A&M University, College Station, Texas.
May 1967	M.S. Department of Mechanical and Aerospace Engineering. North Carolina State University, North Carolina.
June 1960	B.S. Department of Mechanical Engineering. National Taiwan University.
Professional Registrations:	Registered Professional Engineer in State of Texas Certificate Number 56663
Experience:	
1964-Present	Associate Professor, Department of Mechanical Engineering, Southern University, Baton Rouge, Louisiana.
1973-1982	Senior Project Engineer (part time), MEL Consultant Firm, Baton Rouge, Louisiana.
Summer 1971-1976	Westinghouse Hanford Research Laboratory, Xerox Corp., Westinghouse.
Honors, Achievements and Professional Affiliations:	American Society of Mechanical Engieners American Society of Heating, Refrigerating, and Air Conditioning Engineers American Society for Engineering Education Pi Tau Sigma Honorary Fraternity Outstanding Teacher Award for the College of Engineering/Southern University, Baton Rouge, LA 1972-74 Outstanding and Dedicated Service to Pi Tau Sigma 1972-76 Getty Grant in Aid recipient at Texas A&M University 1983

The typist for this report was Mrs. Linda Short.