A REPORT ON A
SABBATICAL LEAVE
SPRING-1974

Presented to the
Faculty, the Administration, and the
Board of Trustees of
Mt. San Antonio College

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STATEMENT

The drafting students at Mt. San Antonio College do not train for any one certain job in any one type of industry. Drafting covers a large area and there is no way to prepare a student for a particular type of drafting job. Industry needs change from day to day and a student has to be prepared to fit in wherever he may be needed. I have always thought that it would be better to teach students the basic fundamentals of drafting and at the same time familiarize them with the basic reference materials from various types of industries. I have visited many idustries in Southern California and have held summer employment at many of them throughout my tenure at Mt. San Antonio College. I believe that this trip has helped me realize that the needs of industry for hiring beginning draftsmen is basically the same all over the country. Many of the people working for the companies which I have visited mentioned attitude and I think that this is an important aspect for my students to understand. Most of the people hiring draftsmen for the industries which I visited required that the people being hired have a good solid base in fundamentals. I think that this is important, that I strive to continue to give my student a good solid base in fundamentals. I received a lot of information on cheaper and easier ways to build tools for manufacturing purposes; I received much information on the latest drafting standards; and I received much information on the latest drafting equipment being used. All of this information

that I can impart to my students, I feel will help them to strengthen themselves in the fundamentals of drafting and design.

On our trip, we visited many historical sites, saw many interesting places, and met many interesting people. We had a short course in United States history, geography, and government. We were even introduced on the Floor of the Colorado House of representatives. I believe that this experience made me a better citizen which will help me in my relationships with students, fellow faculty members, the College, and the community. I will always be grateful to the Board of Trustees for allowing me to take this trip.

COMPANIES VISITED

Honeywell Inc., Marine Systems Division, West Covina, California

I met with Mr. Donald Felberg, dosign supervisor, a good friend and a member of the Mt. San Antonio College Drafting Advisory Committee. We discussed automated drafting. Although Honeywell in West Covina did not have any automated drafting at that time, Mr. Felberg had done an extensive study in that field and gave me the names of several people to contact to see automated drafting at work. Mr. Felberg thought that in many areas automated drafting could cut costs of electronic artwork generation. He also felt that a programming knowledge would be desirable for anyone doing digitizing work.

I then met with Mr. W. A. Stone, engineering supervisor in charge of standards, and discussed the problem of metrification. He said personnel at Honeywell were working on a ten year plan toward metrification and gave me several insights into the problem of metrification. He also gave me the names of several individuals who could give me additional information on standards and metrification.

Mr. Don Evans then discussed the various drafting levels at Honeywell. The starting level was junior detail drafter which required no experience. A student graduating from high school, junior college, or a trade school would start in that position with pay according to his ability. The next positions were detailer,

layout draftsman, design draftsman, and senior designer. The senior designer would be someone with 10 to 15 years of experience. The personnel at Honeywell are encouraged to continue their education with job related classes. If they have prior approval and obtain a passing grade, their expenses are reimbursed.

Jet Propulsion Laboratory, Pasadena, California

Mr. Herbert H. Gernandt, member of the technical staff, a long time friend and also a member of Mt. San Antonio College Drafting Advisory Committee, gave me a tour of the facilities. We then discussed minimum requirements for applicants from junior colleges. Mr. Gernandt thought it desirable for students to be prepared for third-year college admittance. Students should have algebra, plane geometry and trigonometry. Technical math could be substituted for those subjects. Applicants should also have 8 units of mechanical drawing, 2 units of descriptive geometry, 4 units of electronic drafting, 2 units of illustration drawing, 3 units of properties of materials, 4 units of engineering physics, 3 units of engineering measurements, and 3 units of introduction to electronics. Mr. Gernandt also thought it desirable for applicants to have surveying, sheetmetal fabrication lab and machine fabrication lab. Mr. Gernandt stated that a desirable skill was thinking and that they did not want just drafting machine operators.

The beginning job level is draftsman B. The next levels for hourly employees are draftsman A, senior draftsman, engineering draftsman, design draftsman, and designer. There are then 12 levels

of salaried employees.

I talked with Mr. Jim Hicks in the Design Section who is in charge of the automated drafting. He said that a person running the automated drafting equipment should have a good background in drafting. He also thought a basic course in programming computers would be helpful. There was no production work being done with the automatic drafting equipment. They were working on special jobs that would be beyond the scope of draftsmen. They were, however, doing some electronic schematic drawings. They were using a Cal-Comp drm plotter.

Fluor Corporation, Los Angeles, California

Mr. Frank Harvie, general manager, design engineering, discussed the possibilities that are presently available at the Fluor Corporation for junior college graduates. Personnel were being hired in the fields of process piping, electrical, pressure vessels, and structural. Each person hired in is sent through a one to twelve month training program and is started as a designer C. During that period, the trainee is introduced to the type of work done in one of the previously mentioned sections as related to the methods used at Fluor. A designer C is promoted to designer B solely on his demonstrated ability. Further salary increases are based solely on merit. The other job levels are designer A, senior designer and design supervisor. There were approximately 1000 designers at Fluor.

Douglas Aircraft Co., McDonnell-Douglas Corp., Long Beach, Calif.

I made a visit to the X-Shop where two proto-types of the YC-15, Douglas' entry into the USAF's Advanced Medium STOL Transport competition, were being manufactured. I was escorted by Mr. John Stansbury, tooling manager and a long time friend. Mr. Stansbury gave me an insight into the cost saving methods of engineering and manufacturing a new aircraft. We also discussed the job requirements for a tool designer B, a tool designer A, a tool engineer, and a senior tool engineer. I was given a rundown on all of the qualities that a person would have to possess in order to qualify for any of these positions.

Honeywell Inc., Information Systems Division, Phoenix, Arizona

I met here with a committee of drafting supervisors, Mr. Dick Gullette, Mr. Bob Baule, and Mr. Dick Bliss. They said that a two-year college graduate should know more than how to make three views. They also thought that he should have a good background in design principles and know how a part is going to be manufactured. The supervisors said that a junior college graduate should have a good knowledge of engineering design principles as well as a knowledge of strength of materials. They felt that machine shop was closely related to drafting and that the knowledge gained in the shop would help the draftsman better understand how parts could be manufactured. A beginning draftsman should not have the idea that he was hired to draw pictures but should have some initiative in researching a design. If a draftsman doesn't know how

a part could be made, he should go out into the shop and find out.

Circuit boards were being designed by automation with the use of computers, cathode ray tubes, plotters, and digitizers. The supervisors felt that draftsmen would have a need for learning computer programming for computer graphics or automated drafting. They were using the Applicon system of automated drafting at that plant. It was felt, however, that a complete program of interactive graphics was 10 years away and that it wouldn't be feasible for a small company to have such a system.

It was the general consensus that drafting was a well paying profession and that there was a definite need for a well trained draftsman who was capable of becoming a designer and not remaining a detailer. Draftsmen were being forced to think like engineers as they became more involved in their work.

Fluor Corporation, Houston, Texas

I was met by Mr. Charlie Hamlin, general manager, design engineering and introduced to Mr. Norman Davis who conducted me on a tour of the facility. Fluor has to compete with several other companies in the area for draftsmen and designers. They required two years of junior college but hired high school graduates if they had trigonometry and could pass the entrance test. Fluor has a cooperative training program with several other companies in the area. They train personnel in process piping, electrical, pressure vessels, and structural. Each company sends personnel to be trained and the training can be accomplished with one instructor instead of each company trying to do their own training. Fluor started a

junior college graduate at a higher pay level than a person with no experience. The job levels are the same as those at Fluor in Los Angeles.

Texas Instruments, Houston Texas

This was the Systems Division where computer terminals, computer equipment, and seismic equipment were manufactured. Mr. Al Lee gave me a tour of the plant so that I could see how all of the components that were manufactured there were assembled. There was a small drafting department and a draftsman hired there needed very little electronic background. The draftsmen work with the engineers in product development. Mr. Lee felt that drafting was not responsive to engineering needs and that drafting was the biggest expense in product development.

General Electric, Houston, Texas

I was first introduced to Mr. E. L. Berger and we talked about automated drafting equipment and computer-aided design. They were using an Applicon system, a Computervision system, and a CalComp plotter. They could create a drawing on the machine, intruct the machine as to what kind of stock was needed, and program a numerically controlled machine to do the work. Wire wrap was also done by computer-aided design with drafting personnel performing a part by providing a running list, a drawing list, and a list of interconnections. Mr. Berger stated that a designer trained from one to two weeks to learn to instruct the machine and to learn the ground rules associated with good design.

I was next introduced to Mr. Don Knapp, drafting supervisor, and Mr. Ted Kochan who gave me a little background on the qualities a person should possess and the trianing a person should receive in college before they came to work there. They felt that a person hiring in there as a draftsman should have algebra, trigonometry, electronic drafting, and machine shop. They also said that they believed lettering was not important but that line work was.

When I was in Houston, there were approximately 300 drafting positions open in that area. Mr. Kochan further stated that a girl looking for a drafting position could expect 20 to 30 job offers. At General Electric, a junior college graduate could hire in as a draftsman B. At that level he was expected to prepare various types of complex drawings and other documents using general information as a basis. He would also have to prepare alteration notices and update drawings using general change data. He would be expected to operate the Auto-Trol digitizer and Applicon Design Assistant to produce final drawings.

Lyndon B. Johnson Space Center, Houston, Texas

The center's responsibilities include: design, development, and testing of the spacecraft and associated systems for manned flight; selection and training of astronauts; planning and conducting the manned space missions; and extensive participation in the medical, engineering and scientific experiments to help understand and improve the environment.

The center was open to the public from 9:00 a.m. to 4:00 p.m.

for self guided tours. There was no admission charge and no reservations were necessary. The center also conducts guided tours through facilities not included on the walking tour. Advance reservations must be made for that tour.

There were many space exhibits on display which were extremely interesting. There are also many movies explaining the space program in detail. In order to take advantage of all of these things, one must arrive early and stay late. Mission Control Center was a very interesting building to see. On the guided tour, the use of that building and its facilities are explained in detail. Among other facilities were the Vibration and Acoustic Test Facility, the Lunar Receiving Laboratory, the Space Environment and Simulation Laboratory, the mission simulation and Training Facility, the Life Systems Laboratory, and the Flight Acceleration Facility.

Naval Aviation Museum, Pensacola, Florida

The museum was established to collect, preserve, and display many items pertinent to the history of Naval Aviation. There were many types of aircraft on display and there was a large collection of hand-made scale model U. S. Naval Aircraft. Also on display was the Aurora 7 Spacecraft which carried Scott Carpenter into Earth orbit in 1962. The Curtiss A-1 which was purchased in 1911 and is the Navy's first aircraft is also on diplay. The museum was quite interesting and well worth the trip.

Honeywell Inc., Aerospace Division, St. Petersburg, Florida

I was taken on a tour of the facilities by Mr. Stan Solsten and then we talked about the qualities which might be expected from a beginning draftsman who had just graduated from a junior college. A beginning draftsman should be capable of good lettering, understand orthographic projection, and know how things go together. He should be able to do electronic drafting and it would be helpful to know electronic components and to have had some experience in electronic technology. Machine shop experience in school would also be another attribute for a draftsman to possess. Mr. Solsten stated that the electronic field was moving rapidly into automated drafting. He said that electronic circuits were getting so complex that they were difficult to draw by hand. The plant had a Computervision system for automated drafting and design. In order to operate that equipment, Mr. Solsten felt that it would be benificial to know computer programming and to know something about the operation of computers. We also discussed the metric system. It was felt that it would be beneficial to think in the metric system and not use conversions. Mr. Solsten didn't think it would be a serious problem to convert to the metric system.

I met with Mr. Owen Johnson, a drafting supervisor, and he thought it important to teach geometric tolerancing. He also thought that students should learn how to make assembly drawings, know something about castings, and have a knowledge of sheet metal. He said all of the drawings were microfilmed so that it was essential to make dark, clear, and neat drawings.

John F. Kennedy Space Center, Cape Canaveral, Florida

The John F. Kennedy Space Center is the major NASA launch organization for manned and unmanned space missions. We took an escorted two-hour bus tour through the 88,000 acre complex. The tours stop at Complex 39, the moon launch pad and the 525 foot high Vehicle Assembly building. The tours also stop at the Air Force Space Museum, the Flight Crew Training building, and the Mission Control building used on early manned flights.

The large Vehicle Assembly building at Complex 39 has the capacity to accomodate four 364 ft. long Saturn V vehicles at one time. The Saturn V is assembled on a 446 ft. high Mobile Launcher in a vertical position. The Launcher and the assembled vehicle are then moved to the launch site on a Crawler-Transporter. That vehicle was 131 ft. long and 114 ft. wide. It weighed six million pounds and moved on four double tracked crawlers at a speed of one mile per hour.

Attracting as much attention as all of the space hardware were alligators which could be seen sunning themselves occassionally. The Space Center is also a preserve and the wildlife is protected there.

General Electric, Daytona Beach, Florida

I met with Mr. Jim King and he showed me the automatic drafting equipment being used at the Daytona Beach facility. There was a Xynetics 1100 plotter controlled by cards and magnetic tape. That machine could move at the rate of 20 inches per second. There was also a Computervision Photo Plotter which was being used to make

printed circuit boards. There was a Calma system which was used for digitizing, design, and making terrain maps. An Applicon system was used for design, editing, building components for printed circuit boards, and for making tapes for numerically controlled machines for drilling and punching holes. The information for that system was stored on cassette tapes. Mr. King said that he believed that a person going into that field should have an electrical background, a background in drafting, and a knowledge of programming.

I then met with Mr. Joseph Grande and we discussed criterea for draftsmen and drafting personnel. A high school graduate could qualify for the position of trainee if he had taken physics, math, and one year of drafting. The training program was a two year program and the trainee does some simple drawings in order to get acquainted with company procedures and to learn the terminology. After the position of trainee, there are four grades of detailers. It generally took eight to ten years to progress through those four grades. A junior college graduate would usually qualify for the bottom grade of detailer. There were then four classifications of designer with senior designer being at the top of the classification. Mr. Grande stated that electronics would help a draftsmen and that it would be a strong point in hiring someone at that plant. They did use the metric system on some of their drawings as they had some foreign contracts which required its use.

Alabama Space and Rocket Center, Huntsville, Alabama

The Alabama Space and Rocket Center was the largest

space exhibit in the world. It was very impressive and the most interesting one we visited. There was an exhibit building which contained numerous exhibits of actual space hardware and equipment. There were also many participation devices which help one to better understand space and space exploration. Outside of the exhibit building was Rocket Park where many types of rockets and space vehicles were on display. There were the early V-1 and V-2 German rockets and there were the most impressive three stages of the Saturn V rocket laying on its side.

Lockheed-Georgia Company, Marietta, Georgia

I was met by Mr. Ed Garner of the Public Relations staff and he escorted me to the Tool Design department and introduced me to Mr. Leo Parker who was an assembly tool engineer. Mr. Parker was working to reduce their tool design manual from a bulky manual to a useful pocket reference. He was removing information that could be found in other reference handbooks. The new pocket reference would contain drafting procedures, a check list for checking any design, and safety requirements. The Lockheed Tool Design department was working on a ten-year plan for metrification. Mr. Parker stated that their manuals would reflect the duel system in five years with the transfer to a complete metric system taking place in ten years. There were various levels of draftsmen and designers in the Tool Design department. Those levels included trainees, technicians, tool designers, junior tool engineers, senior tool engineers, and senior mechanical engineers. The senior mechanical engineer is also responsible for handling

fixture design.

Mr. Parker introduced me to Mr. Webb Tatum, tool design manager, and Mr. R. B. Swink, assembly tool engineer. They stressed the idea that a student should spend more time on the board. They felt that a student coming there for a job should have drafting, trigonometry, strength of materials, safety requirements, metrics, shop experience in machine tools, manufacturing processes and techniques. At Lockheed, they now use a drawing as a template instead of using dimensions and they only use the critical dimensions. They also use short-cut drafting procedures but try to avoid too many short-cuts which might create confusion. Presentability of the drawing was important.

I then met with Mr. Bob Collier in Engineering and he explained the CADAM, Computer Augmented Design and Manufacturing, program. Designs were stored on discs, tooling personnel could call up any drawing for numerical control use, structural analysis, and flat pattern development. A gerber plotter was used for loft graphics. The surfaces of an aircraft were mathematically defined and loft lines generated and used for undimensioned drawings as well as flat patterns.

Lockheed was studying the problem of converting to metrics and was evaluating an interim plan. The first problem was to identify every area which would be affected in the company. Those areas were documentation, computer programming, equipment, machine tools, tooling (this was discussed earlier in the Tool Design department), purchased items, office equipment, facilities, and the

Relations department personnel who were responsible for training and manuals. Mr. Collier stressed that he thought what was needed in drafting was creativity and a broad knowledge to think up new designs.

National Oceanic and Atmospheric Administration, Norfolk, Virginia

I first became aware of the National Oceanic and Atmospheric Administration at a Rotary Club make-up on the Florida Keys where Lt. Etheridge of NOAA explained how he was charting the mean high tide on the Florida Keys. He suggested that I go to Norfolk, Virginia and also to the main headquarters at Rockville, Maryland.

Mr. Beuguet, Mr. Serena, and Mr. Vanasek at the Norfolk office showed me how the shoreline was mapped for a reimbursable program to determine federal and state boundaries. I was also shown nautical charting, coastal mapping, storm evacuation maps, maps for housing and urban development flood control programs, and airport obstruction charts.

Union Carbide, St. Albans, Vermont

This was another plant that I chanced upon after making-up at the St. Albans Rotary Club. I sat next to a gentleman who suggested that I visit Mr. Jim Alspaugh of Union Carbide.

Mr. Alspaugh, the plant manager, explained that all of the drafting supervisors were busy so he sat down and discussed the drafting program with me. There were three levels of draftsmen in the company. They were detailer, draftsman, and designer. A junior college graduate would generally start at a higher rate of pay than

someone without that training. They have done very little with the use of the metric system. They did use dual dimensioning as some of their equipment came from overseas in metric.

National Air Museum, Smithsonian Institute, Washington, D. C.

The National Air Museum preserves and exhibits historic aircraft, engines, space vehicles, and other items of interest. The Command Module of the Apollo 11 spacecraft which carried the first men to land on the moon was on display there. The "Spirit of St. Louis" was hanging from the ceiling and one could almost see Charles Lindbergh sitting inside flying across the Atlantic Ocean. Also on display was the Douglas "World Cruiser" which was the first airplane to fly around the world. Hanging in the front of the hall, in a conspicuous place, was the Wright Brothers' first airplane which first flew at Kitty Hawk, North Carolina.

Computervision, Bedford, Massachusetts

I met Mr. Keith Mountain, training manager, and we discussed draftsmen and the use of the Computervision drafting equipment. He felt that draftsmen would be an important link in automation. He didn't feel that a course in computer programming was necessary in order to operate their equipment. Mr. Mountain stated that automated drafting would augment the draftsmen's skill and make them more productive. Computervision had a small drafting room with five draftsmen and seven engineers.

North American Phillips, Cheshire, Connecticut

I was met by Mr. John Moody, my brother-in-law, and taken on a tour of the plant. I saw many intricate parts for precision timing devices being manufactured by automated tooling equipment. The plant offices were quartered in one large room with sales in one section, engineering in another section, and accounting in still another section. There were no walls and one could see any part of the room from any other part of the room.

I then sat down with Mr. Bill Mazza in charge of engineering and talked about drafting and design. Each designer does his whole job himself. There were no draftsmen to do the drafting for the designer. Mr. Mazza felt one of the important things in hiring a designer was his background and how long he was on his previous job. He must know how parts are manufactured and learn what is acceptable to the company's way of doing things. Most of the work at North American Phillips was mechanical but each designer had to know something about electronics. There was no formal checking at that plant. Each designer must check another designer's work. They used Mil Std 100 and Mil-D-1000 and also refer to ANSI drawing standards. The designers, besides designing production parts, design their own tooling such as molds, hobbing fixtures, and other types of tooling fixtures.

Lux Time Division, Robertshaw Controls, Cheshire, Connecticut

Mr. Carl J. Goodhouse met Mr. Moody and myself and took us on a tour of the plant. We saw many types of automated tooling equipment punching out parts, drilling holes, and assembling parts for controls. We then went back to Mr. Goodhouse's office and talked about drafting. Mr. Goodhouse said that the minimum requirement for a draftsman there would be a high school education with some drafting. They would prefer, however, a graduate from a two-year trade school or junior college. They had an apprenticeship training program in existence. A person would begin training on the job and the company would send him to a local trade school until he completed 6,240 hours of school and work combined. A new-hire should know the fundamentals of good drafting procedures and should be familiar with tolerancing procedures. The draftsman prepares all of the working drawings for any item that is designed there. The beginning level was layout draftsman. He worked under the supervision of an engineer and did all of the layout work for the development of a part. The next level was design engineer B, who does all of the design work but requires some supervision to make sure the product is completed properly. Then there was a design engineer A who worked completey on his own with very little guidance or supervision. There was no formal metric program and there was no automated drafting. There were tool designers in another department who design the automated equipment which builds many of the products.

National Oceanic and Atmospheric Administration, Rockville, Maryland

Mr. Heywood took me on a tour of the plant where I saw how maps and charts were made for the National Ocean Survey. I learned how they plotted the coastline on maps as well as the mean high water line and the mean low water line. I also saw how storm evacuation maps, tidal current charts, airport obstruction charts, and bathymetric charts were made.

Zenith Radio Corporation, Chicago, Illinois

I met with Mr. M. E. Sanders, chief mechanical engineer, and Mr. M. A. Fanizza, mechanical engineering staff assistant. They both thought that drafting was a stepping stone to a professional engineering career. Draftsmen at Zenith were given minimal exposure to organization to learn the chain of command. They felt that organizational exposure was helpful. They also said that mechanical is the hub of the industry. At Zenith, usually the math was completed for the designer and usually the wall thickness of the material to be used was also selected. The difference between the project engineer and the designer was exposure and knowing how to solve complex problems. The designer did not have to know electronic drafting for printed circuit layout. The purpose of the layout was to put down lines on paper and erase them as a method of solving problems. The designer must then be prepared to make every drawing from that layout. There was no automated drafting but drawings had been made for the Taiwan plant using the metric system with dual dimensions. Zenith used a decimal point in the metric system instead of the comma

and carried the decimal out to two places. They had a need to make a drawing to describe a part and write specifications for the part for documentation purposes. A combination of drafting and photography was used to make their service manuals. Drawings were made to Zenith standards on mylar using graphite pencils. The drawings were then microfilmed.

Sycor Inc., Ann Arbor, Michigan

I met Mr. John Shirk and he introduced me to Mr. Phil Girard who was in charge of the drafting and design department. They made a lot of printed circuit boards there so their designers needed to have a knowledge of electronics as well as mechanical design. A graduate of a junior college would start work as a detailer. The basic requirements were good lettering, good line work, a knowledge of electronic and mechanical design as stated above. Machine shop experience would give a person a tremendous advantage in knowing how the manufacturing process works and knowing how parts are made and assembled. After a detailer shows design capabilities, he would be promoted to designer. There were no formal classifications and there was no regimentation. Pay was earned according to ability. There was no automated drafting as it was felt that it was too expensive for their purposes. If anything came to the design room in metrics it was converted. No drawings were made in the metric system. Red and blue transparent tape was used for printed circuit artwork. Both sides of the circuit board were taped on the same side of the layout. They filtered out one of the colors for photographing

one side of the board and filtered out the other color for photographing the opposite side of the circuit board.

Honeywell, Government and Aeronautical Products Division, Minneapolis, Minnesota

I met here with Mr. Bob Sanford and discussed drafting and design. The basic requirements for a draftsman were graduation from a two-year vocational-technical school. The draftsmen in that area received a concentrated course of 14 - 18 months duration in a mechanical and electronic background. A detailer grade four would make simple production detail drawings. A layout draftsman grade five would make difficult production detail drawings and simple layout drawings. A layout draftsman grade six would make complex production detail drawings, difficult layout drawings and simple design drawings. A design draftsman grade seven would make complex layout drawings, and difficult design drawings. A designer grade eight would make complex design drawings. There were three systems of automated drafting. There was nothing being done in the metric system.

Honeywell, Residential Division, Minneapolis, Minnesota

I visited with Mr. Lowell Foster, director, corporate standardization services, and we discussed parts standardization problems. We also discussed geometric tolerancing problems and he described the problems of metric conversion. Mr. Foster gave me a lot of material on geometric tolerances, geometric tolerances in the metric system and he gave me a copy of the latest ANSI Y14.5 standard

on dimensioning and tolerancing.

Mr. Foster then took me down to the drafting room and introduced me to Mr. Stu Aaker. Mr. Aaker stated that a person who came to work there should have a background in math, physics, engineering mechanics, and descriptive geometry. Electronic drafting wasn't necessary, however. A graduate from an area vocational school would qualify for a job there. The artwork for the printed circuit boards made there were hand taped. There was no automated drafting equipment.

Stearns-Roger, Denver, Colorado

I met with Mr. Ken Shirley who gave me a tour of his area. He stated that piping designers were difficult to find in Denver. There was a piping course in a local technical school, however. Mr. Shirley said that he thought many drawing classes in schools were using obsolete material with no practical value. He felt that the attitude of kids coming out of school was important. They hire students for summer employment and then try to hire them back when they are out of school. New employees needed to know piping, have a math background, particularly trigonometry, know stress, and know flow of fluids. They needed good drafting ability as sloppy work was not condoned. The levels of employment were trainee, draftsman #1 through #4, piping designer #1 through #4, and supervisor. Beginners start at the trainee level in the flow sheet group. There, they work on flow diagrams and do some work on piping arrangement drawings. It usually took six months to a year for anyone to advance out of the

flow sheet group. Promotions were made according to individual capabilities. There was no automated drafting equipment being used. A plotter was used at one time to make piping isometric drawings. There was nothing being done with the metric system but there were plans to use it some day. Structural detailers made steel arrangement drawings and design foundations. The company encouraged its employees to go to school by paying a certain percentage of the cost. There were not many piping models used but they would be used if a customer wanted them.

Martin-Marietta, Denver, Colorado

I met with Mr. Warner in the electrical engineering group. They were making site electrical installations. They were designing for heavy power and using electronic controls. Mr. Warner stated that beginners should be exposed to the electrical code. He also felt that the attitude of a new person being hired was important. He said many applicants rejected the idea of having to start at the beginning. Mr. Warner said that a good mechanical designer could learn electrical but a beginner would be helped if he understood a simple electrical distribution system and know how to represent a simple system. The drafting had to be legible so that it could still be read after the drawings were microfilmed. The levels of employment were draftsman A and B, designer A, designer B, and designer C, associate engineer, engineer, senior engineer, and group engineer. The group used an IBM computer to plot the shortest electrical paths. In a program with NASA they did use the metric system. Dual dimensioning was used only

for mating parts. The company hired co-op students who worked in the summer. Those students came from all parts of the country.

SUMMARY

On my Sabbatical leave, I was accompanied by my wife, LaVergne, my daughter, Diane who was 16, my son, David who was 14, and two very active Wire-Haired Fox Terriers. Our mode of travel was an 18 foot mini-motorhome manufactured by Lazy Daze in Pomona, California.

In December of 1973, we took delivery on the motorhome just as the fuel crisis was getting worse. Quite often we debated whether to buy or whether to forfeit our down payment. As the days passed, the situation seemed to get worse. We finally decided we would take the trip as planned and go as far as we could.

It should be noted that we left on our trip on March 5, 1974 which was the peak of the fuel crisis in California. We were going to leave on the 4th of March but our license plate was odd so we had to wait to buy gas on March 5th. During our whole trip, we were never able to fully relax as we always had to wonder when, how, and where we were going to get enough gas to get to our next destination.

We passed through 34 States and traveled a total of 14,000 miles. In ten of the States we visited, we had a guided tour through the State Capital. In eight of the States, we toured the State Capital on our own and in four States, we just saw the State Capital from the outside. We also toured the Nations Capital in Washington D. C.

We visited three of the four battleships which have been restored and turned into historical sites by the States for which they were named. We browsed through two Presidential Libraries and toured through the homes of four former Presidents. We also got to take a

tour of the White House which was arranged by Congressman Wiggins. Some other sights we enjoyed seeing were the John Ringling home, Thomas Edison's Florida home, Jefferson Davis' home, Maria Von Trapp's Family Lodge in Vermont. Some other places we visited were the Carlsbad Caverns, the Statue of Liberty, Mt. Rushmore, the Badlands, the Petrified Forest, the Painted Desert and Gettysburg.

I would like to extend my thanks to all of the men from Industry whose companies I visited. Each of them gave me much of their valuable time even when they were quite busy. I was not able to warn all of them that I was coming but they all welcomed me and showed me every courtesy. From them I received much information which will be useful both to me and to my students.

I would further like to thank Mr. John Moody, my brother-in law, who arranged for many of my visits in the East, Mr. Kenneth Young from General Electric, and Mr. Donald Felberg from Honeywell who made many other contacts possible.

APPENDIX

COMPANIES VISITED
DURING SABBATICAL LEAVE
SPRING 1974

1. Honeywell Inc. Marine Systems Division,
   West Covina, California (2-13-74)

2. Jet Propulsion Laboratory, Pasadena, California (2-14-74)

3. Douglas Aircraft Co., McDonnell-Douglas Corp.,
   Long Beach, California (2-27-74)

4. Fluor Corporation, Los Angeles, California (2-28-74)

5. Honeywell Inc., Information Systems Division,
   Phoenix, Arizona (3-6-74)

6. Texas Instruments, Houston, Texas (3-14-74)

7. General Electric, Houston, Texas 93-15-74)

8. Lyndon B. Johnson Space Center, Houston Texas (3-15-74)

9. United States Naval Aviation Museum,
   Pensacola, Florida (3-21-74)

10. Honeywell Inc., Aerospace Division,
    St. Petersburg, Florida (3-22-74)

11. John F. Kennedy Space Center, Cape Canaveral, Florida (3-31-74)

12. General Electric, Daytona Beach, Florida (4-2-74)

13. Alabama Space and Rocket Center, Huntsville, Alabama (4-6-74)

14. National Oceanic and Atmospheric Administration,
    Norfolk, Virginia (4-11-74)

15. National Air Museum, Smithsonian Institute,
    Washington, D. C. (4-15-74)

16. Union Carbide, St. Albans, Vermont (4-23-74)

17. Computervision, Bedford, Massachusetts (4-26-74)

18. North American Phillips, Cheshire, Connecticut (5-1-74)

19. Lux Time Division, Robertshaw Controls,
    Cheshire, Connecticut (5-1-74)

20. National Oceanic and Atmospheric Administration, Rockville, Maryland (5-7-74)

21. Sycor Inc., Ann Arbor, Michigan (5-10-74)

22. Zenith Radio Corporation, Chicago, Illinois (5-14-74)

23. Honeywell, Government and Aeronautical Division, Minneapolis, Minnesota (5-16-74)

24. Honeywell, Residential Division, Minneapolis, Minnesota (5-16-74)

25. Stearns-Roger, Denver, Colorado (5-24-74)

26. Martin-Marietta, Denver, Colorado (9-25-74)