REPORT ON SABBATICAL LEAVE 1975-1976

PRESENTED TO THE

FACULTY, ADMINISTRATION, AND

BOARD OF TRUSTEES OF

MOUNT SAN ANTONIO COLLEGE

BY

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ACKNOWLEDGEMENT

When I was interviewed for a teaching position at Mount San Antonio College in the late 1950s, Dr. Edinger asked me to sign a contract for less money than I was making. He extolled the future of the college, the faculty, and the staff. In his words, and I quote, "I guarantee you will not be sorry if you accept a position with Mount San Antonio College." I did accept the offer and I have not been sorry for having accepted that position. I have just completed a sabbatical leave--another reason why I am happy that I accepted Dr. Edinger's offer.

I would like to express my sincere appreciation and gratitude to all who made it possible for me to spend a year on sabbatical leave. First, I wish to thank the Board of Trustees, the College Administration, the Sabbatical Leave Committee, and my colleagues in the Physical Science Department who took over my classes while I was on leave. Last, but not least, I want to thank the people of the Mount San Antonio College District for supporting Mount San Antonio College and its programs.

I feel that the year was a tremendous success in terms of personal growth and re-generation. I will treasure this experience for the rest of my life.

PREPARATION FOR SABBATICAL

When considering the possibility of applying for a sabbatical leave, there are many things to be considered. A great deal of planning must precede a successfully-planned year of leave. Once the decision to apply for a sabbatical is reached, you must decide which of the things you would like to do would be the most profitable for you and the college. The decision was not a difficult one for me to make because I have always wanted to travel extensively in the United States. In addition, I like to keep abreast of the current practices and programs in the area of engineering and technology. Courses such as Introduction to Engineering necessitate a current knowledge of these areas. In light of this, I decided to propose a study-travel program.

Once my proposal was accepted, Margaret and I approached the next problem; namely, what mode of travel we should select. After considering several alternatives, we chose a 19½ foot, self-contained travel trailer. This proved to be a very satisfactory choice for our needs. We used our car to tow the trailer and averaged ten miles to the gallon in all types of weather and terrain.

The problem of what to do with our home and how to keep our financial obligations was solved by having our son, David, stay in the house and maintain it while we were away. Our sons also paid our bills and were our link to southern California.

Our travel itinerary called for extensive travel in the U.S. with the northern and eastern areas to be covered on our first trip. Our plans were changed somewhat because our son decided to get married in March, and rather than risk a divorce and related problems, I changed our travel plans so that we could be home for the wedding and have some time for my wife to prepare for, and enjoy, the occasion. The end result of our travels was the same--we managed to travel within forty-eight of the states and make a trip through the Canadian provinces of British Columbia and Ontario. Some schedule changes were required as far as appointments, but the schools and industries cooperated in every way.

I anticipated a year of rich personal growth and a revitalization of my energy. In no way was I disappointed with any area of the year. Each day was really a new adventure and, although we took time to attend church on Sunday, we never really stopped to rest. The experiences we had and the friends we made have enriched our lives immeasurably. The information I gained and the knowledge I acquired are utilized daily in my classes. I will always be grateful for having been given this opportunity.

STATEMENT

The information and knowledge I gained on sabbatical leave is currently being put to use in my classes. I teach two sections of Intro to Engineering and Technology and I pass on to my students a great deal of information about programs, projects, and particular schools I visited.

The industries and engineering projects I visited gave me first hand information about the work done by engineers and technicians. I find that students are responding better when I cite specific projects and places when giving illustrations.

I have collected much valuable information in the form of handbooks, tables, and personal contacts. I discussed programs as well as specific course content with educators from coast to coast. Some of the ideas and information is being utilized in my classes.

We traveled into forty-eight states and Canada, vis iting historical sites, museums, art galleries, exhibits, and attending plays and concerts. We witnessed racial conflict in many states. We traveled to most of the state capitols and talked to people in all walks of life.

I have shared some of my experiences with friends, faculty members, and church groups, and I will give a report in the Physical Science Department. I feel my experiences have made me a better, more socially and culturally-aware citizen, which will help me in my relationships with my students, faculty members, and the community.

COMPANIES AND ENGINEERING PROJECTS

I visited a number of industrial firms and toured some outstanding engineering projects as well as toured some outstanding examples of architecture. In this section of the report I have included a short summary of a limited number of projects and visitations as representative of the study.

HOOVER DAM, between Arizona and California across the Colorado River.

Hoover Dam, across the Colorado River between Arizona and Nevada is one of the country's outstanding engineering feats. In fact, the American Society of Civil Engineers selected this project as one of the country's Seven Modern Civil Engineering Wonders.

Hoover Dam was dedicated on September 30, 1935 after approximately four years of construction. The dam is classified as an arch gravity dam and stands 726.4 feet above bed rock. It remains as the highest concrete in the western hemisphere. The dam's reservoir, Lake Mead, is capable of storing 28.5 million acre-feet of water, the country's largest man-made reservoir.

Hoover Dam is 660 feet thick at the base and 45 feet thick at its crest and is 1,244 feet across, requiring 4,400,000 cubic yards of concrete to construct all facilities. The power plant produces 1,344,800 kilowatts, one of the world's largest hydroelectric installation. A portion of the electricity generated at Hoover Dam is purchased by the cities of Pasadena, Burbank, Glendale, Los Angeles, Southern California Edison, and the Metropolitan Water District of Southern California are also users of Hoover Dam electricity. The generating facility is operated by the City of Los Angeles Department of Water and Power in conjunction with the Southern California Edison Company under contract as agents of the Federal Government. Hoover Dam is an outstanding feat of engineering and is an excellent tour.

3M CENTER, St. Paul, Minn.

I met with Mr. Gene Steele, manager of the College Relations Department and an engineer by profession. The 3M CENTER at St. Paul is the

Central Research Facility for 3M. In this center, they pursue basic research to advance the company into new areas of science and technology. The research organization is searching for new knowledge that leads to new products and new businesses. Mr. Steele pointed out that they spend over $130,000,000. a year in research and development of new products. In the St. Paul center, they employed a wide spectrum of abilities, but most are graduates of four-year colleges and universities. At the time, I was there, the company was laying-off employees in an economy move.

Mr. Steele discussed the type of graduate they were looking for at 3M. He pointed out that at St. Paul, they are looking for the truly outstanding research-oriented person. He suggested that we mi ght contact the manager of the Camarillo, California plant and establish communications, as this plant uses a number of technicians. Mr. Steele also gave me the names and addresses of other plants including one of their West Texas plants. We toured the grounds, but the security required you have clearance to enter the research facilities.

AMITEK CORPORATION, Cornwell Heights, Pa.

I met with Mr. Richard Moore, a project engineer for Amitek. After a briefing, we picked up safety glasses and hard-hats and went on a tour of the shops and facilities. The major thrust of the company, at this location, is in the area of very large valves used in nuclear generating plants and pipe lines. Mr. Moore explained the design process and the role of the engineer and technician in the company. He felt, as did many of his coworkers, that he had become more of a business manager than an engineer. He felt that the engineering technologist could take over some of the duties presently being performed by graduate engineers, freeing the engineer to do more inovative engineering design work.

The company maintained a rather extensive drafting and design section at the plant. We visited this area and discussed the type of work being done and the requirements for technicians in this field. The basic area of specialization for engineers hired by Amitek is mechanical engineering. Because of the nature of the company project, the engineers for Amitek are required to travel a great deal to check on installation and application.

Another area of interest at the plant was the Research Department. In this department they employed scientists and research assistants, generally technicians. The research was applied and the laboratory was very well equipped.

<u>LUNKENHEIMER VALVE COMPANY</u>, Cincinatti, Ohio

I met with Mr. Charles Mathews, vice president, for a briefing and then was escorted on a tour of the plant. It was interesting to note that a number of new machines purchased by the company were from such places as Italy and Poland.

Lunkenheimer employs machinists rather than machine operators. Every machinist in the plant is supposed to be capable of setting up every machine in the plant. The machines have all been installed and put into operation by the employees rather than having to employ an outside firm.

The company works rather closely with the local colleges. I found a number of technicians who were working days and attending classes at night at Cincinatti University. The company helps employees who are willing to go back to school to improve their skills or who want to advance into other areas. Help is provided in the form of books and tuition.

Another point of interest and a source of pride for the company is two robots used for testing valves. The robots picked up the valve from the assembly line, rotated it into position, actuated the test mechanism, and if the valve was acceptable, placed it on another assembly line for packaging. If the valve was not acceptable, the robots placed the valve into a reject box and returned to pick up another valve for checking. The device was monitored by a small computer, allowing it to work without supervision. My guide commented that it was one of the favorite employees of the company. It didn't need coffee breaks, didn't need rest, and never asked for a raise or bothered to even ask for a paycheck.

After a tour of the plant, I was introduced to the engineering section, which included the Drafting and Design Department. One of the engineers I talked to was teaching in the extended day division at the University. The company employs mechanical engineers, technicians, and technologists. The chief engineer suggested that the draftsmen and design draftsmen they employ should have experience or education in piping and valves, and as many math, physics, and chemistry courses as possible.

<u>FEDERAL BUREAU OF INVESTIGATION</u>, Washington, D. C.

The tour of the F.B.I. facilities was arranged by one of my wife's relatives, a graduate of Citrus College, and secretary to the director of the F.B.I. We were escorted by an agent and were given a tour of the laboratories. The laboratories were not elaborate, but the equipment was some of the most sophisticated computer assisted I have seen. The labs are run by professional people with extensive credentials. Blood, hair, clothing fiber, and such things as pieces of metal were being analyzed. One of the scientists in the laboratory explained that they could determine the approximate age, sex, and a number of other things about a person from an analysis of a hair sample. He stated that they were working on a system of blood analysis as a method of identification much like fingerprint identification.

We were allowed to go to the cafeteria for lunch and also to visit the Directors' Office. Although the director was not in, we did have an opportunity to meet the assistant director.

GENERAL MOTORS BUICK PLANT, Flint, Mich.

The Buick plant at Flint, Michigan is the largest of the General Motors facilities, covering 325 acres and with facilities for making engines, axles and transmissions, a metal fabricating plant, two assembly plants, and a foundry, all housed in 9,000,000 square feet of floor space. The facility employs over 20,000 people.

The assembly line tour takes approximately two hours and covers a distance of approximately two miles of walking and stair climbing. I was impressed with the assembly line procedure which was computer controlled. All models, styles, and colors come through the line with no apparent attempt to keep the same models and styles together. Parts are selected by coded computer cards and the part and the car arrive at the worker's station at the same time.

I met afterwards with Mr. Paul Schmidt, a supervisor in the Steering Gear Department, who arranged for me to talk to some of the engineers. We discussed the requirements for automotive engineering and the requirements for working for a car manufacturer. The engineers pointed out that in their area, a mechanical engineers degree is required, with a good background in the use of computer assisted design. Testing is a very important part of the engineers work because the major components of the automobile must be as safe as possible.

The company operates its own school and is training many of its employees. The metric system is being used by General Motors as the standards for some of their small cars. To interest employees in becoming familiar with the metric system, the company has presented its workers with a set of metric tools. GM will not change to the metric system all at once, but they plan to make the transition gradually.

N.A.S.A., Langley Research Center, Hampton, Va.

Langley Research Center is the oldest of the NASA centers and is responsible for providing technology for manned and un-manned exploration of space and for improvement and extension of performance, utility and safety of aircraft. Langley has a large wind tunnel for testing. The specialized technical areas of Langley are theoretical and experimental dynamics of flight, flight mechanics, materials and structures, space mechanics, instrumentation, solid rocket technology and advanced hypersonic engine research. Another major area is the design and development of simulators for aircraft, lunar landing, and Martian landing projects.

Inside the Visitors' Center is the Apollo twelve spacecraft, moon rock (brought back by Apollo eleven), and approximately thirty exhibits, including Viking. You may test your skill on devices designed to check the astronauts, view movies on the space project, or view space suits and other gear worn or used by our astronauts.

Scientists, engineers, and technicians from the technical disciplines work at Langley. Security is maintained by service personnel, as it is on a military base. This is a very impressive center.

REED TOOL COMPANY, Houston, Tex.

I met Mr. Paul Hilburn, an engineer for Reed Tool Company, at the home office in Houston. After a short briefing, we picked up hard-hats and protective glasses and headed on a two-hour tour of the manufacturing plant. Mr. Hilburn, who is a manufacturing engineer, explained the process of making the products. Reed designs, develops, and manufactures a wide range of drilling equipment for petroleum exploration, mining, construction, and quarrying. The products are started from raw material and, at the end of the process, the tools are painted and crated, ready for delivery to the customer. Drill bits range in size from a few inches to several feet.

One thing I noticed in touring the shops was the low level of noise in most areas and that safety was of real concern to the company. It was impossible for a machine operator to turn on a machine without first having closed sliding doors on the machine which separate the worker from the work piece. Mr. Hilburn stated that OSHA inspects their operation, and some of the improvements in safety have resulted.

After the tour of the plant, I was introduced to the Engineering and Design section and given a lesson on how to drill an oil well. In fact, I was presented with a drilling manual used as the standard in the industry and approved by the American Petroleum Institute. Reed employs one of the largest staffs of engineers and draftsmen in the industry, as well as a research department and a large staff of sales engineers who deal directly with the customers, whether in the U.S. or outside the U.S.

After I had completed my visit and interview, Mr. Hilburn treated me to a round of golf and a steak fry at his home following the golf.

HILLERICH AND BRADSBY COMPANY, Louisville, Ky.

Hillerich and Bradsby is the maker of the famous baseball bat, the "Louisville Slugger" and the equally well-known (to golfers) Power-Bilt golf clubs. I toured the factory and saw the steps of making bats and golf clubs from the rough blanks to the finished product. The plant was large, employing mostly trained artisans since only a small portion of the operations of making bats and golf clubs is automated. The company employs two industrial engineers who said they have been with the company for over twenty years. The engineers set up assembly lines and plan production; they also consult with their design staff--the professional baseball players and professional golfers.

The company furnishes bats for major league players at no cost to the player. Each player has his own unique design of bat on file with the company. The design information includes type of wood, length, weight, finish, and any other variation the player specifies. The best wood is reserved for the production of professional bats while the paying customers receive a lesser grade of wood and workmanship.

The company maintains a museum that is filled with memorabilia from the sports of golf and baseball. The company buys back (from players) famous bats, or clubs, to display in their museum. Henry Aaron's bat that broke Babe Ruth's home run record was purchased for approximately one million dollars.

At the time I visited the company, there were two consultants working on an incentive plan for the company; Mr. Phillip Hall, a mechanical engineer and Dr. John T. Byrd, a specialist in Clinical and Management Services. Their purpose and objective was to work with supervision and committee members to increase their effectiveness and to encourage greater participation and involvement in job-related problems and decisions.

I.T.T. GRINELL CORPORATION, Princeton, Ky.

I met Mr. Ed Bull, the plant engineer, who took me on a tour of the plant. High quality welding, fittings, and flanges are produced at this plant; also, special fittings with large OD, high yield, heavy-wall carbon and alloy and low-temperature. The nominal pipe size of these fittings range from under two inches to over forty-two inches, with wall thicknesses ranging from one-fourth of an inch to four inches. In addition to commodity fittings, such as elbows, tees, reducers, and flanges, they also provide extruded outlet fittings for use as pipeline reducing tees, valve settings, station headers, and manifolds. As we toured the plant, Mr. Bull pointed out the different machines and what they are designed to do. Most of the machines and equipment have been modified to perform a particular function. One machine, a 500-ton combination press, was used for the production of elbows ranging from 12 inches to 42 inches. A 2,000-ton vertical press was used for the final forming, utilizing full-body sizing dies. A horizontal press, with a total length of over 60 feet and a stroke of 22 feet, is used in forming long radius fittings. The radius is made by a curved mandrel being forced into the end of the tube under extreme pressure. The mandrels are solid pieces of steel made in Germany to a tolerance of plus or minus 0.010 inch.

Mr. Bull explained the quality assurance procedures employed in the plant. Inspection starts immediately upon receipt of materials. Color coding is applied for proper identification. Tests for pipeline, or specials, are performed in the Q.C. area under the direction of the chief inspector. Accuracy of all measuring devices are tested and certified. Test technicians check samples using a microhardness tester. Tensil testing is performed using a Rhiele tensil machine with a 60,000-pound capacity. Metallurgical structures and grain-size characteristics are checked with a Unitron metallograph. Various non-destructive and/or destructive tests may be performed on request of the customer.

This plant is a major supplier to major transmission line projects worldwide, power plants (nuclear and fossil fuel), refineries, and mechanical contractors.

In this plant, they had a rather unique labor problem. It seems that almost all their employees either had working wives or they owned a small tobacco farm. As a result, the workers don't mind if a strike is called. Mr. Bull stated that they took a rather soft line on labor problems. I met with other engineers on the staff, technicians, and Mr. DelBono, chief sales engineer.

Mr. Bull invited Margaret and me to visit him at his home on Lake Barkley. We enjoyed our visit very much; the scenery was beautiful. Lake Barkley and Kentucky Lake are part of the Tennessee Valley Authority project built by the Army Corporation of Engineers.

<u>JOHN F. KENNEDY SPACE CENTER,</u> Cape Canaveral, Fla.

The John F. Kennedy Space Center is the nation's first spaceport. Preflight tests are conducted there and manned and un-manned space vehicles are prepared and launched for NASA. Manned Apollo missions, un-manned planetary and interplanetary missions, as well as scientific meterological, and communications satellites, are launched there.

We took a two-hour tour of the 88,000-acre facility after we had spent a great deal of time looking at vehicles, space suits, and viewing movies. The tour stopped at Complex 39 where we got out and went into the vehicle assembly room. This building can accomodate four Saturn V vehicles at once (the Saturn is 364-feet long).

We saw the Crawler-transporter that speeds along at a rate of one mile per hour when it delivers a vehicle in a vertical position to launch site. It weight a mere six million pounds and is 131 feet long and 114 feet wide.

The tour stopped at the early mission control building which is a dome-shaped building with tremendously thick walls. I believe the tour guide said the walls were nine feet thick. The steel door was several feet thick and escape tunnels were constructed underground for escape in emergencies. This is no longer in use as there is no one closer than three miles, and the launch area is monitored by remote T.V. This building appears small after the pictures shown on television.

We saw the flight training building and the Air Force Space museum, but what we were really looking forward to was at the end of our tour. The bus finally pulled up by the office housing the range officer and we got out and took a seat in the bleachers. We were waiting to see the launching of an un-manned space vehicle! I must admit that it was one of the most exciting times on the trip. We could see the launch vehicle spotlighted against the night sky, and we had our binoculars. After a period of approximately 45 minutes, we could hear the countdown start and then the announcement, "We have a blast-off!" Suddenly the entire area was as bright as day and we could see the vehicle climbing and gaining speed incredibly fast. In a few seconds, it was gone from sight; the crowd of several hundred people stood and cheered for several minutes. The purpose of the launch was to study the affect of aerosals in the atmosphere.

LYNDON B. JOHNSON SPACE CENTER, Houston, Tex.

The Johnson Space Center is a 1,620-acre site about 25 miles southeast of downtown Houston. The responsibilities of the Center include: design, development, and testing of the spacecraft and associated systems for manned flight; selection and training of astronauts; planning and conducting the manned missions, and extensive participation in the medical, engineering, and scientific experiments to better understand and improve the environment.

Mission Control at the Space Center is the astronauts link with earth from lift-off to splashdown.

Many of the buildings at the Johnson Space Center are open to the public. There is a self-guided tour (walking) or, if special arrangements are made, you can take a much more extensive guided tour. We arranged to take the guided tour. A very interesting part of the tour was a visit to Building 30 and MOCR (Mission Operations Control Room). Building 32 houses the Space Environment Simulation Laboratory. The lab contains two vacuum chambers--one 35 feet in diameter and 43 feet high, the other 65 feet in diameter and 120 feet high. Components, or a complete spacecraft, may be subjected to a space-like vacuum and temperatures from 280°F below to F. above zero.

Building 49 houses vibration and acoustic test facilities. Space hardware is subjected to the vibration and simulated sounds the spacecraft will experience in flight.

Building 29 houses a 50-foot centrifuge with a 12-foot round gondola at the end. The centrifuge spins to impose g-forces on the astronauts in the gondola at a greater rate than they experience at re-entry.

Both men and equipment are tested to see if they can withstand the stress.

The center has other specialized equipment including a photography processing laboratory, a technical services shop, a printing plant, a cafeteria, a fire department, and a visitors center housing spacecraft from three manned space programs--Mercury, Gemini, and Apollo.

I learned that the center employs science and engineering majors in their summer vacations. Students are required to write to the Director, Johnson Space Center, Houston, Texas, for information on employment.

<u>SHELL OIL COMPANY,</u> Shell Plaza, Houston, Tex.

I met with Mr. Ben Geopfert at his office in Shell Plaza in Houston. Ben is a senior engineering for Shell and a good friend. His experience with Shell spans over 25 years; he has worked in almost all phases of the industry. He has designed off-shore drilling equipment for many years, and is at the present in charge of computer operations at Shell Plaza #2 in Houston.

Ben first became involved with off-shore drilling platforms when they were first installed at Cook Inlet, Alaska. At the present time, Shell is planning another drilling rig to be installed in the Gulf of Mexico. One of the engineers in Mr. Geopfert's section brought in a model of the platform for our examinations. The platform is 385 feet high and will stand about 70 feet above the waters of the Gulf. Many wells are dug from the platform, the drills going out in all directions from the rig. Ben discussed the design and development stages of drilling platforms as well as the process of installing the platform in the Gulf. Drilling platforms are fabricated and floated to location. The platform is designed with air-tight chambers in the legs, called floatation chambers. When the chambers are filled, the platform is on its side and is "floated" to the position of location by tugboats. When the platform is in the proper location, a computer program controls the emptying of the floatation chambers. If everything goes according to plan, the platform will right itself and the legs will settle gently down on the floor of the Gulf. If the platform were to fall on its side, it would be a major disaster. Imagine trying to right a 40-story building in 300 feet of water! Operation cost of a platform of this nature is approximately thirty thousand dollars per day.

We toured the computer section and looked at computer programs, and I was introduced to a number of engineers and technicians. We discussed the need for engineers and technicians and technologists. Shell has been in an austerity program and is cutting back on employees. Ben suggested that Shell was looking for people with advanced degrees, preferably doctoral level science and/or engineering. He indicated that they had cut down on the number of new engineering graduates hired.

BOEING AIRCRAFT, Seattle, Wash.

I was in Seattle in June, just in time to see the unveiling of the YC-14, Boeing's entry into the Air Force's Advanced Medium Short-take-off-and-landing Transport (AMST) Program.

I met with Mr. Ed Fatton, an aerospace engineer for Boeing at the Renton plant. He pointed out some of the innovations on this new aircraft: (1) the Coanda effect--this is an upper-surface blowing method of deflecting engine exhaust along the curve of the wing and downward, reating powered lift, (2) the use of a triply redundant digital electronics system which controls the aircraft's speed and altitude during landings, and (3) a long-stroke landing gear which absorbs shocks usually encountered in landing on rough and/or rolling terrain.

The aircraft is designed to carry 27,000 pounds of cargo into and out of primitice areas. It is powered by two General Electric CF-6-50 engines, shoulder-mounted atop and at the leading edge of the wing to accomplish the Coanda effect.

We discussed the work Mr. Fatton does with Boeing and the qualifications for engineers and technicians. After our tour, Mr. Fatton invited us to go on his power boat for a cruise and dinner at their vacation home on Maurey's Island. We took the ferry to reach his vacation home that offered us a beautiful view back to the city.

OCEANOGRAPHY RESEARCH PROJECT, University of Rhode Island

I met with Dr. Yoder of the graduate school in the "Bunker". The Bunker was an old war bunker that had been converted into a modern laboratory for oceanographic study. Dr. Yoder explained the equipment used and the nature of the project that was being carried on. He explained that the project was funded by a National Science Foundation grant, and that this particular project was nearing completion. We toured the remainder of the facilities, including library, additional laboratories, computer center, and holding tanks for fish and sea mammals.

I was interested in the type of program offered by the graduate school and information on the student body. Dr. Yoder explained that all the students at this particular facility were pursuing a doctoral program in oceanography, marine science, marine engineering, or marine biology. The students were from all areas of the United States and some foreign countries. The background of the students may be biology, chemistry, engineering, or any one of a number of majors. Emphasis is on doing as well as classwork, and the structure of the classes is such that the students are working with researchers in very small groups. All students accepted into the programs must have earned a degree and have done other graduate work.

The school is located on the Atlantic Ocean near Narragansett. The particular project being investigated was a variety of seaweed.

MOBLEY ENGINEERING COMPANY, Graham, Tex.

I arranged an interview with Mr. Mobley, owner of the company and a licensed surveyor. We discussed surveying in general and especially the land laws and their differences in Texas and California. Mr. Mobley said he had been practicing surveying in the area for over twenty years. He was very happy with his choice of work and was more than happy to discuss equipment and procedures. Of particular interest to me was the source of jobs, type of equipment used, and type and training of employees.

The basic source of surveying jobs in this town was a contract for all city surveying. Additional jobs come from local oil companies that are carrying on explorations Prior to a royalty lease, all land to be leased must be reviewed for title and abstracts must be brought up to date before any drilling can take place. A property survey is made to determine boundaries, and before a permit for drilling is issued, the location of the site is marked off by the surveyor.

Other sources of work come from surrounding farmers who want to establish their boundaries. Construction companies also hire the services of this engineering firm

Mobley engineering employed ten or twelve men to do surveying and office work related to surveying. The majority of these employees came from the local colleges and most had an associate of science in surveying. He stated he also used some summer help, employing civil engineering students in their junior or senior year.

The measuring instruments were designed by Hewlett-Packark and were of the latest type. He stated that he felt the accuracy gained and the time saved justified the very best of equipment.

KITT PEAK NATIONAL OBSERVATORY

The National Research Center for ground-based optical astronomy in the Northern Hemisphere is located in the Quinlan Mountains 56 miles southwest of Tucson, Arizona, on the Sells reservation, home of the Papago Indian tribe. The observatory is operated by the Association of Universities for Research in Astronomy (AURA, Inc.) under contract to the National Science Foundation. Members of AURA, Inc. are: The University of Arizona, California

Institute of Technology, The University of California, The University of Chicago, Harvard University, Indiana University, The University of Michigan, Ohio State University, Princeton University, The University of Texas, The University of Wisconsin, and Yale University.

Kitt Peak hosts 14 telescopes, the largest concentration of astronomical instruments in the world. It has a self-supporting community with its own water collection, processing and storage systems, electrical power, fire control system, and roads. Dormitories are maintained for visiting scientists and, as the signs near the buildings reading "Quiet please--workers sleeping" imply, the observers work while the rest of us are asleep.

Probably the most spectacular telescope at Kitt Peak is the Mayall, 158 inches, housed in a 19-story building. This telescope is, in essence, a colossal camera capable of recording objects near the outer fringes of the known universe--objects such as quasars whose light has taken up to ten billion years to reach earth. The Mayall has only been in operation since March, 1973.

Other telescopes include: the 2.3 meter and the 91 cm telescopes of the University of Arizona's Seward Observatory, a 1.4 meter telescope operated by the University of Michigan, M.I.T., and Dartmouth College, a 10.75 meter millimeter-wave telescope of the National Radio Astronomy Observatory.

The McMath instrument is the world's largest solar telescope. The telescope, named after the late Dr. Robert R. McMath, is unique in design. The focal length is 300 feet and produces a 30-inch image of the sun. Three large mirrors form the image of the sun and are housed in a long shaft inclined 32° from the horizontal, which points toward the North Celestial pole. Two-fifths of the shaft are supported at its upper end by a 100-foot concrete tower, while the remainder is underground. The entire shaft measures 500 feet. A rail system inside the shaft carries materials and observers from the entrance down 300 feet to the bottom of the shaft. To keep the McMath cool and reduce turbulence, the telescope building is painted white and an elaborate system of copper pipes containing 18,000 gallons of water and anti-freeze is circulated through the "skin" of the telescope.

The second solar telescope is a solar vacuum telescope. The telescope is housed in a 75-foot concrete tower. Light is directed vertically through a vacuum which keeps the sun's image from being disturbed by rising currents of heated air.

The tour was conducted by an astronomer from the University of Arizona. We were privileged to see and observe the McMath solar telescope and the Mayall while in operation; from them we could see over 100 miles across the desert. We were given an extensive tour, shown a movie, and given an informative lecture by the tour guide.

An interesting feature of working in an observatory is that the observer must work out in the open with absolutely no heat near the equipment. Considering the fact that the wind blows and it is very cold in the daytime on this mountain peak, it makes one wonder how cold it might get at night!

The laboratories and shops are located in Tucson, where most of the optical work is done. There are over 300 scientists, engineers, designers, and technicians employed. The laboratory can polish mirrors up to 180 inches and, as was the case of the Mayall, to a precision of four-millionths of an inch.

The observatory makes time available (in fact, the greater part of the time) for visiting scientists and students. Many observers go to Kitt to do research for advanced degrees.

R. J. BECK CONSULTING ENGINEERS, Tower Building, Seattle, Wash.

I interviewed Mr. Dean Wilson, a consulting engineer with Beck Engineering. Mr. Wilson explained the position of a consultant in industry. He stated that a consulting engineer should have the following qualifications: (1) an education in the field he will be consulting in; (2) a wide range of experience and had responsibility for a number of engineering works; (3) a business background as well as an engineering background; (4) an ability to get along with people; (5) enough financial reserves to last for several months if he is going into business for himself.

We discussed the method of determining charges for engineering consultant work and the services rendered by the consultant. The following list was suggested as services for which the consultant would be paid for providing:

(1) Preliminary studies and cost estimates

(2) Collection of basic data--geologic studies, surveys, etc.

(3) Preparation of plans and specifications

(4) Advice and assistance in selection of contractor and interpretation of plans during construction

(5) In general, to give consultation as needed. He compared the services as being along the same lines as the services provided by an architect.

The consultant may be paid on one of the following ways:

(1) If the service is a familiar one, a lump sum payment may be agreed upon.

(2) Another method is cost plus an agreed percentage for profit.

(3) A percentage of the cost of construction of the project

(4) Daily costs plus a fixes rate per day

Mr. Wilson invited my wife and me to spend the evening at their home in the suburbs of Seattle. His wife took us on a tour of the city and the following Saturday, we were to go sailing and clamming, but the rain proved too much for us and we begged off.

TECHNICIAN - TECHNOLOGY - ENGINEERING

In this section of the report I will present the findings of my study as related to the several areas of technical, technology, and engineering education. I selected several aspects of these programs and tried to arrive at a generalization of a particular type of program. To obtain the information, I interviewed educators in junior colleges, technical institutes, community colleges, two military academies, state colleges, and public and private universities. This particular information will be used in my classes of Introduction to Engineering in particular, and also in my discussions with pre-engineering and technical students in my other classes.

ENGINEERING TECHNOLOGY - ASSOCIATE

Engineering technicians make up a relatively new area in the occupational field. As the rapid advance of technology has forced engineers into a higher level of scientific preparation, a wider gap between the craftsman had created a large demand for technicians. The engineering technician is trained in the physical sciences and his training is to prepare him for work under the direction of an engineer. The technician must know the language of the engineer, have practical skills in the use of instruments, be prepared to make necessary calculations for the work he is doing, and have a field of specialization.

The engineering technology program is generally a two-year associate program. The areas of study, or major, cover a very large spectrum of employment, with new technology programs being initiated each year. The following is representative of the majors available at community colleges, technical institutes, junior colleges, private and public four-year colleges, and public and private universities: Engineering technology majors--Architectural Engineering Technology, Civil Engineering Technology, Chemical Technology, Electronics Engineering Technology, Computer Technology, Construction Technology, Avionics and Instrument Technology, Stationary Engineering Technology, Hydraulics and Pneumatics Technology, Environmental Technology, Urban Planning Technology, Mechanical Technology, and Manufacturing Technology.

The associate degree is generally awarded to graduates of a two-year technology program who have completed the major requirements and the local college and state requirements. The word "associate" in the degree designation seems to be the only part of the title that is standard. I found a variety of degree titles, depending on the school. Typical of the degrees awarded by community colleges, junior colleges, and four-year institutions offering associate programs are the following: Associate in Science, Associate in Engineering, Associate in Applied Science, Associate of Arts with a Major in Construction Engineering, and Associate in Engineering Technology. The reason for the apparent disparity in degree titles is the absence of some co-ordinating body that could bring some uniformity to degree titles.

The curriculum of the technician differs in content and purpose from that of the vocational school on the one hand and the engineering college on the other. The training is technological in nature, emphasizing reasoning and scientific principles applied quantitatively. The preparation is for work in the engineering field, but the training is more specialized and is limited in scope when compared to the engineering curriculum. The programs are shorter (two years), less theoretical, and more intense. Emphasis is placed on industrial practices and the use of tools and instruments.

Requirements for graduation constitute an average figure in semester hours credit of sixty to sixty-four. Programs differ greatly from college to college, and the area of the country also seemed to be related to the quality of the program. In the programs that I rated good or excellent, the course work was divided as follows: the basic sciences and mathematics (15 to 16 semester hour credits), generally dividing the sciences between a general course in chemistry and a general course in physics; the mathematics classes (8 to 9 semester hour credits), designated technical mathematics and including selected areas of college level algebra and trigonometry, and an introduction to calculus.

Technical courses make up about half of the entire curriculum. The technician needs some special technical skills such as drafting to be able to communicate. There are other courses, depending on the option chosen, that are technical in nature and are necessary for the basic education of the technician. Technical courses account for from four to six semester hour units. The remainder of the technical courses, or major, covers areas such as Architectural, Civil, Chemical, Mechanical, and Nuclear Technology. Some technology schools indicated that they emphasized such things as a class or individual project; some practice in analyti cal techniques in problem solving and visits to industry.

The humanities and social sciences account for six or so units with other non-technical courses such as written or oral communication accounting for another three units.

Institutional and mandated courses, along with free electives, accounted for the remainder of the courses. The student may choose to take some courses that will allow him to transfer into an engineering program. As an example, he may elect to take a regular course in college trigonometry, college algebra, and a regular first course in analytical geometry and calculus.

Accreditation of engineering technology programs is carried out by the following organizations. The Engineers Council for Professional Development (E.C.P.D.) maintains accrediting teams to investigate and accredit programs in engineering technology. This is the same organization that accredits the curricula and schools of engineering preparing professional engineers. The Engineers Council for Professional Development only accredits individual programs and only at the request of the school being accredited.

The Institute for the Certification of Engineering Technicians is a national examining body sponsored by the National Society of Professional Engineers. Certification is awarded in three classifications--Junior Engineering Technician, Engineering Technician, and Senior Engineering Technician. Many of the schools I visited did not have certification of their technology programs, but provided information on where and when the I.C.E.T. test could be taken for individual certification. Obviously, it is to the advantage of the student if he is certified by reason of having completed a program that is accredited.

The question of transfer of credits to another institution is generally directly affetced by the offerings of the four-year or baccalaureate colleges in the immediate area. If a student decides to continue for a baccalaureate degree, he may or may not be able to transfer his specialized courses to another institution. Some of the programs I reviewed had an agreement with a four-year institution in the area to accept the associate degree and tailor an additional 2-3½-year program qualifying the student for a baccalaureate degree in engineering technology or a baccalaureate in industrial technology. It would seem wise for institutions offering only the associate degree to pursue a program allowing their students to obtain the baccalaureate degree. With the number of colleges in our area that offer four-year programs in engineering technology and industrial technology, we should have no problems in working out some type of agreement. An agreement such as this would appear to benefit the s chool, the student (allowing him to compete with baccalaureate technicians), and industry by having a better trained technician.

The college of today generally has a placement office and follow-up records of employment which are kept. The schools I visited gave me a typical answer: "We really don't have a problem with placement of technicians." It is a common practice for recruiters to come on campus to interview students for employment. In the programs that have been established for a few years where the employers are aware of the type of graduate they produce, placement is considerably easier than for students coming from a program that has not yet established a reputation.

Salaries vary with demand and with different areas of the country. The entry level for two-year technicians is generally lower than baccalaureate graduates, and less than some craftsmen. The entry level salary ranges from a low of $600 to a high in excess of $1,000 a month. The median is about $8,400 per year.

INDUSTRIAL TECHNOLOGY

Industrial technology is primarily an outgrowth of the industrial arts teacher education and technical institute training. Industrial technology is a relatively new area of specialization within the entire framework of the present, ever-changing technology. Many factors have affected the growth of industrial technology. Among them are: a demand from industry for an individual with training in mathematics and science with a broad, flexible background rather than specialization; and social pressure; and pressure from parents for a baccalaureate degree program. The present program in industrial technology has, as its major emphasis, the preparation of baccalaureate graduates with technical and industrial training who are prepared for lower and middle management.

The industrial technology program is designed as a four-year baccalaureate program requiring from 124 to 130 hour units of credit. This program is most likely to be found in colleges that have a history of teacher preparation, although the program is found in many universities. The most often used degree designation that I experienced when visiting college campuses is the Bachelor of Industrial Technology. In some instances, I found three distinct programs offered at the same school--a baccalaureate degree program in professional engineering; a baccalaureate degree program in engineering technology; and a baccalaureate degree program in industrial technology. In the schools offering the three distinct types of programs, there seemed to be a great deal of competition for students with less than complete cooperation between programs.

The curriculum of industrial technology is by nature more flexible and less specialized than other technician or technology fields. It differs in content and purpose from the associate degree technician (two-year graduate) and the four-year degree graduate in engineering technology.

The following breakdown of the curriculum into areas is a generalization. Mathematics constitutes approximately 10-12% of the total curriculum. The courses in mathematics (including algebra, trigonometry, and occasionally introduction to calculus) are generally covered under the title of technical mathematics. Additional courses in mathematics (such as computer mathematics and statistics) are recommended. The basic sciences constitute approximately 12-13% of the curriculum with a two-semester course in physics and at least one class in general chemistry with an option of more science courses being selected as an elective. Technical subjects account for approximately 12% of the curriculum. Courses in English composition, technical writing, and speech are included. The remainder of the courses are free electives, institutional requirements, and general education courses.

Accreditation of industrial technology programs is generally not carried out, as it is in the engineering profession for engineering technology programs. It is conceivable that the National Association of Industrial Technology may eventually be organized to accredit these programs. At the present time, most schools are depending on the established reputation of the school and former graduates to establish the credibility of their graduates.

One feature of the industrial technology program that is carried out is the formation of advisory boards from industry. The board members meet regularly with instructors and continually keep them apprised of the changes taking place in industry, allowing the programs to be kept flexible and in a state of change to meet current demands. Another service of advisory boards is that they furnish a ready market for the graduates of programs which they advise. The benefits from such boards extend to such areas as co-op programs and easy access to visits to their industrial facilities. The advisory board is of mutual benefit to both industry and the school. Most of the people I talked with felt that there should be a closer relationship between the schools and industry.

The four-year institution offering a degree in industrial technology affords an option to the community college student who is enrolled in a technical area of specialization. The four-year institution can arrange to accept the associate degree from the community college and design an additional two-year program which would broaden and round out the technical graduate's education. Many two-year graduates are cast into the role of competing with four-year graduates for employment. Another advantage for the community college graduate entering the baccalaureate program would be to afford him a chance to advance into the area of supervision and management.

The employment prospects for graduates of the industrial technology program are very good. College educators involved in industrial technology education report a high demand for their graduates with entry level salaries competitive with engineering technology graduates and in a range very near to engineering graduates. At the low end of the spectrum for salaries, the technology graduate may start at about the same level as an associate degree technician, but his potential is much higher because of his training in the field of management.

PRE-PROFESSIONAL ENGINEERING

The pre-engineering curriculum is found in the junior college, community college, and some technical institutes and military academies. This program is designed for those students who want to attend a two-year college for the first two years of their baccalaureate program. The benefits of this program generally off-set any problems that might be experienced when transferring to a four-year institution.

A degree is optional for the pre-engineering student as he is expected to transfer to a four-year institution after completion of the lower division requirements. A degree may be awarded at the completion of the two-year program and is generally entitled "Associate in Science" or "Associate in Engineering".

This is a pre-professional curriculum with a major in engineering. Some of the colleges I visited listed options in the various fields of engineering, which include Aerospace, Mechanical, Chemical, Civil, Electrical, Geological or Mining, and Metallurgical Engineering. The number of units of semester hour credits varied from 60 to 68, although the student not seeking a degree can transfer at any point if he meets the qualifications for the transfer program.

Course requirements in the pre-engineering curriculum are almost the same in all the colleges I visited. Courses in mathematics through calculus are required. Linear algebra and differential equations are recommended along with statistics and computer programming. Engineering physics, requiring a calculus pre-requisite or co-requisite constitutes either two or three semesters and eight to twelve units. Support courses, including technical writing, engineering graphics, and surveying, comprise another six to twelve units of credit depending on option selected. Two courses in general chemistry account for six to eight units. Several schools I visited offered such courses as statics, dynamics, and properties of materials. The criterion for offering such courses was their transferability to the four-year college. The remainder of the courses are general education, free electives, and institutional requirements. The two-year college transfer program is in a unique position of generally trying to meet the requirements of the four-year institution.

Employment at the completion of the program is generally not a factor, although summer and part-time employment might be a consideration. Most schools did not follow up on part-time employment, but most of the educators I talked with said their students did get jobs in the summer. Areas of employment that the two-year graduate is qualified for is working in a laboratory as an assistant, working as a draftsperson, working on a survey crew, and working in private and public engineering offices.

ENGINEERING TECHNOLOGY - BACCALAUREATE

The baccalaureate program in engineering technology is a relatively new area of specialization in the field of engineering that was introduced in the late 1960s. The engineering profession has required their graduates to master an increasing amount of advanced mathematics and engineering sciences at the expense of many of the skill areas. The engineering technology graduate is expected to master established engineering practices and fill the void between the associate level technician and the creative activity of the professional engineer. Such functions as routine planning, construction, production, operations, and sales can be handled effectively by the technologist.

The degree designation is not completely uniform, but the most often used name is Bachelor of Engineering Technology. Other names are sometimes used--Bachelor of Science in Engineering Technology, or a designation of the area of specialization may be added, such as Bachelor of Civil Engineering Technology. The degree is named in such a manner as to insure that it clearly reflects that it is a degree in technology rather than a professional engineering degree.

The engineering technology program is being offered by many baccalaureate schools who also offer professional engineering. Responsibility for the education of the engineering technologist is in some colleges and universities, the responsibility of the school or college of engineering under the combined heading of "School of Engineering and Technology". Other institutions have developed a separate school or department of engineering technology.

The engineering technology curriculum requires from 124 to 135 semester hour units of credit for a degree. The basic sciences of physics, chemistry, and mathematics constitute approximately 24 to 26 semester units of credit. Mathematics courses are most often designated technical math and varies with the requirement of the particular area of technology in amount of units and topics covered. Emphasis is on applications rather than theory and proofs. Forty-five to fifty semester hour units of credit are required in the area of major emphasis (this includes technical sciences and technical electives). Examples of the kind of courses in this area include: Fluid Mechanics and Hydraulics, Structural Design and Basic Electronics. Social sciences, humanities, and communications skills constitute approximately 12 semester units of credit. The remaining units are general education, free electives, and institutional requirements.

The accrediting agency for engineering technology degrees is the Engineers' Council for Professional Development. The E.C.P.D. uses different criteria for accrediting the associate of engineering technology, the bachelor of engineering technology, and the bachelor of engineering.

The question of transferability of credits for an advanced degree poses a problem. I did not find any colleges or universities offering an advanced degree in engineering technology, and most educators felt that the B.E.T. would be required to make up a large number of math and basic sciences as well as a number of engineering sciences before he would be acceptable for graduate study in engineering. It was suggested that an advance degree taken in business administration might better serve the graduate.

Employment for B.E.T. graduates has not been a problem according to educators I visited with. Entry-level salaries are somewhat lower than engineering bachelor degree holders. They noted that placement office follow-ups indicated that most employers did not differentiate between the two degrees and that most B.E.T. graduates were given engineering titles because of job classification or description.

PROFESSIONAL ENGINEERING

The baccalaureate program in engineering is aimed at producing graduates who have the potential of contributing to society in the higher technological levels--in the area of creativity. The engineering curricula, because of this, has been adding more mathematics with a higher level of sophistication, and more engineering sciences. I visited a large number of schools and the programs seemed to fall into two categories as far as approach to engineering education. In the first category, there is no specialization in the lower division and the student is in a general engineering curriculum. He takes a series of core courses in engineering and in his junior and senior years, he selects an area of major emphasis, selecting his major courses from this area. The second category of programs recognize graduates as a specific major or specialization. The basic difference between the two approaches is the degree of specialization. Some educators feel that it is better to afford a more liberal and less specialized education affording a higher degree of transferability of knowlege and possibly avoiding the pitfalls of overspecialization and the resulting probability of obsolescence.

The name of the baccalaureate degree in engineering is determined by the granting institution. The designation may be Bachelor of Science in Engineering, Bachelor of Applied Science in Engineering, or Bachelor of Science in (insert the proper name) Engineering.

In interviewing employers, I found that there was no concensus on degree preference. The employer's preference was dependant upon the employer's previous experience with employees.

The engineering curriculum is designed to produce engineers who can plan, create, organize, and manage sophisticated technical projects. The curriculum is divided into the basic sciences and mathematics, engineering sciences, engineering technology, humanistic and social sciences, and general education. The remainder of the courses are free electives and institutional requirements.

The lower division is devoted to the basic sciences of physics, chemistry, and mathematics through differential equations. Other support courses are required including engineering graphics, computer programming, and additional math classes such as statistics. Basic communications classes are also required.

In the junior and senior year, the engineering sciences and courses in the area of specialization, along with the humanities and social sciences constitute the majority of the courses. The remainder of the courses are general education, electives, and institutional requirements. The degree generally requires 130 to 138 semester hour credits for graduation.

Accreditation is carried out by the E.C.P.D. Many employers do not hire graduates from non-accredited programs for fear they will lend credibility to the non-accredited program. The purpose of accreditation is to insure that the engineer has a quality education.

Employment is generally not a problem for engineers. The present outlook is very good and recruiters are back on the college campuses. Starting salaries range from a low of $900 per month to $1,800 per month.

METRICATION

As a secondary aspect of my investigation, I elected to review the feelings of educators in the fields of engineering and technology, and about the problems facing people in industry about converting to the metric system.

Legislation has been introduced and passed; we are officially adopting the S I metric system. The problems of changing to the metric system are many and varied, not the least of which is resistance to change.

I talked to engineering firms that do a great deal of business in metric countries to see how they handled the problem. To meet the requirements of the country they are working in, they simply convert plans and materials specifications into the equivalent metric units.

General Motors and Ford Motor Company are building automobiles in metric sizes. General Motors, as an incentive for employees to become familiar with the metric system, present their employees with a set of metric tools.

The most often voiced complaint that I heard from industry was the lack of materials in metric sizes and a lack of acceptable metric standards. Many companies feel that they cannot accept the lesser standards of some European countries that they feel will be adopted. Many companies have appointed committees and metric coordinators to proceed with the transition to metrics. Most companies feel that it will be years before the North American System units are phased out.

Engineering educators are faced with the task of teaching two systems. The new engineer must be versatile in the North American System because of existing materials, machines, and projects; he must also be familiar with the standard and derived metric units that he will use in the future. A lack of text material in the S I system and a clarification on universally accepted derived units presents an additional educational hurdle. Most educators are trying to present both systems.

The metric system is a fact of life in the U.S. The problems voiced by industry and the engineering schools are being solved and we will make the transition even though the transition will be expensive and may take a number of years to implement. The end result will be a world-wide system of units that will present no barriers to economic trade.

SUMMARY

My wife and I left West Covina on September 8, 1975, pulling a 19½-foot self-contained trailer and having a total trailering experience of two long week-ends prior to leaving. When we returned at the end of the first leg of our journey in December, we had traveled over 13,000 miles and had graduated to the class of experienced travelers. Our second trip took us back through some of the states we had already visited and into the remainder of the 48 contiguous states.

We visited national and state parks, museums, Indian reservations, national monuments, state capitols, historic sites, the Nation's capitol, and most of the major U.S. cities. We toured reclamation projects, industries, dams and reservoirs, and visited farms and ranches. We visited art galleries, attended concerts and plays, and visited in the homes of new and old friends and relatives. Our travels covered a total of 26,400 miles, 48 states, and two trips into Canada.

I toured many industrial and engineering firms and interviewed engineers, managers, and technicians. I also toured many outstanding engineering works and projects. I visited three of our nation's most important NASA installations. I made many contacts across the nation in industry and collected a veritable wealth of information in the form of handbooks, descriptive pamphlets, catalogues, and standards.

I interviewed engineering and technology educators in community colleges, junior colleges, technical institutes, military academies, and public and private four-year colleges and universities. From these interviews, I attempted to summarize the various programs in engineering and technology. I also collected a large amount of information about curricula and course content.

We talked to people all over the United States about politics, the weather, the economy, religion, and their problems. Our trip captured the imagination (and envy) of people from coast to coast. Each person we came in contact with had their own favorite attraction for us to see, and a person we could contact to arrange an interview or a tour. We attended many churches of many different denominational faiths; we were always treated as friends and honored guests.

This year of sabbatical leave was successful and enjoyable beyond our expectations. Again, I would like to express my appreciation to all of you for making it possible.