BRIDGE of ETA KAPPA NU

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This issue of BRIDGE is a first. It is the first time an entire issue has been devoted to a single subject. Our Eta Kappa Nu Chapter at the University of New Mexico, Albuquerque, has designed, built, and donated to the University a gift so monumental that it surely represents the largest project ever undertaken by any group of students at any university. How large? Well, consider the following:

HKN MESSAGE BOARD SYSTEM

CONSTRUCTION TYPE: Fully Modular; in-game repairs feasible.
DISPLAY SIZE: Two Units; 64 ft. x 21 in. each.
NUMBER OF DISPLAY MODULES: 2 x 63 plus 6 spares.
DISPLAY MODES: Stationary, moving, blinking.
DISPLAY CAPABILITY: Any character set, including ASCII.
GRAPHICS CAPABITLITY: Limited only by display size.
NUMBER OF LIGHT BULBS: 5292.
MAXIMUM POWER: 11 KW per board, worst case.
HKN MEMBERS INVOLVED: 40
TOTAL MANHOURS EXPENDED: 28,000
NUMBER OF SOLDER CONNECTIONS: Over 125,000
COMPUTER CONTROLLED SYSTEM: 3 Interconnected Microprocessors.
TOTAL MONEY EXPENDED: $30,000
NET VALUE: Greater than $600,000
INSTALLATION DATE: February 1978
CONSTRUCTION TIME: 6 months; July 1977-Feb. 1978
ARENA SIZE: Over 18,000 Seating Capacity

ETA KAPPA NU

BRIDGE

SUMMER '79

BRIDGE BRIDGE HKN BRIDGE BRIDGE

(ISSN 0006 9809)

eta kappa nu

Electrical Engineering Honor Society
August, 1979, Vol. 75, No. 4

IN THIS ISSUE

The BRIDGE is published by the Eta Kappa Nu Association, an electrical engineering honor society. Eta Kappa Nu was founded at the University of Illinois, Urbana, October 28, 1904, that those in the profession of electrical engineering, who, by their attainments in college or in practice, have manifested a deep interest and marked ability in their chosen life work, may be brought into closer union so as to foster a spirit of liberal culture in the engineering colleges and to mark in an outstanding manner those who, as students in electrical engineering, have conferred honor on their Alma Maters by distinguished scholarship activities, leadership and exemplary character and to help these students progress by association with alumni who have attained prominence.

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Member Association of College Honor Societies

Delta Omicron Chapter
Univ. of New Mexico - Albuquerque

LIGHTS UP UNIVERSITY ARENA

Story by:
Mark Gaddis, Bridge Correspondent

Photography by:
James E. Freidell
with Contributions by Art Grove

Traditionally, the Delta Omicron Chapter of the Eta Kappa Nu Association has held in high regard its endeavors and objectives to promote the profession of Electrical Engineering through utilitarian servitude to the people of the University of New Mexico and the surrounding community. The Chapter's latest effort to this end has resulted in the largest project, in terms of gross value, ever undertaken by a group of students in history: The design and construction of the largest message board system installed at any university sports arena in the country (perhaps the world). This is a story about that effort; the equipment and the people who made it possible.

THE HISTORY OF THE ELECTRONIC MESSAGE BOARD

In the beginning...Fall 1967

Four newly initiated members of the Delta Omicron Chapter of Eta Kappa Nu presented an idea for a chapter project which would benefit the University of New Mexico: To build an electronic message board for UNM's new basketball arena. The message board would be used to display cheers and statistics during games. All the members accepted the challenge of this project and work was begun in November, 1967. When finished fifteen months later, it was obvious that this was the largest under-taking ever attempted and successfully completed by any chapter of Eta Kappa Nu in the country at that time.

The completed message board was 18 ft. long, 3 ft. high, 12 inches deep and weighed 300 lbs. The display messages were produced with 900 red score-board light bulbs which were used to form 36 characters in two rows, each character consisting of a 5 × 5 matrix of bulbs. This message board contained 5000 diodes, 400 relays, and 50 miles of wire.

Because our chapter was not financially well endowed, most of the components were scrounged or given to us by several companies. IBM donated 400 relays, Westinghouse donated the power SCRs, and Eberline Instrument Corp. provided much of the necessary hardware for the project. The Chapter was also able to obtain a $1500 grant from the Associated Students of the University of New Mexico, the governing student organization on campus.

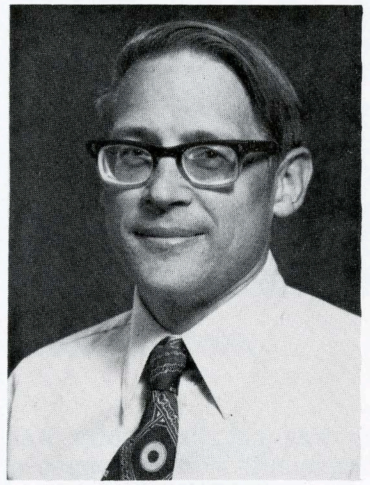
It is estimated that approximately 5000 man hours were devoted, entirely by the chapter members, to the project, and the finished board was worth $60,000. Most of the credit for the design and building of the message board in 1968 goes to Joe Colvin, who served as chapter president during the construction period, and to Tom McKean, Robert Fredricksen and Tom Thompson.

In 1970, the message board system was improved so that the electronics consisted of several easy to service modules. A Flexowriter was added so that messages could be typed in directly. Previously, messages to be displayed were laboriously encoded on hand punched cards before they could be entered into the system via a manually rotated IBM "starwheel." These modifications increased the estimated value of the board to $80,818. The chapter owes a great deal of gratitude to Dave Koller for his contributions to the modification effort.

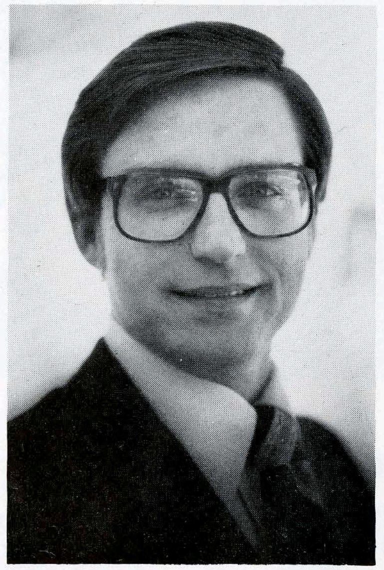
Four Years Later...

In the Fall of 1974, the Chapter was informed that the basketball arena would be remodeled the next Spring to increase the seating capacity by about 3000 seats. Unfortunately, the remodelling was to eliminate the area where the message board was mounted. After talking with the engineers involved with the new construction, it was obvious that there

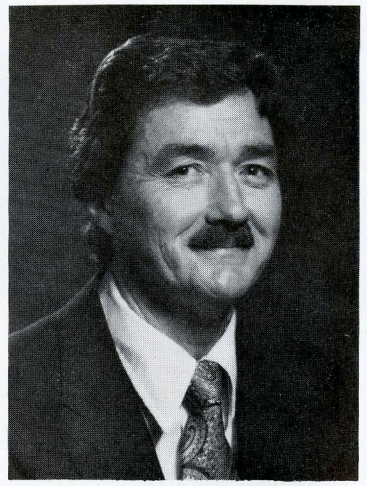
MESSAGE BOARD STAFF
DELTA OMICRON CHAPTER



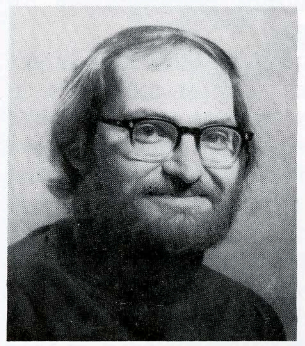
Dr. Harold Knudsen
Technical Advisor



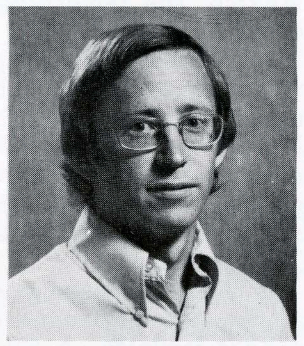
James E. Freidell
Project Manager
Chief Engineer



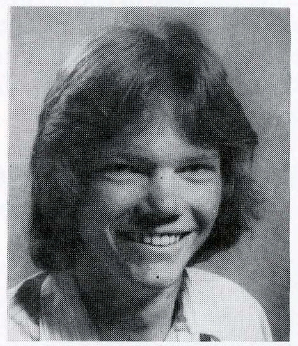
Dr. Ruben Kelly
Faculty Advisor



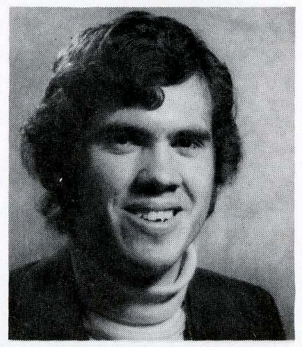
John Brockmeyer
CHIEF
PROGRAMMING
Engineering Staff
Member



J. David Green
PRODUCTION
MANAGER
Engineering Staff
Member

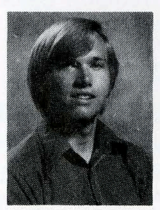


David Thompson
CHIEF
QUALITY
CONTROL
Asst. Production
Manager

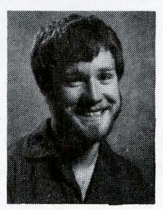


Patrick Sullivan
CHIEF
Components
Engineering &
Procurement

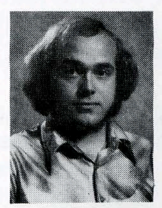
Howard Ross
Head of
P.C. Board Shop



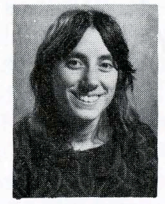
Frank "Bud" Harrison
Asst. Production Mgr.



Ricky Cox
Head of
Drafting

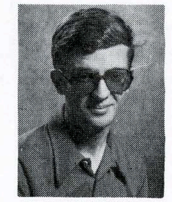


Emil Kadlec
Programmer

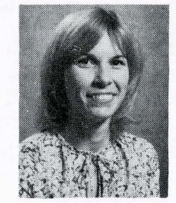


Donna Schultz
production

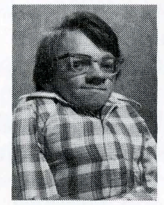
Sara Shelly
production



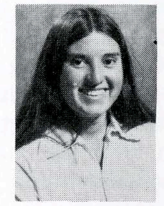
Richard Owen
programmer



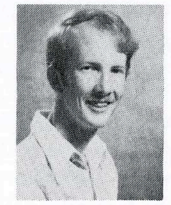
Sue Check
production



Mark Gaddis
engineering &
production



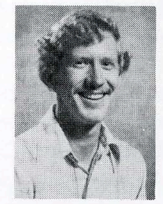
Geri Lopez
production



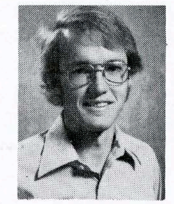
Emil Lassen
production

Diana English
programming assistant

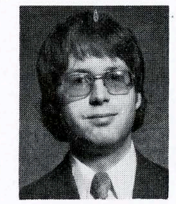
Karen Douglass
production



David Hulsbos
production



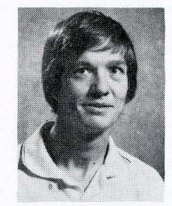
Art Grove
production



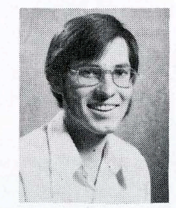
Kevin Denney
programmer

Geri Gafford
production

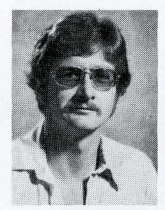
Robert Kunkle
production



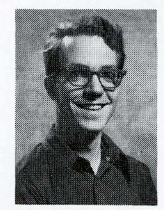
Brian Patno
production



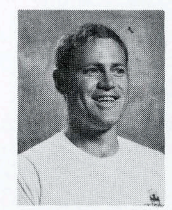
Jeff Lenberg
production



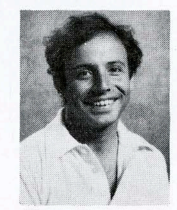
Garry Leiker
production



David Welter
engineering



Clenton Collier
production



Frank Chinisei
production

NOT PICTURED:
Lloyd Harrison, Past Chief of Components Engineering & Procurement;
Mark Vaughn, production, **Evans Spanos**, programmer;
Bernie Dailleboust, production; **Harold Stewart**, production;
Keith Merrifield, production; **Terry Moore**, production;
J. Mark McConaughy, programmer; **Robert Rathge**, production; and
Deb Freidell, a non-member who worked more than 300 hours so she could see her husband, Jim, on Saturdays (sometimes).

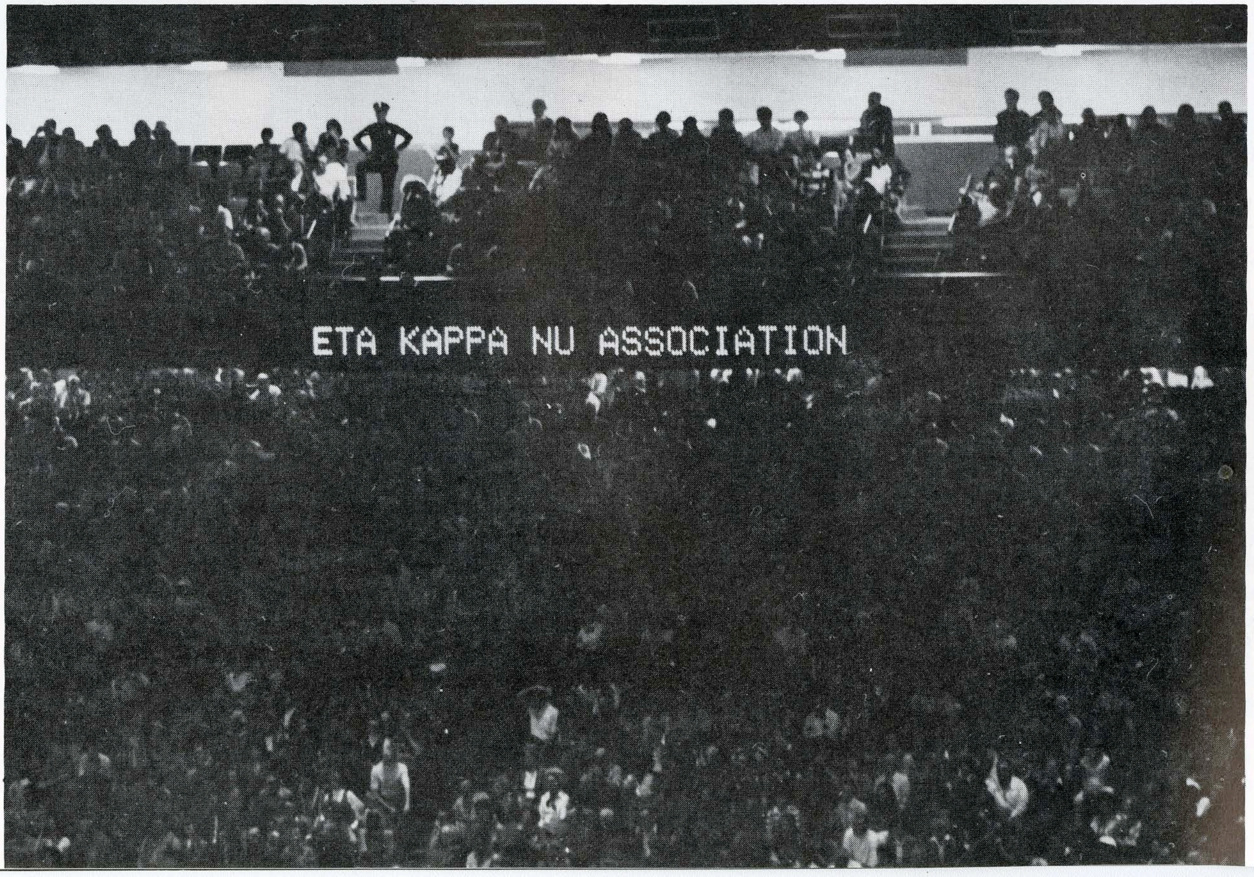
would be no place for the old message board. The only possible location for any type of display device would be a 3 ft. high wall on the front edge of the new mezzanine seating area. The old message board required a larger surface for proper mounting. It became clear that a new message board was needed which would meet the new mounting constraints. Two newly inducted members of the Delta Omicron Chapter, Gregory R. Bryant and James J. Nesrsta, Jr., decided to design a new system which would be a tremendous improvement over the old one.

The old message board produced a purely static display; that is, each character was addressed to a given location as it was typed in, and could not be shifted left or right. The spaces between letters were formed by the physical distance between display characters. A message was displayed from left to right with a blank character used for the space between words. The new message board called for display characters consisting of a 6 × 7 matrix of bulbs instead of the old 5 × 5 matrix. The spacing between characters would be zero, i.e., the distance between column 6 of one character and column 1 of the next character would be the same as the distance between any other two columns. This would enable information to be "walked across" the message board from right to left, Times Square style. The spaces between characters would be formed by a blank column, leaving a standard 5 × 7 matrix to form the character.

Another very important improvement in the new design was the conversion of the switching electronics from diode-relay logic to TTL. The diode-relay logic of the old message board was contained in a large rack located in the arena attic, and the display housing contained only the necessary wiring to supply the switched power to the various light bulbs. The new design used a unique modularization concept; essentially each character was provided its own housing, hereafter termed a module. This allowed all the switching electronics for a display module to be contained within that module, making in-game repairs feasible, since a problem with a module would be limited to the module itself. All of the electronic components in each module would be mounted on plug-in printed circuit boards which could be changed quickly when necessary.

This new design was presented to the chapter and was accepted eagerly. It was estimated that a 32 character message board would cost about $5000 to build, with the chapter members providing the labor. Because the old message board was still in good working condition, the chapter members voted to try to sell it to any interested party if a reasonable price could be obtained. In the meantime, to help raise the necessary funds for the project, the members decided to sell raffle tickets with the prize being two season tickets for the following basketball season. By the Spring of 1975, sufficient funds were obtained to begin six of the new display modules.

Where and when before have over 18,000 people seen our name at one time?



The Ups...and Downs

Late in the Spring semester of 1975, construction had begun on the first few modules of the new message board and chapter members were optimistic about having the new system installed and working by the start of the basketball season in late November. Unfortunately, the sale of raffle tickets the previous season had netted only $1800 and it was becoming imperative to sell the old message board as soon as possible for additional needed funds.

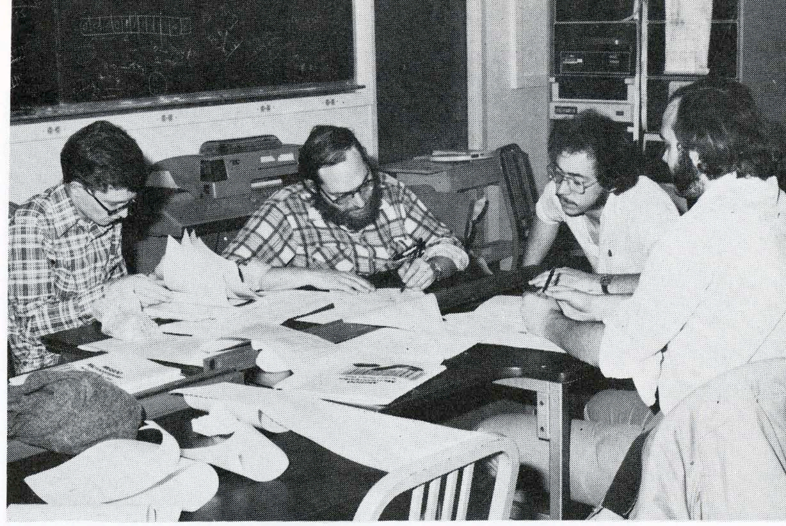
On May 30, 1975, an accident at the basketball arena caused the installation of a new message board to be delayed almost three years. A welder working in the attic of the arena accidentally started a fire which was extremely difficult to extinguish. Before it was brought under control, the fire caused extensive damage to the diode-relay logic of the old message board, which was located in an area of the attic near the fire. Also suffering fire damage were 30 large spools of multiconductor cable stored near the message board electronics. After surveying the damage, the chapter members decided that the old message board had sustained so much damage that it would not be worth repairing. Since the display modules were mounted in another part of the arena they were not damaged. Thus various components were salvaged for later use, including the 900 red score-board light bulbs.

Immediately after the fire, Dr. Ruben Kelly, our faculty advisor, consulted with various university officials to determine if either the Chapter or the University might be entitled to an insurance settlement for the damage to the old message board. Dr. Kelly was authorized to make a thorough investigation into the probable worth of the message board and wire that had been destroyed. He consulted with companies that specialize in the construction of professional scoreboards and message boards used in professional sports arenas around the country. He learned that a professionally built message board having the same size display and capabilities as the old message board would be worth about $82,000. This figure was given to the UNM insurance company and a long drawn-out process started which would hopefully lead to a settlement that would allow production of the new message board.

In February of 1976, the College of Engineering held its annual Engineering Open House. Since four display modules had been completed and a working prototype of the control electronics (including a keyboard) was available, the membership decided to put the new design on exhibit to show the progress made towards the construction of the new message board. Unfortunately, in the process of connecting the circuitry to the power supplies, someone made a mistake which destroyed several integrated circuits. This occurred the night before the Open House, thus it was not functioning for the exhibit. In early March of 1976, three chapter members, Mark Gaddis, Will Shover, and David Welter volunteered to troubleshoot and repair the damaged modules. This was not an easy task because the designers had graduated the previous fall, and the new people had to spend quite a bit of time becoming acquainted with the details of the new circuitry before the actual trouble-shooting could begin. After about three months the system had been completely repaired and was working fairly well. Occasionally a mistake in a displayed character would appear as the information was typed in, but this was attributed to the inexpensive ASCII coded keyboard which was being used at that time.

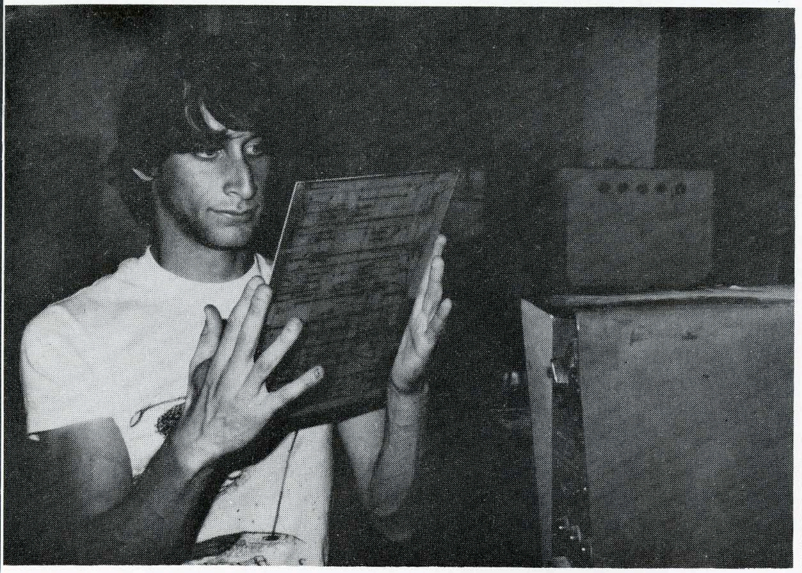
The Fall 1976 Smoker was used by the new President, David Welter and Vice-President, Mark Gaddis, to demonstrate the new message board to the prospective new members. Emphasis was placed on the fact that there were enough parts available to construct several more display modules and that this would require the help of the new members. One of the pledges, James E. Freidell, showed a great deal of interest in the project and was eventually appointed to head the construction of the new modules. Because he had previous experience with the problems involved in the production of complex electronic devices, Jim realized that it was very important that students who would be building the message board would need substantial knowledge and practice in the art of correct soldering techniques. Thus, he decided to teach a soldering course the following Spring semester, based on a NASA soldering course which he had taken himself.

Up to this point, the Chapter was still in financial difficulty as far as building a new message board was



A typical Programming Staff meeting. Lots of paper and ideas floated around at these gatherings.

Near the deadline, long hours made for some pretty tired production workers. During Christmas break many people worked more than 90 hours each week.



Howard Ross inspects one of his recently etched printed circuit boards that eventually ended up in the master computer. Every printed circuit board in the entire system is two-sided, complicating Howard's work.

Production Manager Dave Green missed only one day of production throughout the entire project — something about having to do some Christmas shopping. Without Dave, there wouldn't have been a message board.

concerned. The members decided to proceed as far as possible with the money that was presently on hand. It was hoped that a grant from one of the campus-based organizations might be received to help complete the message board construction. Fortunately, all of our financial problems were alleviated in late November 1976, when the University of New Mexico was paid $82,152.80 by its insurance company for the damage to the old message board. This money was set aside to be used by the Electrical Engineering and Computer Science Department, with the Delta Omicron Chapter of Eta Kappa Nu having control over its use. The entire Delta Omicron Chapter owes a great deal of thanks to our faculty advisor, Dr. Ruben Kelly, for his untiring work with the University to obtain this insurance settlement. Without his efforts, the new message board would still be a "pie in the sky."

THE MESSAGE BOARD OF THE FUTURE

In February, 1977, the Engineering Open House was scheduled to be held and the Chapter again decided to have an exhibit displaying the new message board to the public. Because only four display modules were completed at that time, Jim Freidell decided to build two more so that a string of six could be demonstrated at the Open House. Once these modules were completed, Jim noticed that the incidence of errors in the displayed messages was much greater with six modules connected together than with just four. He suspected that the system was picking up random electromagnetic noise which was causing the mistakes. Because the message board was essentially one long shift register, the binary data information had to be shifted through each module without mutation. If, in the process of moving through the display modules, a binary data bit was altered by extraneous noise it would cause an incorrect sequence of display light bulbs to be lit, thus giving a garbled message. This noise problem was confirmed when it became apparent that the switching of any electrical device in close proximity to the display modules caused a scrambled display. The system did, however, function well enough to be used in the Open House where it was usually possible to type six or seven characters before a mistake occurred.

After the Open House, Jim Freidell did an extensive analysis of the noise problem. He determined that not only was the system extremely susceptible to outside interference, but it was also internally generating noise of its own. During a business meeting preceding the Spring smoker, the Chapter members were brought up to date concerning the problems with the message board design. With great reluctance the members decided to scrap this particular design. Because it was necessary to investigate other possible message board designs, an engineering committee was formed with Jim Freidell appointed as Chief Engineer and Project Manager. Also appointed to the committee were Dave Welter and Mark Gaddis.

PRELIMINARY CONSIDERATIONS — CONCEPTUAL DESIGN

The Engineering Committee decided to seek the help of faculty members who might be able to offer any suggestions for a new message board. Dr. Harold Knudsen seemed to be just the person they were looking for. He was extremely interested in the project and was willing to help. Upon his suggestion the committee set out to determine the implications of a parallel data bus structure, as opposed to the original ultra-long shift register concept which was too susceptible to noise. From the onset, it was apparent the parallel bus would complicate the design, but the underlying question was whether it had sufficient noise immunity to make those complicatons worth the extra effort and cost.

The Engineering Committee decided to construct an 8-line parallel data bus and to perform a study to determine its susceptibility to extraneous noise. Eight lines were used because a microcomputer, utilized in the noise test, could handle that number quite easily. Construction of this data bus was started late in March and was completed during the week-long Spring break at the end of the month. Much of the final wiring was done during the Spring break in the main hall in the Electrical Engineering building because the entire bus structure was 32 feet long, the length of a 32 character message board. The eight data lines were routed through several six foot long tubular shielding structures which contained openings every foot along their length, so that connections to the data lines could be made. An integrated circuit chip was connected at the point where a display module would normally be connected to the data lines in order to simulate the actual loading conditions on the bus structure. Thus, thirty two ICs were wired in, one located every foot along the bus. The completed structure caused many a passer-by to stop and gawk; it had a close resemblance to a 32 foot long centipede with wires appearing as legs.

To test the new bus structure for noise susceptibility, a Motorola 6800 based microcomputer was used to send strings of binary words down the length of the bus and check for errors when they emerged from the opposite end. The computer kept a running count of all errors that occurred. A "noisy" environment was created in close proximity to the bus to simulate the conditions that were likely to be encountered in the basketball arena. This was done by connecting a wide band interference generator to a wire running parallel and next to the data bus structure. The low error rate observed with this test configuration provided some exciting news to the Engineering Committee. A shielded parallel data bus was indeed the way to go! The cost, however, demanded the bus driving logic be placed as close to the bus as possible, preferably as part of the bus if feasible. Furthermore, this complication proved troublesome since it would be quite impractical to locate the display generating mechanism along with the human interface at the board location. As with many tough engineering problems, this one was temporarily set aside, to be dealt with when additional information would provide a clear decision.

It was determined that the new message board would have to be a system based upon functional blocks. Jim Freidell played a very significant role in this decision since he, as Project Manager, wanted a flexible as possible design. Specifically, the new message board would have to "stand the stress of time" and to provide future generations of active Delta Omicron Chapter members the freedom of a continuing project to update and modify, always striving for an increased level of excellence. This motivation demanded the introduction of a computer into the system so that modification would be efficient, the form being largely manipulation of system software.

COMPUTERS . . . COMPUTERS . . . COMPUTERS

A brief digression is necessary at this point to describe exactly how the choice of computer type was made. It was obvious that the new message board system would be built for substantially less than the insurance settlement provided. Jim Freidell could only estimate that $12,000 would be required since the preliminary design was only barely underway. The Chapter as a whole naturally wanted to provide the Department of Electrical Engineering and Computer Science with equipment that would satisfy the needs of all EECS students. The most appropriate suggestion that fitted this constraint was to purchase an "up-and-running" computer system that would provide the student with complex but easy to use programs along with a strong graphics capability. The desk top computer variety fitted the requirements nicely since its affordability might make the purchase of two units possible. It was decided to put off any purchase of a computer until the message board was completed, unless one could be used part time as the message board system computer. After much consultation and consider-

Our Master Computer is shown off by one of Jim Freidell's models. The MPU board is being held.

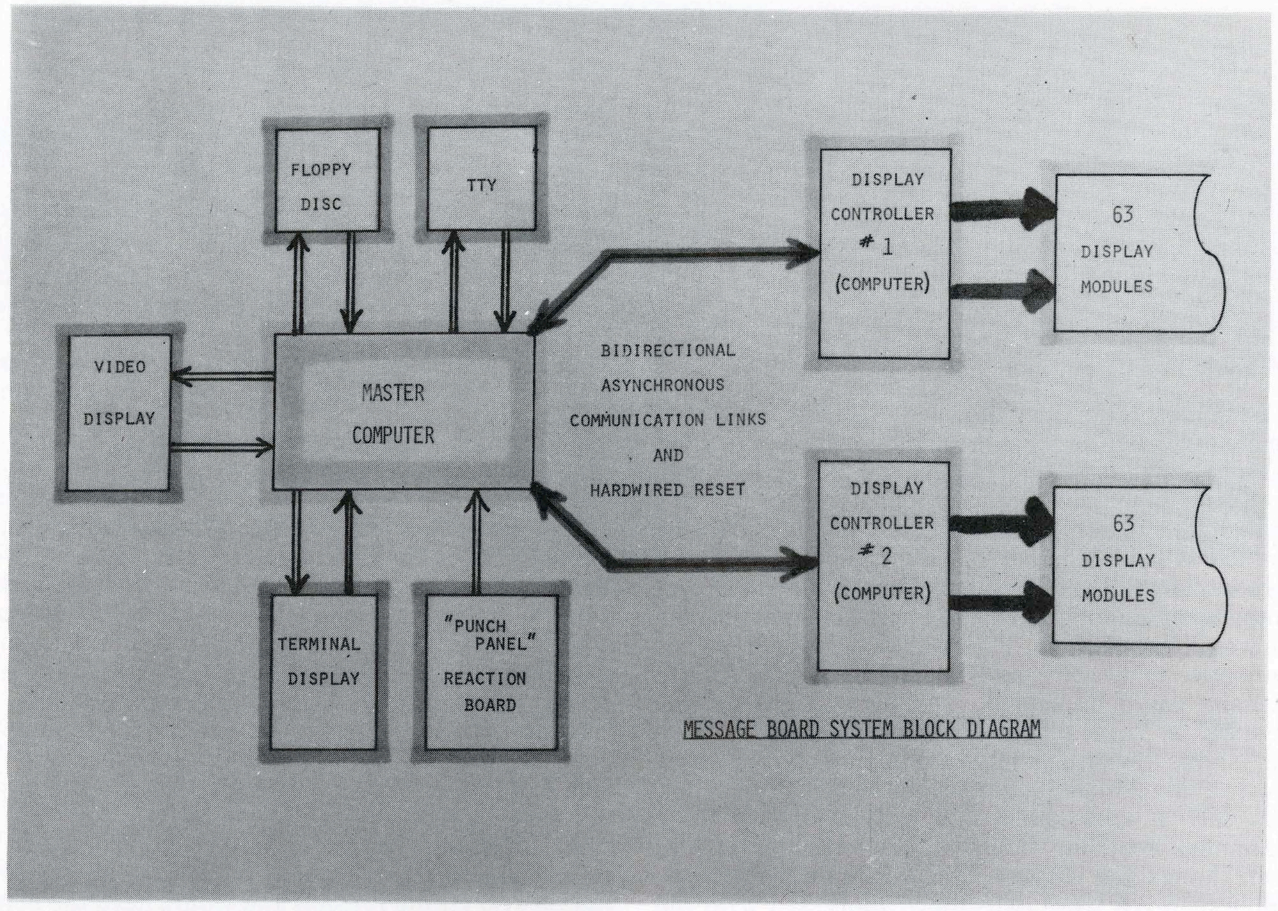
ation, the Engineering Committee decided that regardless of how nice it would be to incorporate such an instrument in the design and thus alleviate a substantial portion of their effort, the message board system must remain a totally separate entity. This, in retrospect, was an extraordinarily wise decision as there exists no guarantee that the Chapter will forever retain control of the message board system.

Since it was felt that a full-size minicomputer was a bit of overkill it was decided to use a Motorola 6800 microprocessor based design for the message board. Dr. Knudsen was at that time teaching a course on microprocessor technology with applications based upon the Motorola device. Furthermore, a new microprocessor lab for the department which would use the 6800 was in the design stage. Perhaps most important, a Motorola 6800 based microcomputer was located in the department's computer room. This allowed the Engineering Committee members some "hands-on" experience and a device that could be used in the design process as well as end of production test. Once the decision concerning the microprocessor was made, the design of the overall system began to take shape fairly rapidly.

FURTHER DESIGN IMPROVEMENTS

Some rough calculations revealed that if the people operating the system were to see the basketball game and the message board simultaneously, the computer and the display must be separated by at least 200 feet (wiring distance). This led to several exciting innovations that would make this design one of the most advanced message board systems in the country. Because the computer would be located about 200 feet from the display controlling logic, some type of data communication link would be needed. Originally, Jim thought that a laser fiber optic system would be the best because it can be completely immune to electromagnetic noise. After some investigation, it became apparent that the cost of such a system would be prohibitive. Thus, a standard multi-conductor shielded wire cable was chosen for the communication link. Due to economic considerations, this meant a 200 foot, noise susceptible, serial data monster had been created. Jim Freidell was not studying to be a computer scientist, but it was rather easy (for him) to see that "adaptive logic on both ends of this link could provide some sort of real-time error analysis." The computer on one end was obvious, but circuitry for the other end could be outrageous. A gathering of the minds was required (meaning Dr. Knudsen was called in... again). It was decided that instead of using just one microprocessor, two would be used! One, called the

The chassis punching assembly line was most efficient with three people working in close harmony. Races were held to see which team could turn out the fastest chassis (perfectly of course).



"display controller," would be housed in a chassis identical in size to the ones used for the display modules. Mounted to the side of the last display module of the message board, it would have complete control over all data sent to the display modules for viewing. The second microprocessor would be contained within the master computer which would be connected to various peripheral input devices such as the data entry keyboard. The master computer would be housed in a control room which overlooks the basketball floor, thus giving the people handling the display messages a good view of the game in progress. Any data to be displayed would first be typed in and stored by the master computer. When the data was to be displayed, the master computer would send the information via a 200 foot communication link to the display controller. Error detection and correction would be performed by both computers using a "hand shake" procedure by means of running check sums. This process would be initiated by the master computer which would calculate the parity of each byte in the message to be displayed. All of the parities would be added together to form a check sum, to be stored in the computer's memory. The data would then be sent to the display controller, which would also calculate a check sum for the received information. This check sum would be sent back to the master computer, which would compare it to the one previously calculated. If the two check sums were identical, a signal would be transmitted to the display controller indicating the information it has is corect. The information would then be sent down the long parallel data bus to the display modules for viewing. If the check sum received by the master computer was not the same as the one stored in memory, the original data would be retransmitted and the entire error checking process would be repeated. This error correction procedure would take place so quickly that the system operators would never know it had occurred.

The second week in April, 1977, Jim Freidell began the soldering course so that production on the new message board could begin in the summer. It ran for three weeks and was extremely well received. Jim had spent many hours before the course running around town to obtain some amazing discounts on tools and soldering equipment which the students could purchase for use in the course and later during the production phase of the message board. As an example, several soldering irons which normally cost $12.50 were obtained for $2.50. A total savings of about 50% on all tools was realized which was tremendously helpful to the students. Once the course was completed, each student was required to pass proficiency tests in order to qualify for message board production. One test involved making several solder connections on a wooden jig utilizing point-to-point wiring. Another test was to make several perfect solder joints on a printed circuit board which had a very small pattern size. Final inspection was done by "Eagle Eye" Freidell who sent many people back to try again before they were finally certified to do production work on the message board.

In May, Jim Freidell was elected as the Delta Omicron Chapter President for the coming academic school year, Fall 1977—Spring 1978. He took over immediately after the Spring 1977 semester because Dave Welter, the outgoing President, had to leave quickly on a Mediterranean submarine Navy cruise. As if he didn't have enough to do, Jim was also elected as the Chairman of the Student Branch of the IEEE.

FREIDELL'S FOLLY — THE IMPOSSIBLE DREAM

A few days after the spring semester ended three of the chapter members went to the basketball arena and performed ambient ligting tests which had considerable impact on the entire message board project. Mark Gaddis, Jim Freidell and Dave Welter took the six display modules, the control system and keyboard from the previous design to the arena and temporarily mounted them on the wall where the new one would be fastened. The bulb power supplies were connected to an autotransformer so that the bulb intensity could be varied. The arena lighting was then set to match actual game conditions. Once everything was properly connected, it was discovered that the last two display modules were not working. This left a message board that was only four characters long, but that was more than adequate. Even though the display was quite small, the three people involved were extremely impressed with the visibility of the displayed characters. For the first time they were able to see exactly how the messages would appear as they were "walked" across from right to left. The new 6 x 7 matrix of light bulbs was easily visible from the other side of the arena, over 300 feet away. After much adjusting of the brightness level, it was determined that each bulb should be supplied about 75 volts. One of the lighting problems was that if the message board was too bright, it could become a distraction to the players on the floor, especially when the displayed message was in motion. On the brighter side, the 75 volt level would extend bulb life significantly. This would be quite important with several thousand to be properly maintained. However, the most important result of the test was not the determination of the illumination level. The fact that the display modules could now be seen exactly as they would appear in the basketball arena meant that the viewability of the message board could be checked from various locations in the arena seating area. It was determined that, with only one message board, about one third of the people watching a game would have little or no view of the displayed messages. Thus, it was deemed necessary to construct two message boards, placed on diagonally opposite walls so that no matter where people were sitting, it would be possible for them to see at least one message board quite well. Also, after examining the length of the walls where mounting would take place, Jim realized that a 63 character message board could be easily accommodated on each wall. He decided that the goal would be to build two 63 character message boards, each having its own display controller (computer). This would raise the total number of microprocessors for the entire system to three.

The decision to quadruple the original size involved much more than the expense of the project. Because all the labor was to be done by the Delta Omicron Chapter members, Jim was counting on his ability to motivate the people around him to complete a project which would be much greater than was originally planned. Many people called this decision "Freidell's Folly" and said the message board would never get finished. Since you are now reading this final report, it is apparent that Jim proved them "dead wrong".

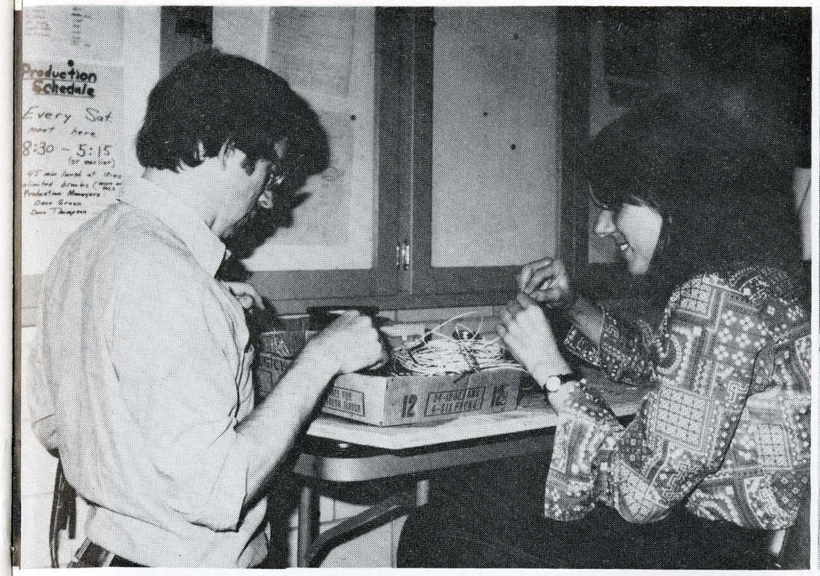
EARLY SUMMER DESIGN WORK

Much of the design work for the new message board was done during May and June, 1977. A tremendous amount of thought was given to every aspect of the design to insure that the final system would perform properly. The design staff tried to be conservative wherever possible to insure functional reliability and longevity for the new message boards. It was decided that every subassembly would be modularized to make in-game repairs as quick and easy as possible. This included the display modules, the display controllers, the master computer and even the data bus.

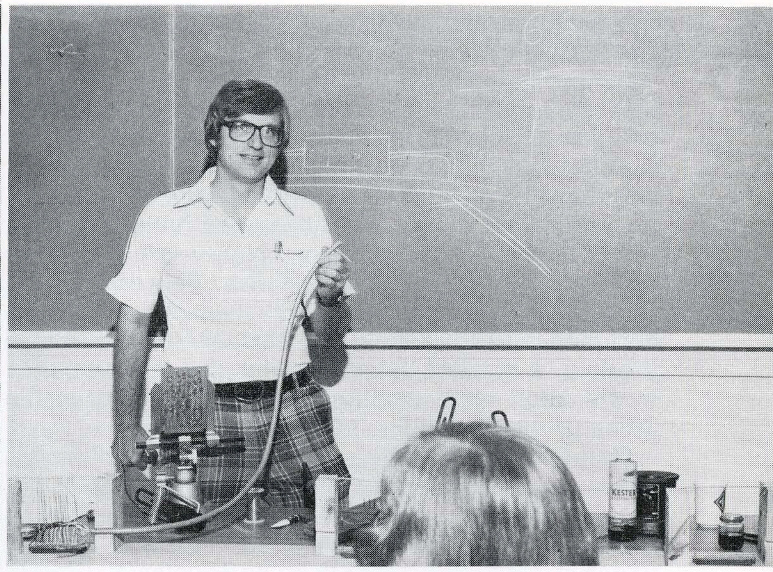
Jim Freidell, being the main moving force in the entire message board project, realized that he could not do everything himself and would need the help of other people willing to help run the production and quality control groups. Thus, he enlisted the help of another Delta Omicron Chapter member, David Green, who had been given the position of Production Manager. Dave was immediately put to work assisting with the design work along with Jim and Dr. Knudsen, who found himself voluntarily putting in more and more time on the most interesting chapter project he had ever seen.

The main design was performed using a "think tank" process whereby everyone on the Design Group would contribute ideas, the best ones being examined and sometimes incorporated in the new system. To arrive at the specifics of the design, the message board system was broken into several small blocks. Each block was defined in terms of its input and output characteristics. Then the necessary circuitry was chosen to meet the design requirements. Because it was imperative to start production on the display modules as soon as possible, the design work on the master computer and the display controllers was put off until the end of summer.

The easiest part of the system to design was the data bus. Because a 6 x 7 display matrix was to be used, 7 data lines would be required, one for each row of the display. There were also 64 display modules, which would need to be individually addressed, thus 6 address lines were also needed. With two additional data lines, one for the clock signal, and one for clear, there would need to be a total of 17 lines, 5 volt power and ground included. Furthermore, since each display controller would contain line drivers at



All of the wires had to be cut to specified length, stripped, and tinned.



A 3-week course was given to Chapter members by Jim Freidell on NASA and industrial soldering standards.

one end of the bus, resistive loads at the opposite end were necessary. Because the data bus would be 64 feet long it was absolutely necessary to modularize it so that the entire length would not have to be removed to correct a problem. The decision was made to make the data bus in six foot sections which would be plugged into each other. Once the bus structure was completely mounted it would be possible to remove any section without disturbing the remainder. To make the required connections to and from the display modules, it was decided to use PC board edge connectors. This would allow the display module electronics on PC boards to be plugged directly into the data bus, thus helping to reduce noise. To facilitate the insertion and mounting of the PC boards, card guides were to be installed on the bus at the location of each edge connector.

Perhaps the most demanding and critical hardware design effort was that of the electronics for each of the 126 display modules. The driving parallel data bus structure proved relatively noise-resistant in early tests and the design crew was determined not to make the interface an electrically weak link of the system. Some overdesign was to be inevitable and this was the place to do it. To minimize the possibility of noise being propagated from a module to an entire data bus, open collector inverters were used on all 15 inputs from the bus. The power for these inverters was to be derived from the display controller power supply via the bus, all other module logic was to be powered by a 5 volt supply contained in each module. Due to the 6 x 7 matric nature of each module, seven 6-bit serial in - parallel out (SIPO) shift registers were chosen for the local memory. The clock for these registers was derived from the bus clock and module address circuitry by means of a pulse width comparator for noise rejection purposes. SCR's were chosen for lamp drivers largely due to economic reasons. CMOS IC's were chosen where practical since they were cheaper than their TTL family counterparts. Once thoroughly designed, the circuit was bread boarded. One full week (which consists of seven 14-hour days) was required to debug the circuit. (To this day it remains a mystery why a CMOS inverter rings with a 510 pF capacitor from input to ground!) Jim Freidell, largely out of desperation, solved the problem with a series 10KΩ resistor (he swore he would someday determine why this solution worked). Dr. Knudsen wrote a program for the department's 6800 μP to fully test the prototype under a generated high noise environment. Another week of severe tests proved the design worthy of acceptance, now simply a milestone annotated on the progress chart.

Module chassis had already been ordered but it was now necessary to begin ordering the tens of thousands of components required to construct 132 sets of module electronics. To obtain the best prices it was necessary to contact several suppliers and compare quotes. Lloyd Harrison, appointed as Components Engineer tasked with purchasing, had most of the responsibility. Since paperwork (read; red tape) is a necessary evil in such work, Lloyd filled out many University purchase requisitions and did much leg work to obtain the necessary signatures. He also needed to work closely with the design crew to determine substitution suitability and required quantities, including percentages to take care of early failures and the inevitable mistakes in production.

Because the printed circuit laboratory in the Electrical Engineering Building was fairly small, the 132 PC boards for the display modules were to be produced by a professional company set up for mass production. All preliminary design work on component placement and part pattern layout was done by the chapter members. The boards were to be double sided with edge connector patterns on each end to facilitate connection to the data bus and the display modules.

In early July 1977, Jim Freidell met with the University of New Mexico Staff Engineers to work out the details of the mounting structures which would support the display modules on the wall in front of the upper mezzanine seats. Jim recommended that they be designed for a weight of 40 lbs. for each module even though the estimated maximum weight was about 32 lbs. This meant that the entire mounting structure would need to be designed to support 2560 lbs. It was also necessary to produce a method for mounting the modules that would allow each module to be easily replaced for quick in-game repair.

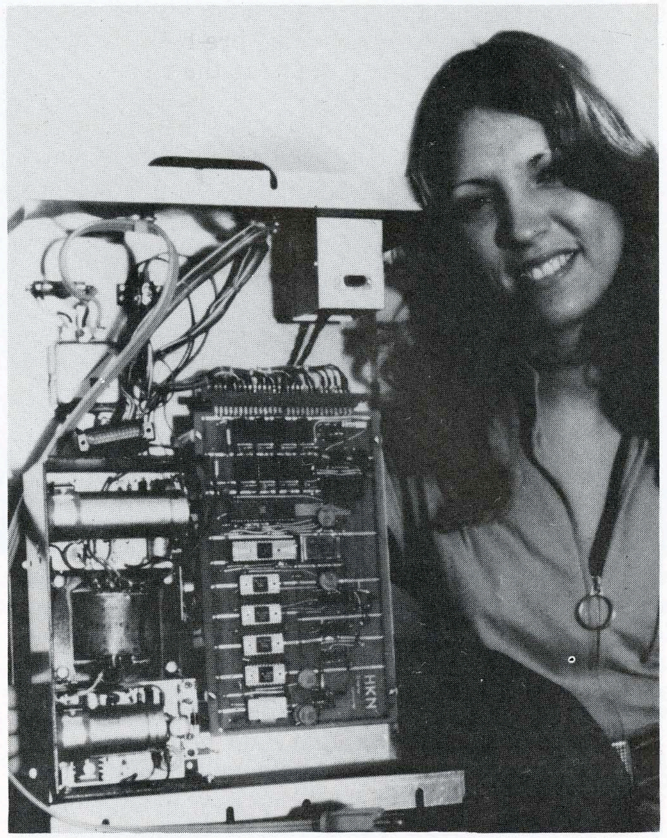
Besides the mounting structures, it was necessary to have a new electrical power circuit installed in the basketball arena. This was necessary because each message board could draw a maximum of 11 KW under worst case conditions. The decision was made to give each board a three phase, 115 volt, 50 amp supply. There would also be a separate 115 volt, 10 amp supply for each display controller to avoid switching transients on their supply lines.

The power supply for each module required a 5 volt supply for the digital electronics and full-wave rectified 75 VRMS for the light bulbs. Dave Green worked on designing the 5V regulator while Jim "played" with transformers. Several different off-the-shelf models were tried in an airtight prototype of the module chassis but it was finally determined that there were no commercially available power transformers which met all of the requirements for voltage, current, size, electrostatic shielding, and heat dissipation (desired efficiency). Because the transformer would be enclosed inside the module chassis and mounted in close proximity to the electronic components on the PC board, it was important to use a transformer which would not become too hot after being operated for several hours. It was custom wound to obtain the required operating characteristics.

Another necessary item for operation of the new message board system was a large control room from which both message boards and the playing floor could be seen. Jim decided that the best location was directly above the radio and television network control room. The new room would be 8 ft high, 20 ft wide and 10 ft deep and would have a glass front to give the people inside the best possible view. Because the room was located over 50 feet above the playing floor, an unobstructed panorama would be had of nearly the entire arena. This is needed, when considering that the University of New Mexico basketball arena is the third largest in the country, seating over 18,000 people. (It also had the second largest attendance last year, second only to national champion Kentucky).

START OF PRODUCTION

In the second week of July 1977, Jim Freidell called a meeting of all members of the Delta Omicron Chapter to announce that production would begin on



Shown is one of three "display controller" computers that hang alongside each message board. One is a spare, reserved for in-game repairs.

the coming Saturday and continue every Saturday from 8 to 5 until the project was completed. The goal was to have both message boards up and running by the first home Western Athletic Conference game during the 1st week in February, 1978. Jim stressed the fact that a great many people would have to help with production each Saturday in order to meet the February deadline. A special bulletin board was set up in the student lounge in the Electrical Engineering building for posting the production schedule, section meetings, progress reports, and the milestone chart which Jim had devised.

The tremendous volume of work required during the production phase of the project made it necessary for professional production line and quality control methods to be adopted. Every one of the thousands of solder joints would be checked for quality and every electronic subassembly would be thoroughly tested before being installed in the proper location.

Production work on the display module chassis began in late July. These chassis were purchased from Bud Radio Corporation and were already pre-bent and ready for drilling. Each chassis required 63 holes to be drilled for component mounting and ventilation. That's a total of 8316 holes drilled manually using a drill press and/or hand drills. The biggest problem were the 42 1⅜" diameter holes which had to be punched in the front of the chassis to accommodate the light bulb sockets. Because 5544 of these holes had to be punched, having it done by a

professional company was considered. However, since the chassis were already pre-bent, a punch press could only do the holes near the center of the chassis. The holes on the edge were located very close to a bent lip on the chassis, thus hindering the operation of the punch press. It therefore became apparent that members of the Delta Omicron Chapter would have to punch the holes by hand using chassis punches. After one day of very slow progress and some very tired people, Jim decided that there must be a better way. He talked with some workers at a local machine shop and they suggested using an impact wrench to drive the chassis punches. Jim borrowed an electric impact wrench and took it to school to test the idea. It turned out to be much easier but took about 40 seconds per hole, still too slow for the production schedule everyone was trying to meet. The electric device was returned and traded for a pneumatic impact wrench. Because it was air powered, a high pressure air supply was needed. Fortunately, one was available in the maintenance and repair shop located in the Electrical Engineering building. When this new device was first tested, the people using it could not believe their eyes. The new hole was punched in about two seconds! For obvious reasons the impact wrench quickly became known as "the bionic arm." A second impact wrench was soon acquired and what could have been pure drudgery turned into fun when the two chassis punch teams decided to have races to see who could punch the 42 holes in a chassis the fastest. Needless to say, the chassis punching went much faster than anyone had thought possible with all 132 chassis being completed in slightly over four weeks. (Note: The teams worked only on Saturdays.)

Even though most of the parts had been ordered in June, many had not arrived by the time production began in mid-July. It was important to begin work on the wiring harnesses to connect the display module light bulbs and power supplies to the digital electronics on the PC board. Each wiring harness had 45 wires, 42 for the light bulbs and one each for the 5 volt power supply, the 75 volt power supply and the ground connection. Every wire was to be color coded and cut to a specific length. They would then be soldered to a PC board edge connector. Because each of the 132 modules required a wiring harness, this was by far the most time consuming part of the entire construction process with about 50% of the production time being devoted to them.

The initial phase of the wiring harness production involved the cutting, stripping and tinning of 5740 color coded wires. These wires were sorted by size and color and placed in boxes so that they could be easily located during assembly of the harnesses. Since the connections to the light bulb sockets had to be made with larger diameter wire than was to be used for the harnesses, it was necessary to cut 5544 stubs 1½ inches long from #10 stranded wire. Forty two stubs would then be soldered to the correct wires for each wiring harness. Once the stubs and PC board edge connector for a harness were properly connected, it became necessary to bend the wires into the proper shape and lace them securely together. Many jigs were commercially available to hold the wires properly while they were being laced together, but these devices proved to be quite expensive. Jim Freidell devised a jig which consisted of a wooden board with several nails. These nails were spaced exactly so that when the harness wires were guided around them in the proper manner, it was quite easy to lace the wires together. The finished harness could then be removed from the jig and the proper shape would be retained, allowing a neat professional appearance within the display module chassis.

After each wiring harness was arranged in a jig it would have to pass quality control by the team of Dave Thompson (Chief of Q.C.), Dave Green, and Jim Freidell. They checked the solder connections at the P.C. board edge connector and the stub connections at the other end of the harness. Visual verification of correct color and wire length was made. Leaving nothing to chance, a full continuity test was then required. Only after passing full quality control the harness was laced, passed by the heat gun to shrink some tubing, and lovingly placed in the completed harness box. This quality assurance procedure ensured that very few problems would be encountered once the wiring harnesses were installed in the display modules and tested. (Only one set of two misplaced wires were found in final test).

Throughout the year, it proved difficult to get the chapter members to come and help with production. Jim Freidell and Dave Green had to do a considerable amount of phone calling to urge people to put in their fair share of work.

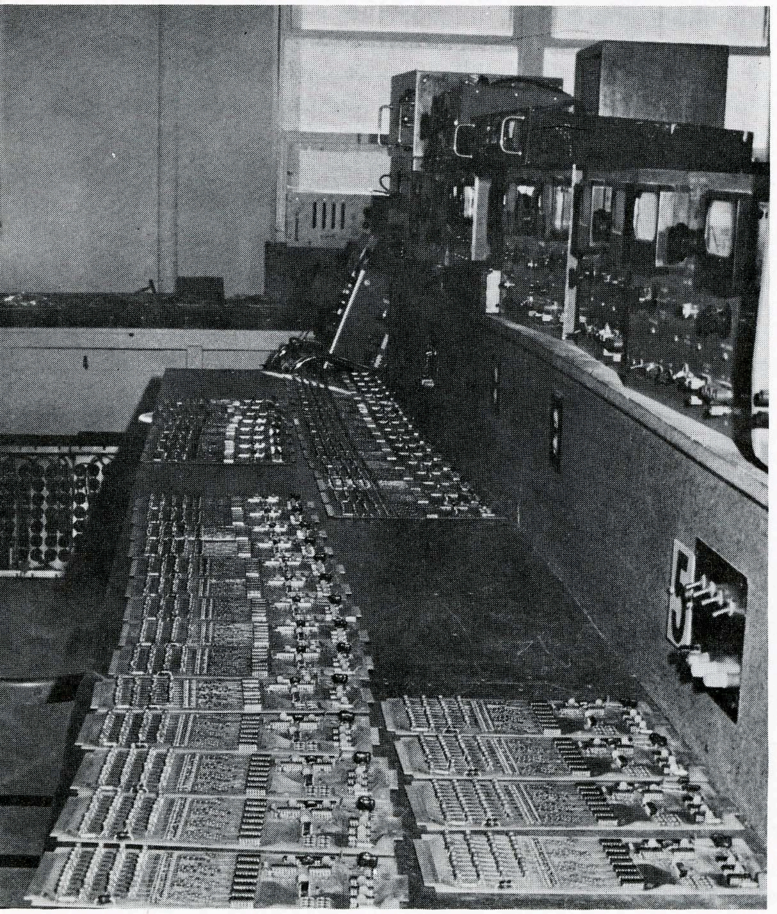
Two weeks before the fall semester began, a group of three people, Evans Spanos, Kevin Denney, and Jim Freidell attended a short course on micro-computers taught by Dr. Knudsen. This course was held in two 4-hour sessions and covered nearly everything in Dr. Knudsen's semester-long EE444 microprocessor course. Once the course was completed, the design of the software for the computers was initiated. The first thing was to determine the communication format to be used between the master computer and the display controllers. Once this was decided, it was then possible to define the necessary display controller functions. All the software was written by the chapter members, using algorithms and flow charts which were eventually implemented using assembly language.

Once the Fall 1977 semester began, design and construction was started on the hardware of the master computer and display controllers. Work also began on the terminal display which would contain the data entry keyboard for the main computer. The terminal display would also utilize 32 HDSP2000 alphanumeric displays which were donated to the Chapter by the Hewlett Packard Company. Each display is capable of producing four alphanumeric characters using LED illumination. The decision was made to use two rows of 16 displays each, which would allow 64 characters per row to be displayed. The top row would be used to display command instructions and the bottom row would be used for the messages to be shown on the message boards.

In late September, the design of the computer software was given a boost when a new Graduate Engineering student, John Brockmeyer, was appointed as Chief of the Programming Staff. John, who had joined Eta Kappa Nu at another University, had considerable assembly language experience. Work was immediately begun on the editing functions of the terminal display. Also, the design of the character generator was started. Because the character generator was software based, the displayed characters would not be limited to those in the ASCII Code, providing great flexibility to the system for graphics display.

As the fall semester progressed, all phases of the message board project were going quite well. Nearly all of the necessary components had arrived by October and were in the process of being installed. Two notable exceptions were the 75 volt custom wound transformers and the display module PC boards, both of which were expected to arrive momentarily. Before each Saturday, the Production Managers would meet to discuss what had been accomplished the previous week. Plans were then made for the production details for the coming week. The components inventory was checked to verify that all necessary items were available when needed. This mid-week planning was necessary to insure that no unforeseen problems arose.

Here some of the module printed circuit boards have passed final test and are awaiting solvent cleaning (to remove flux residues) and serialization.



In late November, the display printed circuit boards arrived, allowing that assembly line to begin operation. The printed circuit boards took up a substantial amount of production time. This was due, in part, to the fact that each board required 632 very small solder connections. However, a large amount of production time was also used to bend leads and mount all of the necessary components on each PC board. Furthermore, special anti-static handling was required due to the CMOS IC's. Static-free work-benches were set up for all critical PC board assembly operations. Once a printed circuit board was completely finished, with all of the components properly mounted and soldered in place, it was carefully examined by one of the members of the quality control staff. Because the pads of the conductive foil pattern were so small it was necessary to use a 1/16″ diameter soldering iron tip during construction. This small size also meant that the person performing the quality control checks had to be very careful to insure that no bad solder joints went undetected. Many joints which appeared good at first glance were found to be marginal upon closer inspection and had to be re-worked. After the solder connections of a PC board were approved, the board was connected to a computer which contained a complete test program for the display module electronics. The PC board was also connected to a 6 x 7 matrix of light bulbs so that the results of the test could be observed. The computer program first checked the addressing circuit to determine if the board recognized when it was being addressed. Each PC board was wired in exactly the same manner except for certain jumper wires which determined the address code for that board. Every board had a different address, and it was necessary to make sure that it responded only to the correct address. Thus, the computer generated every possible address and monitored any incorrect response. Next, the computer generated a series of signals which tested the light bulb switching circuitry. The result of these signals was an alternating checkerboard display which was visible on the previously connected matrix of bulbs. Once a PC board had successfully passed all of these tests it was ready for burn-in testing to catch premature component failures.

Once the Christmas vacation for 1977 began, Jim Freidell decided that it was necessary for production to be held every day if possible. Fortunately, for the chapter members, the spirit of the Christmas season finally got through to "Scrooge" Freidell and he actually let everyone have Christmas Eve and Christmas day off. But it was back to the grindstone the next day.

The New Year, 1978, brought a most welcome surprise. The custom-wound transformers had finally found their way to Albuquerque. Over three months late, the manufacturer air-freighted them to us (with a little prodding from Jim and a friend named Noel Runyan, a former UNM EE student, who happened to live near the California manufacturer). Twelve hour days were worked by all, to fit the nearly finished modules with this missing link.

By early January 1978, one of the display controllers had been completed, so the decision was made to use it to run several of the display modules during burn-in tests. Two wooden racks were built which would hold 8 display modules each. The test consisted of running 16 modules for 4 or 5 hours to determine any premature component failures which might occur. During this time, the display controller would run a continuous program which caused a repeating pattern to move across the face of the display modules. Once the 16 modules had passed the test, they were replaced with 16 more and the burn-in test was repeated.

INSTALLATION

During the 2nd week in January, installation of the north data bus was begun at the basketball arena. By that time all of the mounting structures and electrical wiring had been installed at the arena. Also, the new control room was nearly finished and it appeared to be very nice indeed. After the installation of the north data bus was completed a potential problem surfaced which all of the careful planning had accidentally overlooked. When a signal was applied to a data bus line it would travel down to the end and then would be reflected back. This caused a standing wave pattern along the entire length of the bus structure! It was determined that when 5 volt data pulses were applied to one end of the bus, 13 volt spikes would appear near the middle of the bus. These spikes would certainly be deleterious to the 5 volt digital logic devices inside the display modules unless they were first attenuated. Fortunately, it was determined that the module electronics provided sufficient load to the bus lines to damp out the hazardous spikes. To be on the safe side the display modules were installed in sequence from each end of the data bus structure toward its center, making measurements each step of the way.

During the 3rd week of January, installation of the south data bus and display modules was started. Also, construction on the master computer and terminal display, which had begun many weeks earlier, was shifted into high gear. Things were beginning to get fairly rushed, with the first home Western Athletic Conference basketball game for the Lobos less than two weeks away.

D - DAY

The day before the game, the 1st Friday of February, 1978, everyone was trying to tie up all the loose ends so that the message board system would be operational the next day. Several people worked straight through the night with no sleep. The terminal display was still far from being ready and

Making the wiring harnesses for each module was a tedious task. Nearly half of the production time was required.

most of the work was devoted to getting it together and running.

By 10 o'clock Saturday morning, it was apparent that the terminal display would not be ready for the 2 o'clock game. It was still necessary to connect three wire wrapped component cards to the keyboard and the wired alphanumeric displays. Fully testing this peripheral would require a couple of hours itself. Furthermore, a small disaster struck in the middle of the night. The PDP-11 computer handling the cross-assembler broke down under the strain of John Brockmeyer's gallant 68 hour continuous effort (no, he didn't sleep) to finish the needed master computer software. This left his weary programming team to assembling the final pieces of software by hand, a tedious task even when wide awake. A small error existed in a semi-essential portion of the software and it just defied detection. Dr. Knudsen, upon hearing about the problems, quietly went to his office and produced a real surprise for all the chapter members who worked so hard for this one day, only to fall

A partially completed module was shown to prospective members at the Fall 1977 Smoker. Sara Shelly did not know at that time that she would work more than 500 hours on the Message board.

barely short of their goal. He created a small program in assembly language that could be used in the display controllers, stand-alone, without assistance from the Master Computer. With his program recorded in two PROM's, Dr. Knudsen delivered it to some very tired students in the control room just minutes before the game. Hurriedly, they rushed to each message board and installed the PROM's. At an appropriate time during the game two switches were thrown, powering up the message boards, which resulted in the words "GO LOBOS, BEAT UTAH" repeatedly walking perfectly across the two 64 foot long displays. The terminal display was finished and the software bug fixed a few days later, and the message board system was fully operational for the next home game. It turned out that the Delta Omicron Chapter missed its most challenging goal by about six hours! (Or did it? Who said what was to be displayed at the first home Western Athletic Conference basketball game?)

OPERATION OF THE MESSAGE BOARD SYSTEM

The master computer has complete control over all facets of the message board operation. It has the responsibility of monitoring all of the input-output devices including the keyboard, punch panel and the floppy disc unit which will be added later this year. The master computer must also take care of data and display command transmission to the display controllers. Error detection and correction is continually performed by all three computers to insure that error-free information is sent to the display modules. Hereafter only one board is discussed, as the operation of the other is identical.

Once the correct information has been received by the display controller, it is stored until given a display command by the Master Computer. The display commands contain information which specify the format to be used during display of the data, such as a walk left display or a static display, which fills the board with the message instantly.

With respect to the display controller, the process of transmitting data to each individual module is identical regardless of the displaying mode. First, a 7-bit data word in parallel format is set up and momentarily held on the data lines, essentially making it available to any module that grabs it. The display controller is quite a bit smarter than a module in that it knows which module is supposed to get the data currently on the bus and it tells that module when to pick it up. This is accomplished by a parallel (binary) addressing of that module using the address lines. The display controller places a pulse on the data bus clock line informing the addressed module to pick up the data upon receipt of the pulse. Now let us examine what the module does with this new piece of information.

Each module contains 7 serial input - parallel output shift registers, one tied to each data line. When properly checked, each shift register picks up the bit on its data line, shoves it into memory, pushing what was there up into a higher level of memory and so forth. Each "level" corresponds to a column for that module and each shift register is connected to its own row of light bulbs. Therefore, it should be easy to see that the new 7-bit data word corresponds to a column displayed and it is entered into and displayed on the rightmost column of that module. The column that was there previously is shifted one column to the left. After repeated clock pulses (addressed to our example module) the "new" column has found its way over to the leftmost column of the module. If one more shift occurs, that original 7-bit data word is lost forever to the great "bit bucket in the sky". However, we would like to continue moving that column down the whole display. The display controller is a smart little devil and it remembers that 7-bit data word so it automatically knows when our example module "loses" it and sends it over again to the module just to the left of our example module. As this process continues for each module a message is walked across the whole display. For the static display mode, the same process occurs, but it walks a whole message on so fast that no motion can be sensed by the human eye. Should noise interfere with a particular 7-bit word it will be displayed, but the error will be confined to the addressed module until it is walked off that module and forever lost. This is of little consequence, as no error has yet been displayed. The only other data line contained in the data bus is the clear line, its purpose being to clear simultaneously all the shift registers. Selective clearing of shift registers is accomplished by loading in a blank column or groups of blank columns.

CAPABILITIES OF THE NEW MESSAGE BOARD SYSTEM

Once all the planned peripherals are added to the Master Computer and the necessary software is written, the new message board system will have a data display capability which is second to none. One of the peripherals presently being constructed is a punch panel which will have several push buttons. There will be one button for each player of both teams. There will also be buttons for entering or requesting data. When used in conjunction with a floppy disc unit which will also be connected to the master computer, every statistic for either team will be displayable on the message boards, merely at the push of a button or two. The free throw average of a player can be called up simply by pressing the button for that player and the free throw percentage button. Once the free throw is shot, the player's average is automatically recalculated. This is done by telling the computer whether the shot was successful or not. Because field goals are not as easily recorded due to penalties called by the referees, this data is entered into the computer memory only when official statistics have been received.

There are several other display options which can be realized. Because each 63 character message board has its own display controller, it is possible to operate each message board independently. Thus two different messages can be displayed, one on each board. There is also extensive work being done to develop an entertaining graphics software package. The entire message board can be thought of as a graphics display matrix which is 7 bulbs high by 378 bulbs long. Because the character generator is software based, it is possible to display anything, not just the usual ASCII character set. A new peripheral currently in design will allow an operator to shade in dots on a piece of paper to form a new character or a whole graphic display, pulling the paper through the peripheral to enter the data.

There are also several options which give a great amount of flexibility when displaying messages or graphics. They are:

1. Static Display - allows a message to be displayed instantly.
2. Walk Left - a message is walked from right to left, one column at a time.
3. Walk Right - a message is walked from left to right, one column at a time.
4. Walk Through - allows one message to be statically displayed while a second message is walked through it.
5. Blink Display - allows the characters in a message to be blinked on and off repeatedly.
6. Walk Around - as a message is walked off one board it can be walked onto the other one.
7. Clear Boards - independently clears each message board.

With a good imagination nearly anything can be displayed on the new message board system, especially since options 1 through 5 can be accomplished for a whole display, part of it, or even a single column.

TRIBUTE TO THE MEMBERS OF THE DELTA OMICRON CHAPTER OF ETA KAPPA NU

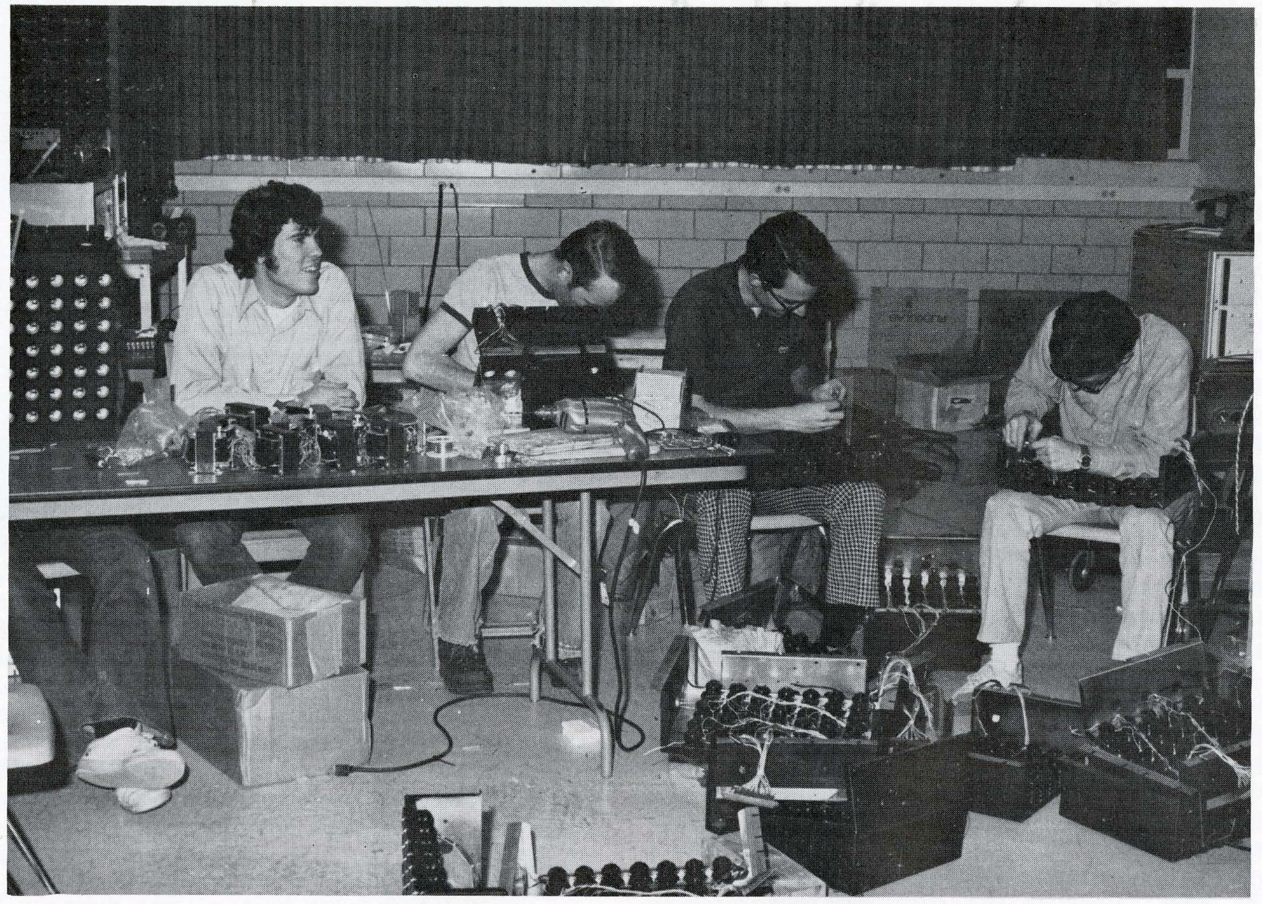
It is essential to keep in mind that, by any account, this was an almost impossible project. Even now, Jim Freidell cannot believe the project was actually completed. The chapter members contributed over 28,000 hours of their own time to complete the message board system. Many people gave up their entire summer and Christmas vacations to help in production. It was not unusual in December, two months before the deadline, for someone to come in and work for 8 hours, go home to eat supper, then come back to school and work another 8 hours, occasionally continuing for several 7-day weeks. The completed message board system cost $30,000 but its estimated value is well over $600,000. Over 125,000 solder connections were made and inspected for quality, and only a very small percentage required reworking.

Both Jim Freidell and Dave Green should be given a tremendous amount of credit for their untiring devotion to the project. Every week they had to plan ahead to the coming Saturday, anticipating every possible problem, and preparing a prodcution schedule to keep things moving smoothly. Every facet of the design and production was supervised by these two people, and it is doubtful if there is any professional production company in the country that could have done a better job than the team which was organized and put into action by them. Considering the complexity and immensity of the project, it is amazing that the date chosen in May 1977 for the board to be fully operational was missed by only six hours. This was after eight months of intensive design and production which eventually culminated in an electronic message board system which is probably one of the most sophisticated of its type in the country. Every member of the Delta Omicron Chapter should be extremely proud of this accomplishment. Hopefully, this report demonstrates what can be accomplished when all of the members of a chapter put all of their time and effort into a worthwhile project for their college or university.

OTHER CHAPTER ACTIVITIES, ACADEMIC YEAR 1977 - 1978

The academic year 1977 - 1978 was not devoted solely to the message board project. Necessarily, the usual chapter activities were held plus several other items are worth mentioning.

In August 1977, one of the members of the Delta Omicron Chapter, David D. Welter, was presented the Alton B. Zerby Outstanding Electrical Engineering Student Award. This was the second time a student from the University of New Mexico has been named as the recipient of this award and the first time that any college or university had been so distinguished more than once. The first student from



Every laboratory and at least one classroom in the Electrical Engineering Building was used for production at one time or another.

UNM to receive the award was a blind electrical engineering student named Noel Runyan. He received the award in 1973.

In September 1977, the new Chapter President, Jim Freidell, decided that it would be a great idea to invite Noel Runyan to be the guest speaker at the Fall initiation banquet in late November. Noel, who was at that time working for IBM, was contacted and eagerly accepted the invitation.

At the same time, Jim obtained a complete list of all members, old or new, who were receiving *The Bridge of Eta Kappa Nu* in New Mexico. Each member was sent an invitation to come and see the message board production process during Saturday, November 19, 1977, and to attend the initiation banquet that evening. An invitation was also extended to each of the National Office members. Jim was soon informed that National President, Marcus Dodson and his wife, would attend the banquet.

In late September, the Fall smoker was held at a plush local apartment complex. The turnout was the largest we have had for a smoker, with over 80 people attending. Besides stressing the reasons for and the importance of joining HKN, we also gave the potential new initiates a pep talk about the chapter's largest project, the new electronic message board system. A brief outline of the project was given to show the tremendous amount of work which was needed to complete the message board for the first home Western Athletic Conference basketball game in February. The prospective members were also given the chance to examine one of the first display modules of the new message board.

About mid-October, the local Public Broadcasting Service television station did a show about the message board production and the people involved in the project. Additionally, the *New Mexico Daily Lobo* campus newspaper published a front page story entitled "Electronic Messages to Flash UNM Arena."

In November, the final preparations were begun for the initiation banquet. Saturday morning, November 19, Jim picked up President Dodson and his wife at the Albuquerque International Airport. After convincing them to take a brief rest at their hotel room until lunch, Jim rushed back to school: The local NBC station was coming to film a story on the message board for its newscast. After lunch, Dr. Kelly and Jim drove Mr. Dodson and his wife to the Electrical Engineering building on the University of New Mexico campus. Here, the President and his wife were given a complete tour of the production facilities. Because this was a production day, there were almost 40 people working on various aspects of the project, including module and wiring harness construction, quality control inspection, and software development. The next stop was the University Basketball Arena to see the new message board mounting structures and the partially completed control room overlooking the playing floor. Mr. Dodson was very impressed with what he saw and said he believed this was the largest project ever attempted by any chapter in the country.

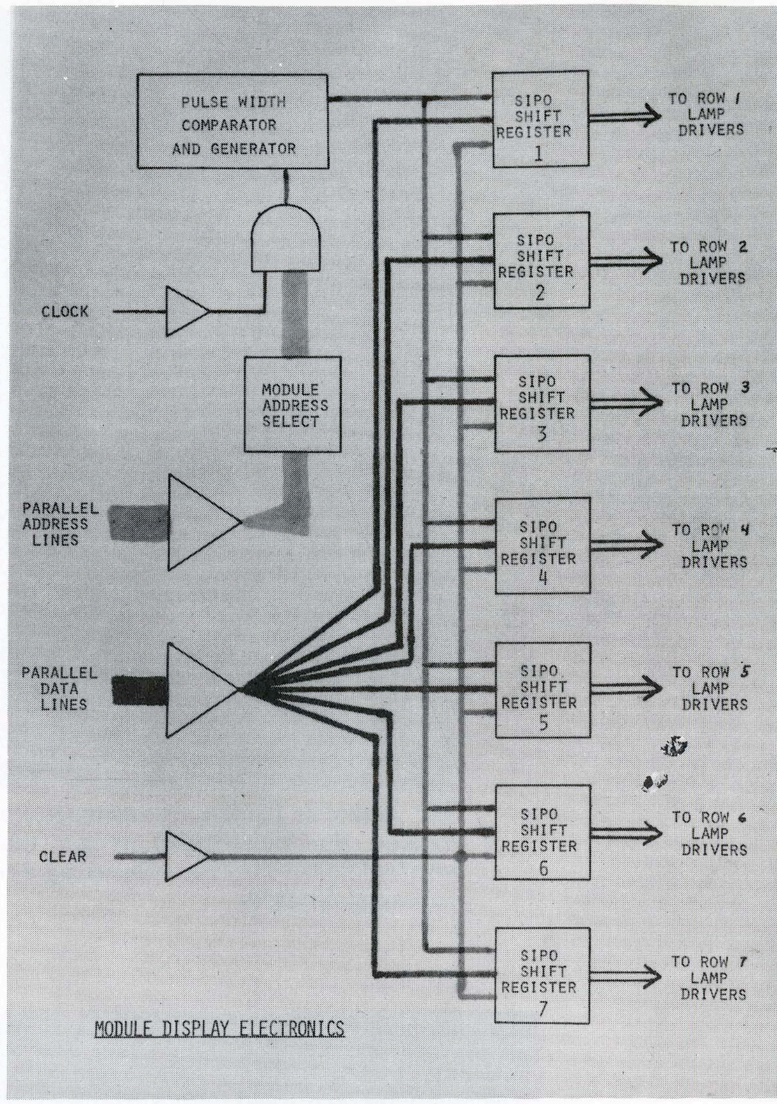
That night the initiation banquet was held at Bella Vista Restaurant. It was the largest and most successful one in the history of the Chapter. Over 100 people attended as 26 new members were initiated, including 6 professors. After an excellent meal, the Chapter gave out two Distinguished Service Awards, both of which were presented by President Dodson. These awards were developed for the Chapter by Jim Freidell who consulted with the National Secretary, Paul Hudson, about the wording of the awards. Dr. Ruben Kelly received one of the awards for his tremendous contributions as faculty advisor and for his untiring work with the University to help obtain the insurance money which enabled the new message board system to become reality. Dr. Harold Knudsen received the other award for devoting an enormous amount of his own time in helping to design the message board and for acting as a very willing technical advisor for the entire project.

The biggest attraction of the Fall 1977 banquet, however, was the guest speaker, Mr. Noel Runyan, whose talk was entitled, "The Impact of Technology on the Visually Handicapped." He has been totally blind since the age of 16, and yet was able to take, and pass with flying colors, complex engineering courses at UNM which cause problems for many sighted students! His talk, laced with his unique sense of humor, included several slides plus actual demonstrations of some of the new devices which are being produced to help the visually handicapped. It was probably the most interesting and well received after-dinner speech in the history of the Chapter. The evening ended on an enthusiastic note with Mr. Runyan receiving a standing ovation.

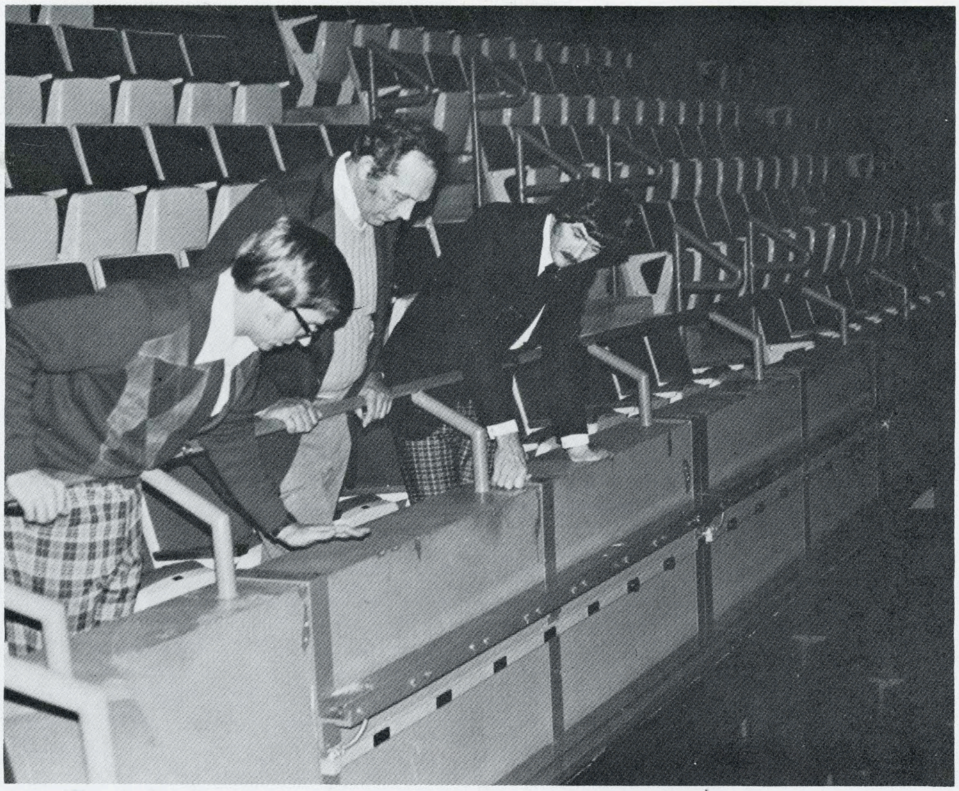
Because the University of New Mexico was the first university to have two winners of the Alton B. Zerby award, Jim Freidell decided to get these two people together on a TV show at the local PBS network station. This was done two days after the banquet, with both Noel Runyan and David Welter discussing the impact that the award had on their lives.

While he was in Albuquerque, Noel also helped Jim produce a videotape to help handicapped students. Also helping in this project were a deaf girl and a paraplegic, both of whom were students at the time. An interpreter for the deaf was filmed at the same time, because it was cheaper than dubbing the words onto the film. The film was devoted to helping handicapped students overcome some of the non-physical problems which are encountered at any college or university.

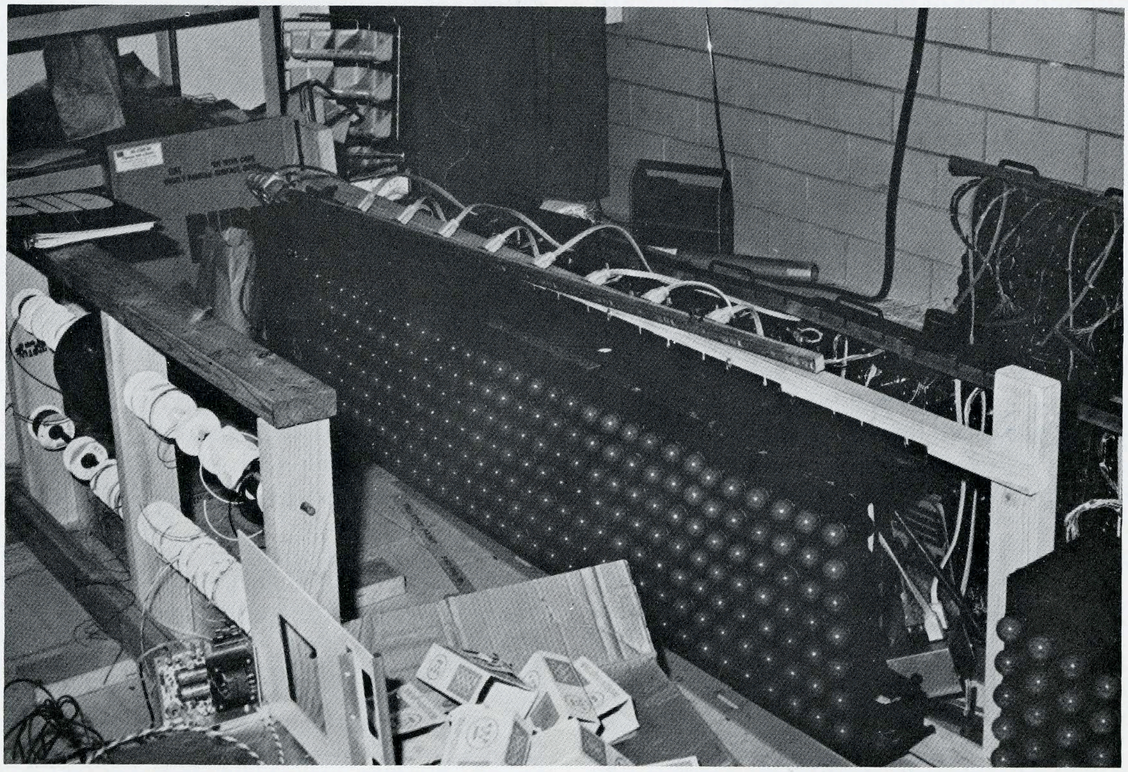
In November, 1977, a female student who is a paraplegic, contacted Jim Freidell about the possibility of having some of the chapter members repair her chief means of transportation, a modified electric golf cart. Jim accepted the job and after a careful inspection, discovered that the speed control circuitry was not operating properly. Instead of having four forward and reverse speeds, it had only two, fast and faster. Because the company that had built the device was no longer in business, Jim designed and built a new speed control system which was much more reliable than the old one. It also made the golf cart much easier to drive.



In late Frebruary, Jim Freidell was invited to speak at the Albuquerque Section of the IEEE Annual Symposium on Microprocessors and LSI Technology. It was the first time in memory that a student was invited to give a paper at this conference. Appropriately enough, the title of Jim's talk was "An Advanced Message Board Design". The presentation included slides of the hardware and the people who built it. Also, a working model was put together from five of the spare modules and a display controller so that the letters HKN could be repetitively walked across, for all to see. The nearly 500 engineers in attendance gave the warmest reception of the day to a group of dedicated, hard-working, and tenacious young electrical engineers, the members of the Delta Omicron Chapter of Eta Kappa Nu.



Mr. Marcus Dodson, International President of Eta Kappa Nu (center) visited the basketball arena where he saw the partially completed control room and the mounting racks that would eventually hold the two message boards.



All display modules, including p.c. boards, were burn-in cycled for 4 to 5 hours to catch premature component failures.