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CCCCC  OOOOO  MMM MMM PPPPPP  UUU UUU TTTTTTTT  IIIII NN  NN  GGGGG
C      O      O  MM MM  P    P  U    U  T    T  T    I    N  N  G
C      O      O  M M M  P    P  U    U    T    I    NN  N  G
C      O      O  M M M  PPPPP  U    U    T    I    N N N  G  GGG
C      O      O  M    M  P      U    U    T    I    N  NN  G  G
C      O      O  M    M  P      U    U    T    I    N  N  G  G
CCCCC  OOOOO  MM    MM PPP      UUU      TTT      IIIII NN  NN  GGGG

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      AAA  TTTTTTTT
      A   A T  T  T
      A   A    T
      AAAAA  T
      A   A    T
      A   A    T
      AAA AAA  TTT

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MMM MMM IIIIIIII  CCCCC HHH HHH IIIIIIII  GGGGG  AAA  NN  NN
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M M M      I    C      H  H      I    G      A  A  NN  N
M M M      I    C      HHHHH      I    G  GGG  AAAAA  N N N
M  M      I    C      H  H      I    G  G  A  A  N  NN
M  M      I    C      H  H      I    G  G  A  A  N  N
MM  MM IIIIIIII  CCCCC HHH HHH IIIIIIII  GGGG  AAA AAA NN  NN

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From the MTS and the Computing Center to ITD and Microcomputers: The Defining Years (1966-1986)

By

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History 265

April 12, 1999

As the University of Michigan Computing Center approaches its 40th anniversary on July 1, 1999, a look back into its rich past is in order. During these forty years, the Computing Center, which was swallowed up by the University's Information Technology Division (ITD) in 1984, evolved from a center supporting a basic batch-mode processing system, to one that developed a cutting-edge timesharing system, and finally to a huge organization that manages hundreds of microcomputers on a campus-wide network. Although the computing industry seems to re-invent itself overnight, for the University of Michigan, the twenty-year time period between 1966 and 1986 was the most critical in its history to date. These years saw two drastic shifts in computing paradigms and laid the foundations of the University's modern computer system.

A Brief History of the Computing Center

The University of Michigan Computing Center was officially established on July 1, 1959. The Center was founded on a radical idea: computing power for any student or faculty who could exhibit a need for it. Its founding idea was that its equipment would be put to use to "supplement the University course instruction and as an aid to the student in solution of a problem"¹ The center's first computer was an IBM-704, which was installed on August 7, 1959. This new machine was put to use almost immediately, as by 1960 the computer was being used in a total of 60 courses, both undergraduate and graduate.² This computer was not the University's first computer, however. A machine called MIDSAC (Michigan Digital Special Automatic Computer) had been constructed at the University's Willow Run Research center in the early 1950s. The major difference here is that the MIDSAC was a machine that was built as a research project for research projects, whereas the Computing Center's equipment could be used by any students or faculty who had a problem to solve. Dr. Robert C.F. Bartels, who was the first director of the Computing Center, drove this point home in a letter by saying:

"The equipment [the IBM-704] is therefore not available for use on routine problems pertaining to the administration of the University. It is available to faculty and students of

¹ Memo from Robert C. F. Bartels to Vice President of Research Ralph A. Sawyer titled "Progress Report of the Computing Center 1959-1960." [Progress Report 1959-1960]

² Progress Report 1959-1960

the University of Michigan without charge for unsponsored research and educational activities consistent with this policy. Sponsored projects and other schools are charged an hourly rate based on actual operating costs for the time of usage."³

That is, the machine would be used first and foremost for the University's educational purposes, but would also be available for use by other schools and industrial research and government-supported research at a cost.

The costs associated with running computers at this time were immense. Since the Computing Center did not charge students to use the system directly, a system had to be devised so that the Center had adequate funding. The solution that the University came up with was *computing allocations*. These functioned as such: anyone needing access to the computer would be given a computing allocation, which worked much like a bank account from which computing services could be charged to. At the beginning each fiscal year, funding was placed in this account if the account holder had a valid reason for using the system. These reasons included being a student enrolled in a course that required regular computer work, working on a research project that required computer access, and working a doctoral thesis that required computer access. The amount of money that was placed in the account also depended on what type of user held the account. There were several types of users, and their computing accounts could either be supported by the university or by private funding. The computing allocation was important, as a user of the system was billed for every minute his/her work was processed. The actual money that was placed in these accounts came directly from the University's general fund (in the case of a student or non-industry sponsored research) or from the user of the system.

When the Computing Center first opened to students, the prevailing method of computing was called *Batch Mode*. Batch Mode (sometimes also called Batch Processing) came about as a method to increase the number of tasks the computer could run in a given time period by limiting the amount of human interaction. A batch mode system does this by running one program immediately after another.

³ Letter to Mr. Charles W. Bachman, manager of data processing research at the Dow Chemical Company in Midland, Michigan from Bartels. The letter was dated August 30, 1960.

To operate a computer in batch mode during the early days, the user had to put all of his/her program and/or data onto a set of cardboard cards. The cardboard cards, usually called *punch cards*, had spaces that could have holes punched in them to represent the letters and numbers of the program and/or data. The patterns of punched holes look similar to the patterns of pencil marks on a completed “ScanTron” exam. The punching could be done by hand (by manually punching holes in the card) or by using a device called a *keypunch*. This could be a long, laborious process, as a simple program could require several hundred cards. Once the program and all of its associated data was placed on the cards, the stack of cards was placed on a *card reader*, which read the cards one-by-one into the computer. When all of the cards were read into the computer, the program could be run. Computer operators then ran the programs (also called *jobs*) one after another in *batches*. These batches could be scheduled at any time during the day. The downside of batch mode was that the results of the program’s run were not available immediately. A user had to wait minutes, hours, or even days for the computer to run his/her program. If there was an error in the program or if the punch cards were submitted out of order, the program had to be re-run and the person who had submitted it had to wait for output again.

By running a computer in batch mode, many more people could have access to the computer’s resources, as more tasks could be run through the computer. Batch mode kept the computer busy at all times of the day. This was important, because at the time, computing equipment cost millions of dollars to buy and tens of thousands of dollars per year in electricity, communications and cooling costs. A computer not doing anything for even a few hours at a time was a colossal waste of money. Hence, to get full use out of the equipment, computer operators had to try to keep all of its hardware utilized at all times. By having limited human interaction, batch mode systems could achieve this by continually running one program after another. Batch programs could not ask questions of the user— they just simply took data, transformed it somehow, and printed out the results. The alternative to batch mode was called “interactive.” An interactive computer system allows a user to run programs from a terminal or Teletype and get back the results

immediately on a video screen or a printer. This is how a person would use a personal computer today. However, the early equipment and the early operating systems software could only run one program at a time. This meant that if the computer were run interactively, it would only allow one person to run one at any given time. Since a computer, even back then, can work much faster than a person could type this would be a huge waste of computer time and money.

Despite its benefits, batch mode was clearly a poor way to interact with the computer. The lengthy waits for output and did not lend itself very well for many useful computer applications. For example, a batch mode system would not be very useful for word processing. It also tended to leave some of the computer's resources underutilized. Interactive mode on these early systems was out of the question— it was just way too wasteful. The tradeoff that system designers came up with was called *Timesharing*. The essence of timesharing is that the computer has programs belonging to several users in memory at once and switches between them rapidly in order to make it appear to the user that his/her job is the only one running. This works because, as mentioned before, a person cannot type faster than the computer can process information. Timesharing is the basis of all “multitasking” personal computer operating systems today (extended quite a bit, of course). Furthermore, a properly implemented timesharing system can have multiple interactive users and can run multiple batch jobs at the same time. The timesharing operating system that was designed by The University of Michigan Computing Center was called *Michigan Terminal System (MTS)*.

MTS: The Early Years

Early hardware, such as the Computing Center's IBM-704 and later IBM-7090 systems simply did not have enough power, storage and specialized equipment to handle a timesharing system. What made timesharing systems possible was the invention of *virtual memory*. A virtual memory system employs a complex scheme which allows the computer to extend its main memory by using a disk or similar device to store portions of memory that are not immediately needed. In doing this, a computer with virtual memory

can look like it has more real memory than it actually does. A timesharing system needs to be running on a virtual memory system to allow more than one program to be in active memory at any given time.⁴ This makes switching between the programs both possible and fast. In addition, real memory (called physical memory or RAM) was *very* expensive at the time, while disk space was considerably cheaper. Virtual Memory, (also called “Virtual Storage”) was proposed in a 1966 paper titled “Program and Addressing Structure in a Time-Sharing Environment.” This paper was based on ideas developed at the Massachusetts Institute of Technology (MIT) and was written by Bruce Arden, Bernard Galler, Frank Westervelt, and Tom O’Brian. Arden, Galler, and Westervelt were associate directors of the Computing Center.⁵

The problem with virtual memory is that to implement it efficiently, a systems programmer needs certain hardware in the computer available. In the mid-1960s, no hardware existed to perform virtual memory functions. To get the required hardware, a new machine had to be constructed, and in 1965, the Computing Center contacted IBM. In the Computing Center’s report for 1964-65, Robert C. Bartels, spells out the plan for MTS when he wrote:

The Computing Center senior staff devoted a considerable period of time during the first half of the year on evaluation of recent developments in computing equipment with regard to their suitability for use in a large-scale time-shared facility. As a result of the study, the Computing Center recommended that the University install an IBM System/360 with a model 67 processing unit in November, 1966... it has the capability of serving as many as 30 remote terminals with various input-output devices attached (such as keyboards, teletype units, display units, etc.). In making these recommendations, the Computing Center envisions a computer system which can respond simultaneously to many users via terminal devices, and one which is capable of serving a wide range of the University’s research and instructional needs for direct communication between the computer and man or instrument at rates consistent with human reaction times.”

⁴ This is obviously a gross oversimplification. A true, paged virtual memory system not only provides more working memory for the system, but also things like protected memory (one program’s memory space cannot interfere with another’s) and address independence (a program can load itself into any address in memory it wants to). However, for the sake of this paper, this simple explanation will suffice.

⁵ Topel, Susan. “A History of MTS— 30 Years of Computing Service”. *Information Technology Digest*. 13 May, 1996. Vol 5. No 5. Available online at <http://www.itd.umich.edu/ITDigest/0596/feat02.html> [Topel]

The new machine was the IBM System 360/67M (the ‘M’ was for ‘Michigan’). It was a standard IBM 360 machine with additional timesharing system-specific hardware. This hardware was designed with the help of Dr. Bernard Galler and others at the Computing Center. Unfortunately, it wasn’t delivered until 1967.

Even though the hardware did not exist yet, MTS development had already been initiated on an older IBM System 360/50 as a bunch of experiments in timesharing. The 360/50 system was part of the U.S. Department of Defense’s Advanced Research Project Agency’s (ARPA) CONCOMP project. This project focused on the CONversational use of COMPuters, hence the name. MTS architects Mike Alexander and Don Boettner were able to create a prototype system called the “U-M Multi-Programming System” (UMMPS) by combining a “half-page of code on the kitchen table” with a small multi-programming system that was developed at the MIT Lincoln Laboratories. “This was the earliest incarnation of MTS, which Alexander and Boettner intended as a ‘throw-away system that we worked on while we waited for TSS to become available.’”⁶ TSS was a timesharing system that IBM had started to build. It was not available when the IBM 360/67 was delivered to the Computing Center.

When the 360/67 arrived at the Computing Center, development of the MTS system moved over to the new machine and accelerated. The preliminary MTS system was released to campus in a limited fashion in May 1967.⁷ “Limited” meaning, that it was still very much a development system. During this time, users were able to try out the system without being charged for the time. Charges would be levied for the first time in June 1967 when an accounting system was installed.⁸

Throughout 1967, the system was improved. An improved memory management system was added in November in order to take advantage of the 360/67’s new virtual memory hardware. “This was the start of true timesharing and allowed the number of

⁶ Topel, 2

⁷ Topel, 2

interactive system users to increase tenfold.”⁹ A batch mode subsystem was also added to MTS, which would allow batch jobs to run at the same time that interactive terminal users were using the system. The primary purpose of this addition was to give more users access to the system, since terminals and teletype machines were still quite expensive. MTS was now ready for prime time.

MTS at a Critical Junction

Although MTS was up in running in 1967, the Computing Center’s older batch-mode IBM 7090 was still running most of the Computing Center’s jobs. In 1968, a second IBM System 360/67 was purchased. This new machine presented a problem in that there was simply not enough space in the Computing Center’s North University Building machine rooms to house both the IBM 7090 and the new System 360/67.¹⁰ The only viable solution was to get rid of the 7090.

The removal of the IBM 7090 sparked a debate in the Computing Center— should MTS be put into full production on the new system, or should the computing center purchase IBM’s TSS operating system, which was now ready for release. TSS (Time Sharing System) was the operating system that IBM was developing specifically for the 360/67 series. It was long delayed, and at one time was labeled “experimental” by IBM. The decision to go with MTS or TSS was an important one, as it affected everyone on campus who was using Computing Center services. In the end, the Computing Center went with the MTS system. In a 1980 interview that Dr.



⁸ “A Brief History of the Computing Center”, Computing Center Newsletter, 12 November 1980. Vol 10, No 19. Pg 1-5 [1980 Galler Interview]

⁹ Topel, 2

¹⁰ Topel, 2

Bernard Galler, an associate director of the computing center gave, he summed up the decision as to why the Computing Center never switched to TSS:

"IBM put a lot of effort into TSS, but it got so big and so horrendous, and there were so many really new things that had never been done before, that they got into trouble... Now it turned out that MTS got better and better, and TSS also go better and better... But while TSS has some things that MTS doesn't, it never became good enough that we through we should change to it. And, of course after awhile there was such an investment in MTS here that TSS would have had to have been *much* better to switch to it."¹¹

Consequently, MTS was made the operating system of choice of the Computing Center's mainframe computer. The transition from the IBM 7090 to the IBM 360/67 occurred in the fall of 1968.

The Computing Center: Too big for its Building

The MTS system was in widespread use as little as a year after it was released to campus. Dr. Robert C. Bartels notes in his insert to the 1969-1970 president's report that:

"The University's Computing Center, widely recognized as one of the leading academic and research computing facilities in the world made the transition to the full-duplex IBM 360/67 time-sharing system making use of the MTS (Michigan Terminal System) in the fall of 1968, and has made steady progress since then in developing the capabilities of the system... more than one-hundred teletype terminals are in operation around campus; and fifteen of the University's small computers... have facilities to connect to the central computer. While handling remote terminals in conversational mode, the computer can at the same time perform up to ten different tasks in the batch-processing mode, with a turn-around time in minutes. The number of total users rose to as high as 8,000 during the year, and these were distributed through 39 different schools and departments..."

MTS was clearly on its way. The bulk of its users were graduate students engaged in research. In all, during the winter term of 1968, 234 thesis projects used the Computing Center's mainframe system. In addition, students were being given computer work as part of regular assignments. During that same term, there were 200 computer-related courses

offered by 36 different schools. This was up from the 17 different departments requiring the use of computers during the 1964-65 academic year. These courses had a total of 4074 students in them, which was up 28% from the 3178 students enrolled in them during the winter term of 1967 as well.¹² The breakdown by school is shown in the table below:

Computer Use in Courses in Winter Term 1968

| College School or Department | Number of Courses | Students Enrolled |
|---------------------------------|-------------------|-------------------|
| Architecture & Design | 2 | 36 |
| Business Administration | 13 | 403 |
| Education | 3 | 72 |
| Engineering- | | |
| Chem & Met Engineering | 14 | 277 |
| Civil Engineering | 14 | 239 |
| Electrical Engineering | 12 | 386 |
| Engineering Mechanics | 1 | 15 |
| Industrial Engineering | 7 | 207 |
| Mechanical Engineering | 12 | 265 |
| Meteorology & Oceanography | 3 | 39 |
| Naval Arch & Marine Engineering | 12 | 130 |
| Nuclear Engineering | 2 | 11 |
| Literature Science, & The Arts | | |
| Astronomy | 3 | 6 |
| Chemistry | 3 | 37 |
| Communications Sciences | 9 | 391 |
| Economics | 6 | 138 |
| Geography | 3 | 29 |
| Geology & Mineralogy | 1 | 14 |
| Library Science | 2 | 41 |
| Mathematics | 4 | 471 |
| Political Science | 14 | 195 |
| Psychology | 13 | 69 |
| Sociology | 8 | 170 |
| Zoology | 3 | 46 |
| Others | 3 | 6 |
| School of Natural Resources | 3 | |
| School of Public Health | | |
| Biostatistics | 4 | 18 |
| Environmental Health | 3 | 8 |
| Health Department | 1 | 22 |
| Hospital Administration | 1 | 20 |

¹¹ 1980 Galler Interview, 4

¹² These statistics are taken from a letter titled "Report on the Computing Center" by P.E. Darlington that was dated September 11, 1968. It was sent to Dr. Robert C. Bartels.

| | | |
|---------------------------|-----|------|
| Medical Care Organization | 1 | 2 |
| Dearborn Campus | 18 | 267 |
| School of Social Work | 2 | 3 |
| GRAND TOTALS | 200 | 4074 |

Source: Report on the Computing Center by P.E. Darlington, September 11, 1968

As it can be seen from this table, that in 1968, computer use was not strictly limited to the historically computer-related fields, such as engineering. There were many students in the social sciences such as Sociology, Political Sciences, and Communication Sciences using the computer.

This explosion of computer use led to a serious space problem in the Computing Center's North University Building home. Therefore, in order accommodate the growing Center, the regents approved the plan for a new Computing Center building in June 1968. The building was to be constructed on North Campus at the cost of \$1.5 Million. This cost was met with funds allocated from a university-wide \$55-Million campaign and was supplemented by allowances for facilities usage in research grants and contracts.¹³ The 28,500 square-foot building opened in 1971. The new Computer Center building had been designed both to hold current computing equipment and for future expansion. It had a three-floor structure that allowed the computer to be installed in a vertical configuration in order to minimize the cable lengths between the various components. This was prudent because long cable lengths between components could result in slowdowns and/or errors. The entire building was built with raised false floors, with the exception of the north and south lobbies and a paper storage room. The false floors allowed the computer cables to travel underneath them as well as to provide air-conditioning to the equipment and the building. The interior of the building was free of support columns and walls. All of the partitions were built atop the false floor, which was to make future reconfiguration of space easier. The building had machine rooms, office space for Computing Center staff, and a user area, which had terminals, Teletype machines, keypunches, card readers, a

¹³ "The New Computing" *Michigan Technic*. October, 1971.

place to pick up output printouts from the machine (called “an output window”), and a place where you could talk to system “counselors.”¹⁴

This building would provide enough space for the Computing Center until the mid-1980s. A common theme throughout the history of the Computing Center would be its continual search for space for one thing or another. Once the North University Building was vacated of the Computing Center, it became a remote site with a direct connection to the new Computing Center Building. It offered all of the user services that the Computing Center Building offered (such as output printers, teletype machines, terminals, keypunches, card readers, a counseling area, and an output window). Now that MTS users could have their output sent to two different places, a naming system had to be invented. The naming system that was instituted consisted of a four-letter site name to designate either the Computer Center or the North University Building remote site. Under this system, the Computer Center was given the name CNTR and the North University Building was given the name NUBS. The NUBS site still exists today by that name, although now it is full of Macintosh and Dell microcomputers.

Bringing MTS to its Knees

As the number of users on the MTS system increased, so did the load placed on the system. Early on, the Computing Center had implemented a rate structure that attempted to balance the load on the system. In this rate structure, more money would be deducted from a user’s computing allocation if he/she ran his/her jobs or logged into the system in the middle of the afternoon versus at four o’clock in the morning. For instance, in 1981, a user of the MTS could specify that his/her batch mode job run at Normal, Low, or Deferred rates. Since a batch mode job required no interaction from the user, he/she could run it at any time if there was no rush to get it done. The Normal rates were the highest rates, and the deferred rates were the lowest. Thus, by having the job run at deferred rates could save a lot of money out of the user’s computing allocation. Remember that the user’s computing allocation was billed for every minute that the CPU

¹⁴ Fronczak, Edward. “University of Michigan Computing Center Extended Tour Details”. November 1978.

of the computer spent working on it, so this was important, especially for large jobs. Running deferred jobs was also especially important for students, as when their allocation was all used up, they either had to beg for more or fund it themselves (usually the latter). The time at which the user's job actually ran depended on the type of user (student, commercial user, etc.), the time of the year (only for commercial users), and the day that the job was to be run. If it was a Monday and the student user chose "Normal," his/her job would run anytime from 7:00 AM to 8:00 PM. If the user chose "Low," his/her job would run anytime from 8:00 PM to midnight and finally, if the user chose "Deferred," his/her job would run anytime from midnight to 7:00 AM. This didn't really apply for interactive terminal users, however. They were charged the rate that was in effect when they logged onto the terminal, but also could submit previously stored batch jobs from a terminal session. This led to long lines at NUBS even late at night! These rates and times changed quite frequently. In fact, rates were raised across the board every time the Computing Center replaced the computer with a faster one in order to account for faster processing times. Below is a sample rate table:

Rates (Effective July 1, 1981)

University Rates and State/Federal Rates

Commercial Rates

| Differential Rates | Normal | Low | Def | Differential Rates | Normal | Low | Def |
|---|---------------|------------|------------|---|---------------|------------|------------|
| Term. Conn. Time/hour | 1.38 | 0.97 | 0.97 | Term. Conn. Time/hour | 3.41 | 2.73 | 2.05 |
| Hi-Speed Conn. Time/hour | 2.23 | 1.56 | 1.56 | Hi-Speed Conn. Time/hour | 5.49 | 4.39 | 3.30 |
| TELENET Conn. Time/hour | 9.88 | 9.47 | 9.47 | TELENET Conn. Time/hour | 11.91 | 11.23 | 10.55 |
| Processing Time/minute | 18.86 | 13.20 | 7.55 | Processing Time/minute | 39.10 | 31.28 | 23.46 |
| Unit Record/1000 records | 0.32 | 0.22 | 0.22 | Unit Record/1000 records | .76 | .61 | .45 |
| Tape Drive Time / hour | 4.63 | 3.24 | 3.24 | Tape Drive Time / hour | 11.07 | 8.85 | 6.64 |
| Tape Mounts / mount | 0.32 | 0.22 | 0.22 | Tape Mounts / mount | .76 | .61] | .45 |
| Fixed Rates and Material Charges | | | | Fixed Rates and Material Charges | | | |
| Disk Storage/ page-day | | | .0013 | Disk Storage/ page-day | | | .0027 |
| Calcomp Plotting / hour | | | 6.15 | Calcomp Plotting / hour | | | 12.92 |
| Printer Paper / 1000 pages | | | 8.15 | Printer Paper / 1000 pages | | | 8.15 |
| Cards Punched / 1000 cards | | | 2.94 | Cards Punched / 1000 cards | | | 2.94 |
| Calcomp Paper / foot | | | .10 | Calcomp Paper / foot | | | .10 |
| Paper Tape Punched / 1000 feet | | | 1.80 | Paper Tape Punched / 1000 feet | | | 1.80 |
| Page Printer at WSU /1000 (no holes) | | | 34.80 | Page Printer at WSU /1000 (no holes) | | | 44.80 |
| Page Printer at WSU /1000 (holes) | | | 35.20 | Page Printer at WSU /1000 (holes) | | | 45.20 |

Research Rates**Non-University**

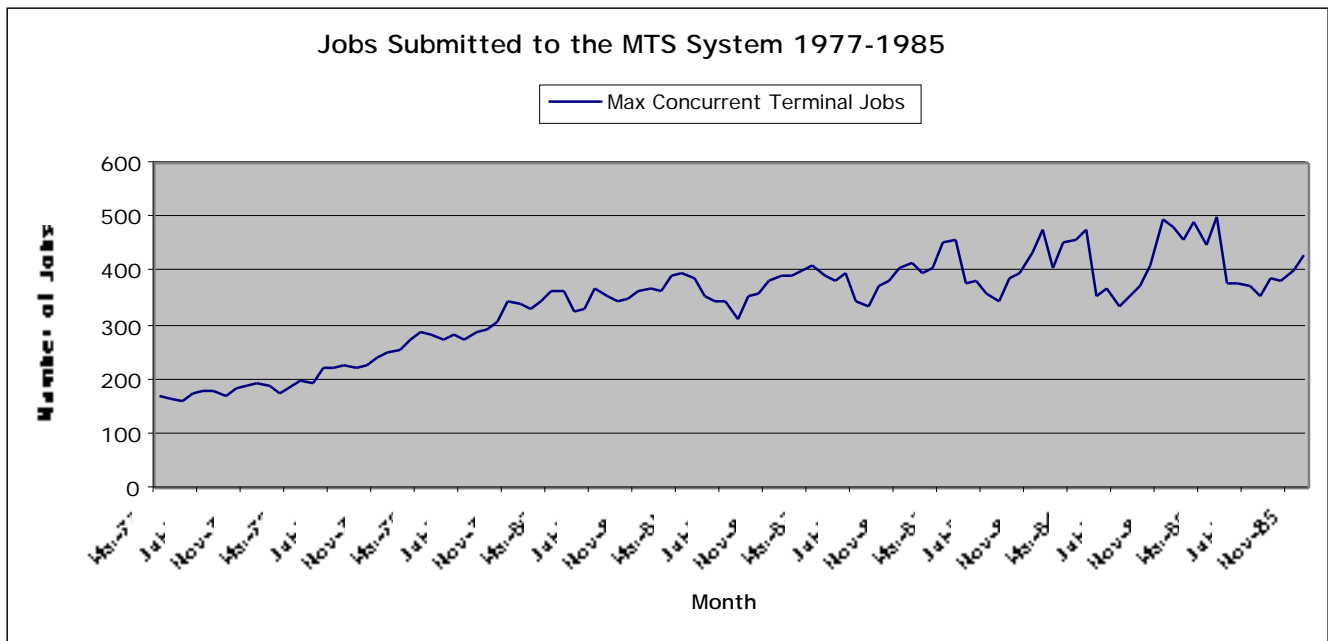
| Differential Rates | Normal | Low | Def | Differential Rates | Normal | Low | Def |
|---|---------------|------------|------------|---|---------------|------------|------------|
| Term. Conn. Time/hour | 1.52 | 1.07 | 1.07 | Term. Conn. Time/hour | 1.52 | 1.07 | 1.07 |
| Hi-Speed Conn. Time/hour | 2.45 | 1.72 | 1.72 | Hi-Speed Conn. Time/hour | 2.45 | 1.72 | 1.72 |
| TELENET Conn. Time/hour | 10.02 | 9.57 | 9.57 | TELENET Conn. Time/hour | 10.02 | 9.57 | 9.57 |
| Processing Time/minute | 20.75 | 14.53 | 8.30 | Processing Time/minute | 20.75 | 14.53 | 8.30 |
| Unit Record/1000 records | 0.35 | .24 | .24 | Unit Record/1000 records | 0.35 | .24 | .24 |
| Tape Drive Time / hour | 5.10 | 3.57 | 3.57 | Tape Drive Time / hour | 5.10 | 3.57 | 3.57 |
| Tape Mounts / mount | 0.35 | 0.24 | .24 | Tape Mounts / mount | 0.35 | 0.24 | .24 |
| Fixed Rates and Material Charges | | | | Fixed Rates and Material Charges | | | |
| Disk Storage/ page-day | | | .0014 | Disk Storage/ page-day | | | .0014 |
| Calcomp Plotting / hour | | | 6.77 | Calcomp Plotting / hour | | | 6.77 |
| Printer Paper / 1000 pages | | | 8.15 | Printer Paper / 1000 pages | | | 8.15 |
| Cards Punched / 1000 cards | | | 2.94 | Cards Punched / 1000 cards | | | 2.94 |
| Calcomp Paper / foot | | | .10 | Calcomp Paper / foot | | | .10 |
| Paper Tape Punched / 1000 feet | | | 1.80 | Paper Tape Punched / 1000 feet | | | 1.80 |
| Page Printer at WSU /1000 (no holes) | | | 34.80 | Page Printer at WSU /1000 (no holes) | | | 34.80 |
| Page Printer at WSU /1000 (holes) | | | 35.20 | Page Printer at WSU /1000 (holes) | | | 35.20 |

Source: *Computing Center Newsletter*, 15 July 1981, Pg 5

Note: This is not a complete table. It is missing a few rate tables, but it should be enough to get the general idea

Using rates to balance out the load was not enough, however. It soon became clear that the IBM System 360/67 did not have enough power to keep up with the demands that the users were placing on it. As more and more people connected to the system at the same time, the response time of the system rose dramatically. The problem got so bad that in 1973, system operators needed to find a way to improve the response time. A short-term solution to the problem was to ‘busy out’ terminal connections. That is, whenever the number of connected terminals to the system reached a certain number, the system would not allow anymore connections. In March 1973, MTS programmers found a better way to handle this problem. They developed what they called “a more refined method of balancing the terminal and batch load.” The method that was developed was called *Limited Service State* (LSS). LSS was invoked by the system whenever “the demands on the CPU by terminal users’ programs were great enough to

seriously degrade system performance.”¹⁵ When LSS was invoked, the system blocked users from running any programs. About the only thing that a user could do on an MTS system in LSS was edit files. If the user tried to run a program he/she would get a nasty message saying “THIS IS A LIMITED SIGNON; RUNNING OF PROGRAMS NOT ALLOWED.” LSS plagued users until the system had been upgraded enough times to support the number of people who wanted to access it. This occurred in the early 1980s, when the April 18, 1983 issue of Computing Center Newsletter noted that LSS was “rarely used.” However, several hardware upgrades were needed to get to that point.

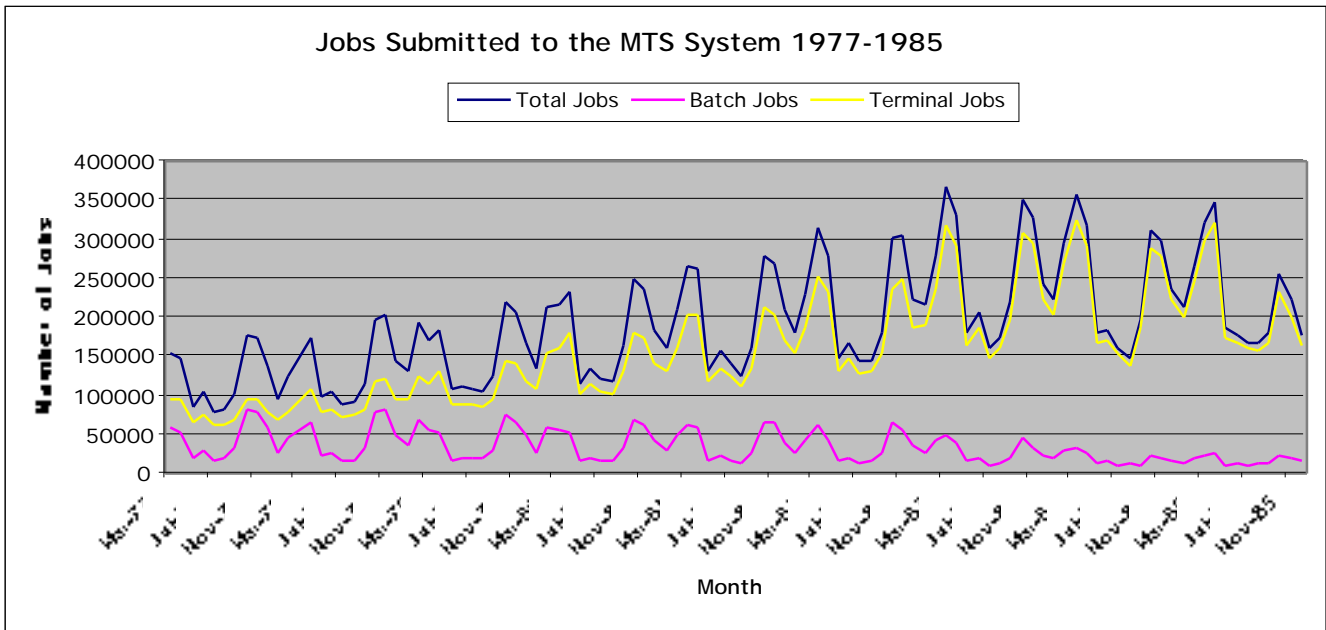


MTS: Moving up in the world

The first major hardware upgrade came in 1975, when the Computing Center purchased a completely new computer system. The new system was an Amhdal 470V/6. Amhdal was a relatively new company that produced mainframe systems that were completely compatible with IBM systems. At the time, Amhdal gave the university the best “bang for its buck” in terms of price and raw computing power. After the initial upgrade, the main MTS system went through four major overhauls from 1975 to 1987. In

¹⁵ “Ten Years Ago on MTS”, Computing Center Newsletter, 18 April 1983. Pg 4

March 1979, the Amhdal 470V/6 was replaced with an Amhdal 470V/7. The 470V/7 was then upgraded to a 470V/8 in March 1980. The next upgrade occurred after many months of delay when the 470V/8 was upgraded to an Amhdal 5860 machine in November 1982. In the spring of 1985, Amhdal donated a 470V/8 to the Computing Center. This machine was run concurrently with the 5860 and was called “Blue” (or UB). The 5860 was called “Maize” (or UM). Finally, in February 1987 the Computing Center turned full circle and replaced both the Amhdal 5860 and the donated 470V/8 with a single IBM 3090-400. In between all of these major upgrades were many smaller ones that added memory, hard



disk storage, tape drives, and paging devices to the system. A Xerox 9700 laser “page printer” was added in 1981 to provide high speed, high quality printing. All of this was necessary to keep up with the increasing load. Of course, what was causing this additional load was that the Computing Center added more and more terminals over the years. The addition of terminals to the system was needed to reduce the amount of time that students had to wait for an available one. This became more of a problem as more people began using the system’s interactive mode on video terminals rather than the batch mode processing. As the included graphs¹⁶ show, there was a rise of about 150

¹⁶ These graphs were produced from usage statistics that were published in the *Computing Center Newsletter* almost every month until 1986.

connected terminals in 1977 to a peak of about 500 in 1985. The other graph shows the rise in overall jobs and terminal jobs and the falloff of batch jobs on the MTS system. Notice the cyclical nature of the graphs– the cycles fall in line with the academic calendar. There are sharp peaks in the spring months and deep valleys in the summer months. There are also valleys near the January/December months. This is further proof that students were one of the main consumers of computing power on campus. Also note that there begins to be a fall off in the number of jobs submitted starting in 1985. This can be attributed to the arrival of microcomputers on campus, which took over for many tasks, such as word processing and text editing.

Using MTS for Work

The swell of people using the system also brought horrendous terminal shortages on campus. Throughout the *Computing Center Newsletter* issues, there are literally dozens of complaints about long lines, people cutting in line and long waits for printouts. In the 1979 Computing Center User Survey, the users that responded ranked the locations of public terminals as “very good” or “pretty good”, while the overall availability of public terminals was judged to be “poor.”¹⁷ Long lines at the NUBS and CNTR public terminal clusters weren’t the only problem, however. The MTS system could also be accessed remotely using a terminal, a phone line, and a modem. Many departments, who bought their own terminals for their faculty and staff, accessed MTS in this way. In doing so, they encountered frequent busy signals. This led to many people hoarding phone lines– dialing them up early in the morning and holding on to them throughout the day, whether they used the system or not.

The user survey also gave an indication of the makeup of the users of the system in 1979. The people who responded to the survey had to put themselves in a category according to their primary use of the MTS system. Of the people who responded, 30.5% did U of M research sponsored by outside funds; 23.9% did U of M student course work; 10.6% did U of M research sponsored by general funds; 9.0% did U of M student thesis

¹⁷ “Summary of Computing Center User Survey”, *Computing Center Newsletter*. 8 August 1979. Pg 6-8

work; 8.7% did outside educational/government work; 6.1% did U of M faculty course development and teaching; 3.1% classified their use as outside nonprofit private organization work; 2.6% classified their use as outside industrial organization work; .3% classified their use as U of M faculty individual consulting; and 5.2% classified their use as “other.” Thus, as can be seen by these statistics, a bulk of the users were students using the system for general course work. Since students were least likely to own their own terminals or microcomputers at this time, they also represented a bulk of those who waited in line at the public terminal sites. Furthermore, as time went on, more and more people were using the system interactively instead of in batch mode (as shown in the first chart). By doing this, users only exacerbated the terminal shortage.

The Computing Center purchased as many terminals as they could in order to combat the problem. They were able to sprinkle a few public terminals in various places across campus, and in 1978, there were terminals in places such as the Chemistry Building, Mason Hall, East and West Engineering, South Quad and West Quad. However, the center soon found it in a space crunch once again. Furthermore, many users complained about the condition of NUBS. Comments by users in the Suggestion Box column of various issues of the *Computing Center Newsletter* called NUBS noisy (the click, click, click of noisy old keyboards echoing off of an uncarpeted floor), dark, dirty, and generally unpleasant.¹⁸ What the Computing Center needed was a new terminal/remote station. The Computing Center petitioned the regents, for a new space and funds for new equipment. At the regent’s July 1982 meeting, the Center’s plan was approved. The UNYN site was born.

The Computing Center’s plan involved converting space in the basement of the Michigan Union that was a five-lane bowling alley into a public computing site (hence the name “UNYN”). This site would offer many of the amenities that NUBS had, including keypunches, terminals, a card reader, two printers, and counseling areas. Furthermore, this site would have a much greater emphasis on terminal access than at

NUBS. Dr. Aaron Finerman, director of the Computing Center announced the acceptance of the Computing Center's plan to the regents by saying:

"For many years, MTS users have had to suffer with the congestion at NUBS. Until now, the Computing Center has been able to only sympathize with users and to attempt to upgrade an overloaded facility. UNYN should make a significant difference in the computing atmosphere at U-M"¹⁹

Construction of the site went on throughout the fall of 1982. The site officially opened on March 8, 1983, which was a little more than a month behind schedule. It opened initially with 37 terminals, 6 printers, 3 special graphics terminals and 12 keypunches.

Unfortunately, within the three weeks that the UNYN site opened, it was the target of theft and vandalism. In an article titled "An Open Letter to UNYN Users" on the front

page of the April 18, 1983

issue of the *Computing Center*

Newsletter notes that several

small items had been stolen (no

computer hardware, though),

graffiti had been written on the

walls, cigarettes had been put

out on the floor, and a picture

had been "scratched." The

article then goes on to say that

"At this rate, the UNYN will quickly deteriorate to the conditions cited in numerous past complaints about NUBS: dirty, unpleasant, and an atmosphere not conducive to study or computing."



1983 also saw a few other improvements in the Computing Center's public facilities. To supplement the new sites at UNYN and NUBS, a smaller terminal room in the east engineering building was opened up in December. It held thirteen terminals and

¹⁸ It may be interesting to note that while food and drinks were not allowed in the NUBS site, smoking was! The 8 February 1978 Computing Center Newsletter notes that "smoking is restricted to the work tables in the south end of the work room."

six printers. Also, in order to cut down on line jumping and general confusion over waiting for a terminal, the Computing Center instituted a queuing system in October. The queuing system was installed in the NUBS and UNYN sites and resembled the familiar “take-a-number” system that most people see at bakeries and delis. However, these measures were still not enough to keep up with the demand. In the 1984 Computing Center Survey, the number of people rating the availability of public terminals as “totally unsatisfactory” had gone from 8% in 1983 (the survey was taken after the UNYN site had opened) to 17% in 1984.²⁰ This was a sure sign that more terminals would be needed.

Using MTS for Play (as long as you weren't caught)

As MTS usage exploded in the late 1970s and early 1980s, it became clear that some general guidelines needed to be placed on the use of the system. For instance, using the system's limited resources for playing games was a big concern of the Computing Center (and people who were waiting in line for a terminal!). In the January 24, 1979 issue of the *Computing Center Newsletter* there was a note about a user using one of the graphics terminals to play the video game *Othello*. The Computing Center did take disciplinary actions against the person in question, but it did not yet have a firm policy about using the computer's resources in that way. So, in February 1979, the Computing Center began formalizing its policy on “frivolous use” of the computer system.²¹ This was rolled into what became known as the *Conditions of Use Policy*, of which the final draft was first printed in the August 8, 1979 issue of the Center's Newsletter.

The Conditions of Use, as printed in August 1979 has three parts to it that a potential user had to agree to in order to use the system. The parts were *Authorized Use*, *Appropriate Use*, and *Responsible Use*. In the first part, Authorized Use, the user had to agree to respect the intended usage of accounts on the system, respect the privacy of others, respect the integrity of the system (users should not develop or use programs

¹⁹ “Note from the Director”, *Computing Center Newsletter*. 1 September 1982. Pg 1.

²⁰ “Computing Center Survey Results”, *Computing Center Newsletter*. 16 July 1982. Pg 2.

²¹ *Computing Center Newsletter*. 7 February 1979. Pg 4.

which could damage the system or harass other users), and respect the financial structure of the system (users should not develop or use programs to alter or avoid the charges levied by the system). In the second part, Appropriate Use, the user had to agree to only use the system “in a manner consistent with the instructional and research objectives of the academic community.” And finally, the third section, Responsible use, noted that users are expected to not deliberately engage in wasteful practices. These practices included using large amounts of unnecessary paper and cards, holding dial-up telephone lines for long periods of time, and using public terminals for nonessential work. The Conditions of Use Policy represented the Computing Center’s attempt formalize the guidelines that it had hoped users would follow in the past. Much of the 1979 Conditions of Use Policy lives on today as ITD’s Conditions of Use, which everyone is required to sign before receiving a computing account.

Beyond the simple problems of people wasting valuable computing time playing video games; MTS had its fair share of security problems. The most common of these were stolen passwords. An article in the March 18, 1981 *Computing Center Newsletter* notes that “Stolen passwords contribute to the majority of the security problems faced by the computing center... the number of passwords reported to the Computing Center as lost or stolen has ranged as high as 60 per month.” There were also two people arrested in 1983 for Illegal use of MTS. They were prosecuted under the State of Michigan’s new computer fraud laws. Both of them plead guilty and ended up doing community service work and paying court costs.²²

Connecting it All Together

In order to connect large number of terminals and remote sites to the MTS system, the Computing Center had to develop methods of doing so. Since in the late 1960s and early 1970s, the idea of having a large timeshared system was in its infancy, no off the shelf hardware was available to do this. So, the University had to build the

²² “Michigan Laws Concerning Unauthorized Computer Use”, *Computing Center Newsletter*. 3 October 1983.

equipment. What was needed were *Data Concentrators*. Data concentrators are smaller computers with special hardware to connect to many terminals. These concentrators took all of the data coming from the terminals, combined it in a certain way and sent it off to the mainframe. They also had to take data from the mainframe, determine which terminal it was being sent to, and send it to the destination terminal. The data concentrators were connected to the mainframe computer by one or more high-speed phone lines. The first data concentrator was a regular Digital Equipment Corporation (DEC) PDP-8 minicomputer with hardware designed by Computing Center staff. These were actually designed and developed during the same ARPA-funded CONCOMP project that had carried out the early MTS software work.²³ Later, as timeshared computing became the norm, the Computing Center was able to purchase smaller data concentrators from companies such as Memorex. Now that connecting terminals within the University was taken care of, what about connecting the University's MTS system to other universities around the state? Furthermore, what about allowing remote users to dial into the system using a phone line and a modem? The answers to these questions lie in a corporation known as Merit.

Merit traces its roots back to the early 1960s, before timesharing systems had been developed. Its original idea of a state-wide computer network connecting the higher education institutions in the state was actually proposed in 1963 as a response to "a blue-ribbon commission tasked by former Governor George Romney to review Michigan higher-education role."²⁴ A committee called the Michigan Inter-university Committee on Information Systems (MICIS) was formed with the University of Michigan, Wayne State University, and Michigan State University as members. Out of this committee, the Michigan Educational Research Information Triad, Inc. (MERIT) was established as a non-profit corporation in October 1966, following the approval of the three institution's governing boards.²⁵

²³ Aupperle, Eric M. "Who, What, and Why". <http://www.merit.edu/about.merit/who.html> This document is a rather good history of the Merit network written by the President of the Merit Network. [Merit History Document]

²⁴ Merit History Document, Pg 1

Merit's initial funding came from appointments from the State of Michigan and from the National Science Foundation (NSF). The University of Michigan agreed to host Merit at its expense, due to a stipulation in the \$400,000 NSF grant that the money was for direct project funding. "As a consequence of this initial commitment by the U-M, Merit has always been housed by the University and all Merit staff have been U-M employees."²⁶ Once the funding had been acquired, the network construction could begin.

The first thing that needed to be done was to build improved data concentrators that could carry more information over longer distances. Merit called these simply "Communications Computers" at first. As the basis for their design, Merit chose to use the previously mentioned CONCOMP design that was already in use by the Computing Center. They contracted a company called Applied Dynamics to work with them in designing and building the hardware over a two-year period from 1969-1971. "On December 14, 1971 at 12:20 a.m., the first experimental connection occurred between the IBM mainframe computers at U-M and WSU. Nearly a year later, the Control Data Corporation at MSU was added to the network."²⁷ The network was officially dedicated at a ceremony that took place on May 15, 1973. MTS users could now connect to systems at WSU and MSU. Gradually, just about every higher education institution in the state would join the Merit network.

The Merit network greatly expanded in the 1970s and 1980s. In the mid-1970s, Merit developed a system in which terminal users could dial using into the network directly using modems and telephone lines. This system, known as "Hermes" became well known to dial-in and terminal users throughout the 1980s and into the mid-1990s when the system was finally taken down in favor of faster, commercially available hardware. Unfortunately, the Hermes system only added to much of the overcrowding problems that MTS experienced at this time. In 1976, the Merit network was connected to the commercial Telenet network, which greatly expanded the number of hosts that could be connected to from Merit hosts. In 1980, Merit joined EDUNET, a project of the

²⁵ Merit History Document, Pg 1

²⁶ Merit History Document, Pg 2

Telenet Corporation, which gave MTS users reduced-rate access to machines belonging to the 120 members. Some of these members included Carnegie-Mellon University, MIT, Notre Dame, USC, and Stanford.²⁸ In 1983, an effort to connect the Merit network to the ARPANET (the forerunner of what would later be called The Internet) was led by Hans-Werner Bruan, a network specialist from Germany. This effort was realized in early 1985 when a server known as “Fuzzball” (for the software that it ran, which was also called Fuzzball) was put on the network to act as a bridge between the Merit network and the ARPANET network. This project was funded by the Computing Center and the College of Engineering’s CAEN (Computer Aided Engineering Network) project.²⁹ An interesting note is that in the December 13, 1986 issue of the *Computing Center Newsletter* an article informs would-be Internet users that they had to be *authorized* in order to use the Internet. The authorization process involved printing out, signing, and mailing Merit’s External Use Policy. Keep in mind that at this time, Merit was connected to the Internet, but the MTS systems were not. In order to access the MTS systems from the internet a user had to connect to Merit’s Hermes service and then from there connect to the MTS machines.

Now that MTS was connected to its remote sites, and could connect to external sites, what about to the other computers within the university? Some of the other computers included several at the College of Engineering on their Apollo network, the Data Systems Center (which held the University’s administrative records), UM-Flint’s computers, UM-Dearborn’s computers and mainframe computers at the Medical Center. The answer to this problem was UMNNet.

The first UMNNet proposal was published in the March 17, 1982 *Computing Center Newsletter* right on the front page. The summary of the proposal’s history sums up the project as follows:

²⁷ Merit History Document, Pg 2-3

²⁸ “Merit News: The Four Merit Hosts Join EDUNET”, *Computing Center Newsletter*. 29 October 1980. Pg 3

"...In 1977 the University Committee on Computer Policy and Utilization produced a report recommending the development of 'Hierarchical Computing.' According to the report, the Computing Center, the Data Systems Center and the Hospital Data Systems Center would each have a hierarchical computer network emanating from it. Subsequently, a Technical Subcommittee, appointed by the Vice President for Research, recommended that a single campus network be developed rather than having three separate hierarchical networks, thus shifting the emphasis from hierarchical to distributed computing. The Subcommittee further recommended that the Computing Center manage a task force to develop a detailed network design. A proposal for the network's implementation was submitted by this task force to the Vice President for research in April 1981..."

UMNet was a big step. It would eventually be used to connect all of the mainframe, minicomputers, microcomputers, terminals, and various other peripherals throughout the University's Ann Arbor, Flint and Dearborn campus. External links to it would be provided by Merit, as well— allowing access to Merit's vast network links from any UMNet connected machine on campus.

Two things extended UMNet's usefulness: the telecommunications upgrade the university went through in 1985 and the explosion of remote sites on campus in the 1980s. The first real test of the system came in 1983, when the UNYN site opened, as the UNYN site was the first site on campus to be connected to the UMNet-Merit network. The real boom came when starting in 1985, the University began upgrading its telecommunications system. In doing so, they also provided provisions for data transfer and not simply just voice lines. Wiring between the buildings was replaced and new dual jacks were installed. These dual jacks could be wired to a data concentrator, which in turn was wired the UMNet-Merit network. What this meant was that anyone could have access to the network could have their jack wired for data. They would then purchase an inexpensive, higher-speed device called a *line driver*, instead of a slower, more expensive modem to connect their terminals. This ease of connection brought smaller computer clusters to areas of the campus that currently didn't have them. In addition, it made the Residence Hall Computing project both possible and more useful, as it was now easier

²⁹ Aupperle, Eric, "Merit's Rapidly Expanding Internetwork Linkages—A message from the Director", Merit Network News. January 1986.

for the users of those sites (especially in the smaller halls) to connect to MTS. Eventually, the new connections would even be spread to all of the dormitory rooms, allowing the increasing numbers of students with personal computers to connect them directly to UMNNet with line drivers.

MTS and the Development of Campus E-mail

In the past ten years, it seems that e-mail has been able to work its way into just about every aspect of campus life. E-mail at the University of Michigan, like most other Computing Services, had its roots on the MTS system.

A system had already existed in MTS for collaboration-type messaging. This system was called \$CONFER and was introduced to the campus in 1975. It worked much like a bulletin board, in that anyone who subscribed to a confer discussion could read all of the messages in it, as well as post new ones for everyone to see. This worked well and was one of the most popular services on MTS, however it made no provisions for private messages. The first mention of work on an e-mail system occurred in the October 10, 1979 issue of the *Computing Center Newsletter*. In his “Notes from the Director” column, Dr. Aaron Finerman briefly mentions that the Computing Center was actively working on an “inter-user message/mail capability for MTS.” This work would eventually evolve into the E-mail system known as \$MESSAGE, which was released in July of 1981. The new system was found to be useful almost immediately by its users, even though at this time the only people that could be e-mailed were other MTS users. No external e-mail access had been provided yet.

A type of limited external e-mail access was announced on September 10, 1983, when the University’s MTS system joined *Mailnet*. Mailnet was a mail network hosted at MIT, and in the beginning only had a few other members, including Harvard, the University of Wisconsin, the University of Iowa, Northwestern University, Carnegie-Mellon, Stockholm University (Sweden) and a bunch of others. Unlike today, however, the external e-mail wasn’t instantaneous. The Mailnet system worked by having a

computer at MIT call, using a phone line and a modem, each of the member institutions and exchange the outgoing mail and incoming mail. MIT's system called MTS four times per day for the mail exchange; at 3:00 a.m., 9:00 a.m., 1:00 p.m., and at 7:00 p.m.³⁰ Mailnet mail was used until 1986, when it was replaced with mail exchange over the internet, as it is today.

The Next Great Change: MTS and Microcomputers

The microcomputer revolution began to eat away at MTS's computing throne on campus, and would eventually become one of the main factors in its death. Microcomputers brought to the University powerful computing hardware that was very affordable. The first mention of microcomputers in the *Computing Center Newsletter* occurs in the September 29, 1979 issue. The article, titled "Personal Computers for Rent," was information about a rental service provided by Dr. Karl Zinn and his Center for Research on Learning & Technology (CRLT). For \$15 per week, a faculty member could rent a Commodore PET computer, and for \$30 per week, an Apple II computer. A slow start maybe, but a start nonetheless.

At first, many people bought microcomputers for use as less-expensive, full-featured terminals for connection to MTS. In 1981, the Computer Center developed a program for Apple II computers to connect to and exchange files with the MTS system. A similar program was released for the IBM PC, after the machine hit the campus in 1982. Talks and seminars were given by the Computing Center staff about the use of these new machines with MTS as well. Besides connection with MTS, another major use of these early machines was word processing. An article in the June 6, 1983 newsletter notes that "In the past few years there has been a proliferation of microcomputers on campus. We know that more than 65% of microcomputers purchased by University units are used at least part of the time for word processing applications. The same article then goes on to list the quantities of microcomputers that were purchased by University units. Of the 629 microcomputers purchased, the leaders by far were Apple and IBM, with 126 and 291

³⁰ "Network Electronic Mail Service Now Available", *Computing Center Newsletter*. September 10, 1983.

units, respectively. In July 1983, the Computing Center announced it would be expanding its microcomputer support and places Gavin Eadie and Leigh Daniels on the support committee.

In October, 1983 the Computing Center was able to negotiate a contract with Apple Computer that “permits the sale of one computer per person directly to students, faculty, and staff.” The University was allowed to buy units for their uses as well.³¹ These machines were offered at deep discounts— below a normal dealer’s cost. This led to a classic town-gown clash between the University and some local Apple Dealers. In a November 7, 1983 letter to the Vice President of Research that was passed on to the Computing Center, Richard J. Weir, Executive Director and Co-Owner of Complete Computer Center in Ann Arbor writes:

“Given the breadth of the University Community in Ann Arbor and surrounding towns from which we draw our retail market, we are seriously concerned that we would go out of business if the University enters the retail business. In Ann Arbor, virtually everyone would either works for the University, or has a neighbor or friend who does. The retail market for Apple Computers would be destroyed.”

This letter was to no avail, however as the deal did go through. It was further strengthened by the formation of the Apple University Consortium (AUC), on January 24, 1984, of which the university was one of the first 23 member institutions. Incidentally, the same meeting in which the AUC was introduced, so was the new Macintosh computer. With these two events, the University’s long-standing relationship with Apple and the Macintosh computer began.

Another significant event in the evolution of microcomputer use occurred in 1984, when the Computing Center announced that it would be offering publicly available microcomputers in NUBS. At this time, NUBS was being refurbished and would reopen with 25 Zenith-150 IBM PC compatible microcomputers in the place of keypunches. The center explains the removal by saying:

³¹ “Apple Computers Contract”. Memo to J.F. Brinkerhoff from W.S. Sturgis dated October 20, 1983

"The need for keypunches has grown dramatically smaller in the last few years. This trend should continue, especially as more and more users turn to microcomputers for off-line data entry and transfer to MTS... the Computing Center eventually plans to reduce the number of publicly available keypunches to one or two, and the number of card readers to one..."³²

With that simple statement, the card-punching era drew to a close with the advent of easier and cheaper to operate microcomputers. Terminals would also be moved from the UNYN site to a new classroom site in Angell hall, making room for the installation of Macintosh computers in place of the terminals. There would be about 550 microcomputers on campus by the end of 1986. In contrast, there would only be about 240 publicly available MTS terminals at this time.³³ This is up quite a bit, considering that at the beginning of fall term 1985, there were only a combined total of 190 public microcomputers and terminals on campus.³⁴

In order to provide space for all of these new microcomputers, new sites needed to be opened. By the end of 1986, there would be fifteen public microcomputer sites. These sites were sprinkled throughout the campus in such locations as the Frieze Building, West Engineering, Angell Hall (although not the Angell Hall "Fishbowl" site yet), and the North Ingalls building. In addition to the fifteen public sites, there would also be twelve residence hall computing sites that would be jointly operated by the Computing Center and the Housing Division. This group would eventually be called the ResComp group, and would have sites in every residence hall on campus. The project originally started in September 1985, with a temporary pilot site in Mosher-Jordan that was only intended to teach computing skills to its residents.³⁵ The program really did not get underway until 1986. The opening of the first six sites were announced in the March 3, 1986 issue of the *Computing Center Newsletter*. Two large sites would be located in the Mosher-Jordan and Bursley residence hall. The permanent Mosher-Jordan site would contain 19 Macintosh computers and the Bursley site would contain 22 Macintosh

³² "Number of Keypunches to Be Reduced", *Computing Center Newsletter*. 1 April 1984. Pg 3

³³ "550 New Micros Installed", *U-M Computing News*. 1 September 1986. Pg 2

³⁴ *Computing Center News*. 20 January 1986. Pg 2.

³⁵ "Forum on Students and Computers at U-M: Residence Hall Access". *Computing Center Newsletter*. 30 September 1986. Pg 1

computers. At the same time, smaller sites containing Apple Macintosh computers would be opened up in Fletcher Hall, Martha Cook and Baites I and II. About one month later, sites would open in Alice Lloyd, “Mark” Markley (this is how it was spelled in the April 14, 1986 Newsletter), South Quad and Stockwell. ResComp was on its way to becoming a valuable computing resource for students.

The beginning of the microcomputer era ushered in the complete close of all of the user areas in the North Campus Computing Center building as well. The growth of the Center’s staff to approximately 105 people and the installation of the second MTS machine (UB, another 470V/8) had forced them to convert first the area formerly used for older, larger mainframe hardware and then the user areas to office space.³⁶ By April 30, 1984, the only publicly accessible area contained three terminals and the input/output area. This was the entire extent of the Computing Center’s public facilities on North Campus.³⁷ Fortunately for engineering users on North Campus, CAEN (the Computer Aided Engineering Network) had been founded in 1983, offering them access to high-powered (and high cost) Apollo Workstations and Apple Lisa computers.

New Buzzwords: Information Technology Division

The Information Technology Division (ITD) was formed in 1984, “to manage academic and administrative computing at U-M, and to enhance the general computing environment for students faculty and staff...”³⁸ The first director of ITD was Doug Van Houweling, whose later title would be Vice Provost. It would have three units at its inception: Office of Administrative Systems, the Center for Information Technology Integration, and the Computing Center.

In order to provide better computing services for the students, ITD held three student forums. The first two were held in September and October 1985 and the last one

³⁶ “DRAFT: Revision Date 02-13-85 PROGRAM STATEMENT: Computing Center”. Author Unknown. From the

³⁷ “CNTR User Area to Close on 30 April”, Computing Center Newsletter. 16 April 1984. Pg 3

³⁸ “Information Technology Division Featured”, Computing Center Newsletter. 19 May 1986. Pg 1

was held in January 1986. The forums mainly focused on the expansion of computing services and the usefulness of the residence hall computing sites. Doug Van Houweling attended the sessions to listen to the student's concerns, explain the ITD position on various issues and to run a question and answer session. These forums were obviously important to ITD, as in September, 1985 the Regents of the University approved ITD's plan to levy a \$50 per term computer fee on every non-Engineering and non-School of Business Administration student. Engineering and School of Business students were exempt, as they were already charged \$150 per term for computing services.³⁹ This fee would be increased to \$100 per term in the spring term 1986, which would be a sore spot for some students that expressed themselves during the second forum.⁴⁰ Thus, for many students, this would be the first time they would be directly funding information technology efforts on campus. In addition, the collected money would only be used for student services, so the funding from students would directly benefit them. Initially, the funds would be used to purchase workstations for use in public sites and residence hall sites. Later, the funds would be used to aid in the connection of students' personal computers to the UMNNet network using the previously mentioned updated telecommunications system.⁴¹

Student funds were also used to increase student access and funding on the MTS system. In September 1985, for the first time, students that were not enrolled in a course with specific computer assignments could get an account on MTS. These accounts were known as "Student Request Accounts" and "Thesis Request Accounts" (to provide more funding for those working on doctoral dissertations). A similar account, called a "Faculty Request Account" was available for faculty as well. The primary aim of these new accounts was to "allow students and faculty members who have not previously used computers to take advantage of the computing resources that are available on MTS."⁴² By May 1986, 4,730 students would be added to the system via the request accounts, along with 824 thesis and 1,945 faculty. Staff request accounts would also be available at this

³⁹ "Student Computer Fee Approved", *Computing Center Newsletter*. 14 October 1985. Pg 3. [Student Fee]

⁴⁰ "Second Public Forum Addresses Campus Computing", *Computing Center Newsletter*. 11 November 1985. Pg 4.

⁴¹ Student Fee, Pg 3.

time as well.⁴³ The main implication of this mass sign-up was that afterwards, just about everyone had access to e-mail. This was a big step forward toward the feeling of near-necessity towards campus e-mail today.

We Built This CITI...

Doug Van Houwling established The Center for Information Technology Integration in January 1986. Its primary focus was to “create an interconnected computing environment on campus.”⁴⁴ What this meant was they were attempting to tie together a heterogeneous computing system with one network. This was a daunting task at the time, as CITI had to contend with machines manufactured by IBM, Apollo, Sun, Digital Equipment Corporation and Apple that all talked in different network protocols. One of their major achievements was the development of the applications software needed to roll out the UNIX computing environment that is in use on campus today. They also played a major role in developing the AFS/IFS file system for unified file access. The CITI group formed industrial partnerships with Apollo, Apple, and Digital Equipment to rapidly advance their projects, provide financial support, and even to commit their own staff. Clearly, the developments made at CITI would map out the future of computing services on the University of Michigan campus.

Epilogue

After the envelopment by ITD, the Computing Center was never quite the same. More emphasis was placed on microcomputer support than MTS, except for e-mail and confer services. In fact, by 1986, MTS was barely mentioned at all in the *Computing Center Newsletter*. It was pushed aside in order to provide more space for the faster moving world of microcomputing news. The publishing of *Computing Center Newsletter* ceased after the June 16, 1986 issue in favor of the ITD publication, *U-M Computing News*.

⁴² “Student Request Accounts Are Available”. *Computing Center Newsletter*. 2 September 1986.

⁴³ “7,500 Request Accounts Opened so Far”. *Computing Center Newsletter*. 19 May 1986.

⁴⁴ “New Directors for CITI”. *U-M Computing News*. 25 September 1986. Pg 2-3.

The developments made at CITI on the “new connected computing environment” sounded its death knell to MTS. The problem with MTS was that it ran on old, expensive hardware, was not supported by software vendors (making commercial software either expensive or impossible to get), and had no native TCP/IP support (which is required for a true connection to the internet). Thus, it was scrapped in favor of the ITD login service, which runs a widely supported operating system called UNIX on much cheaper hardware. UNIX had amassed a large following by the academic community, as well as hardware and software vendors. So moving to a distributed UNIX environment was a logical decision. Furthermore, as the personal microcomputers were becoming more and more powerful, the need for powerful centralized computing was reduced. Towards the end of its life, it seemed as if the powerful MTS was really only being used as an e-mail and file repository. This too, could be accomplished with a much less expensive system. After a brief period of migration, the MTS system was shutdown on June 30, 1996, ending a production run of 29 years.

In the twenty years from 1966 to 1986, the Computing Center and ITD weathered the switch from batch mode to timesharing and the beginnings of the switch from centralized mainframe computing to distributed workstation-based computing. These changes in computing paradigms represented major changes in the thought patterns of those who were implementing them. Thus, the staff during this time period deserves a lot of credit for the excellence of the computing systems that the students, faculty and staff of the University of Michigan use today. It was the systems that they developed that brought the institution to the forefront of instructional information systems research, development and deployment. It was these systems that form the basis of the information technology services that make other institutions envious today.