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## **A Brief Introduction to the History of Computing in Agricultural Economics**

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\*University of Kentucky Staff Paper 473, October, 2013. David L. Debertin is professor emeritus of agricultural economics at the University of Kentucky. These are the notes from the retirement seminar on computing technology employed in agricultural economics presented by Dr. Debertin in April, 2013. These notes and photographs describe the history of computing in agricultural economics over a period of over 40 years from 1969-2013.

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to the History  
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# **A Brief Introduction to the History of Computing in Agricultural Economics**

## *Abstract*

**From Addiators and slide rules to modern, internet-connected laptop computer terminals, academic computing has undergone a remarkable transformation in the past 50+ years. This paper traces some of the remarkable changes that have taken place since the early 1960s, a period of about 50 years. Changes have occurred not only with respect to the computational ability of computers, but also to massive increases in their storage capability, making it possible to do things that could not have been even dreamed of only a few years ago.**

**All of this is presented in the context of what it meant for research, teaching and extension programs in agricultural economics, with photos of much of the hardware that was employed along the way. Some of the hardware became obsolete quickly, as newer and better things came on the market. But other hardware was highly innovative, and stayed around for a long time in part because it was well thought out and did useful things in a reliable fashion.**

# **A Brief Introduction to the History of Computing in Agricultural Economics**

## **Chapter 1: the Mid-Late 1960s**

Number-crunching in agricultural economics has undergone a lot of changes in the past 40-50 years. I am going to try and walk you through some of this. In retrospect, many of the technologies employed 50 years ago seem almost unbelievably cheesy. But somehow, we managed.

I would have been a junior at NDSU in the school year 1967-68. Of course, I signed up for an intermediate level course in applied statistics: a three-hour course with one hour lab.

All through high school, 1961-65, my Addiator and I were inseparable, and I still have it. The Addiator was good at adding and subtracting using the little stylus, but there was no practical way to multiply or divide. The photo here is not mine, but is identical to mine. I always thought this was a much more practical device than a slide rule. Slide rules were pretty good at multiplying and dividing, but the accuracy of the addition and subtraction left something to be desired.



Engineers tended to favor slide rules: Statistics types not so much, as the statisticians did not like the rounding error that invariably had to take place on slide rules. Statisticians like exact numbers.

The best slide rules from the period were from K&E, something like this one. The engineering students all wandered from class to class with leather-cased K&E's strapped on their belts—in retrospect they were like an engineering-student version of an old-west gunslinger. The engineering students thought they were the brightest kids in the room, and the leather-cased K&E's on their belts only added to the aura.



Of course, we statistics gurus didn't quite see it that way. We thought there was no way that those K&Eers could do anything that was accurate enough to suit our needs. So my junior-level statistics lab was equipped with 25 mechanical calculators similar to this one. Each of these machines likely cost the University at least \$800 and maybe up to \$1,500, and that was in 1967 dollars. So laying out for these units in a lab was no small matter.



I quickly learned in my lab that these units were not *that* much smarter than my Addiator was. They *could* multiply and divide, but that was a struggle, and they were particularly inefficient at some kinds of division.

I don't know if this has occurred to you, but both multiplication and division are offshoots of addition and subtraction. Let's say you want to take 35 times 6. One way of doing that is to simply sum  $35+35+35+35+35+35$ . The correct answer to this addition is 210. You could add 35 six times, or you could take 35 times 6 directly. Either answer is correct.

Now let us suppose we want to find how many times 35 goes into the number 210. All we would need to do is keep track of how many times 35 can be subtracted from 210 to reach zero.

That is,  $210 - 35 - 35 - 35 - 35 - 35 - 35 = 0$  or 35 can be subtracted from 210 six times before reaching zero. So  $210$  divided by  $35 = 6$  via successive subtractions. If the number



was not evenly divided by 35, say 214, we would end up with 6 times plus a remainder of 4.

All of this worked relatively efficiently, most of the time, but what if the number we were dividing into (the *dividend*) was very large, say 2,496,382, and the number we were dividing by (the *divisor*) was very tiny, like 0.00012? These oddball things happen frequently in statistics. The calculator would need to make a lot of successive subtractions to reach an answer! The calculator was run with a motor powered with AC current, and the greater the difference in size between the dividend and the divisor, the longer the calculator would have to run. The calculator could run for up to hours before reaching an answer. So long, in fact that the calculator could physically overheat and break down.

This, I am certain is where the phase “number crunching” originated. It had to do with the sound of mechanical calculators performing division when the dividend was huge and the divisor was tiny.

More than a few mechanical calculators met untimely deaths doing long division. And rules in statistics labs had to protect the university investment in the machines. One rule was that if we got a mechanical calculator into a lengthy long-division mode you were out the door with a grade of “F” in the class! So we were all very careful. Oddly, the only way to shut

off the units we had that got into a cycling mode was to physically unplug them from the AC current. They did not seem to have any breaker switch or other self-protect mechanism built in. Worse, when you plugged them back in again, they would frequently start up and try to continue with the task at hand of performing the division, so even physically unplugging them often did not reset them.

It was not until I got into graduate school that I got to work with my first electronic calculator, but we were mostly still on the mechanical units. Of course, we did have access to an IBM 360 computer, which will all be in Chapter 2 of this story.

## **Chapter 2: 1969-1970**

So, I entered graduate school in agricultural economics in the fall of 1969. The department at that time was running mostly with mechanical calculators very similar to the one I used in the statistics lab a couple years earlier, and employed statistical clerks to do various “number crunching” tasks. Computers were becoming an increasing part of the activity. The department had a staff person assigned to punching data cards on a key punch machine.

The NDSU ag. econ. department acquired its first electronic calculator in the winter of 1969-70. The graduate students all had desks in a “bull pen” in the creepily-old South Engineering Building across from Morrill Hall where the faculty and staff had offices. Somehow the new \$2300 calculator ended up getting placed in the grad student bull pen. It used a round green cathode ray tube for a digital display. I do not recall the brand name on the machine, but it looked something like this Singer/Frieden 1162 unit. I am right on the date on this one which showed up first in 1969. I do also recall that it had an actual square root key on it, as this one does.



<http://www.oldcalculatormuseum.com/friden1162.html>

This one is listed as being priced at \$1195. My recollection is that the one the department bought was physically quite a bit bigger, and that they paid about \$1,600 for it. There were several mechanical calculators in the grad student room, but we all lined up for blocks of time on the new CRT machine. The CRT machine seemed to have no problems doing long division.

Meanwhile, real computing was progressing. The one University computer (mainframe) was an IBM 360

[http://en.wikipedia.org/wiki/IBM\\_System/360](http://en.wikipedia.org/wiki/IBM_System/360)

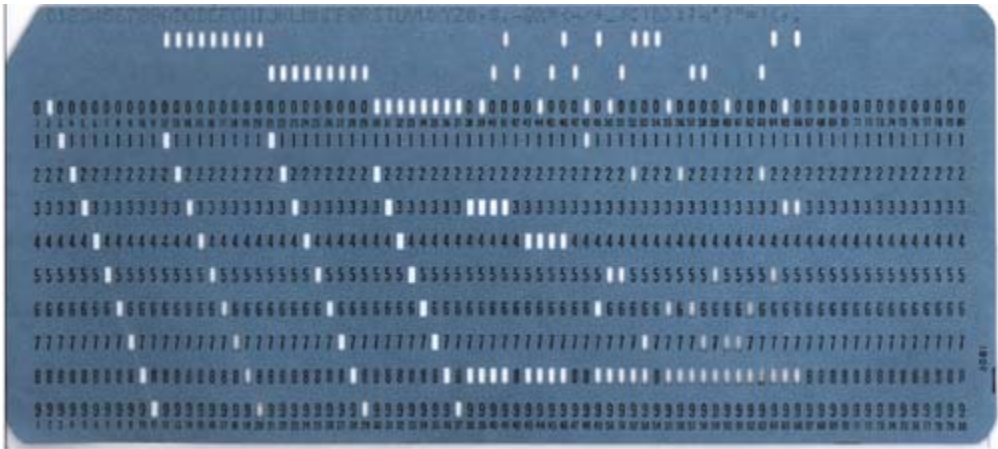
The 360 was strictly a machine for doing batch processing, one job at a time. There was no shared use of the machine. Instead, you entered your data on Hollerith cards, which was read into a card reader, and the jobs were processed pretty much in the sequence in which they were read. The 360 could read data coming in from cards, but it could also write data to the big magnetic tapes popularly seen in the science fiction movies of the era.

In the photo, note the twin-reel tape drive unit on the left, as well as the huge multi-layer disk drives. The flash drive you have in your pocket stores way more than these giant disk drives would store. The disk drives would probably have computer code for data processing. Individual users could also store tapes at the computing center containing data to be read when the job was processed. A typical computer job involved

some data entry from cards and some from tape. The computer operator would get a message on the printer to mount a specific tape at the right moment to process your job, or perhaps get a message to write to a tape that you had stored at the computing center. Tapes are not random access, so if you wanted to make changes in the middle of a data set you had created inside the computer program, it had to be rewritten in its entirety. Disk space then was far too expensive and scarce for the storage of user data.



Putting data for statistical computing on 80-byte Hollerith cards was no small task.



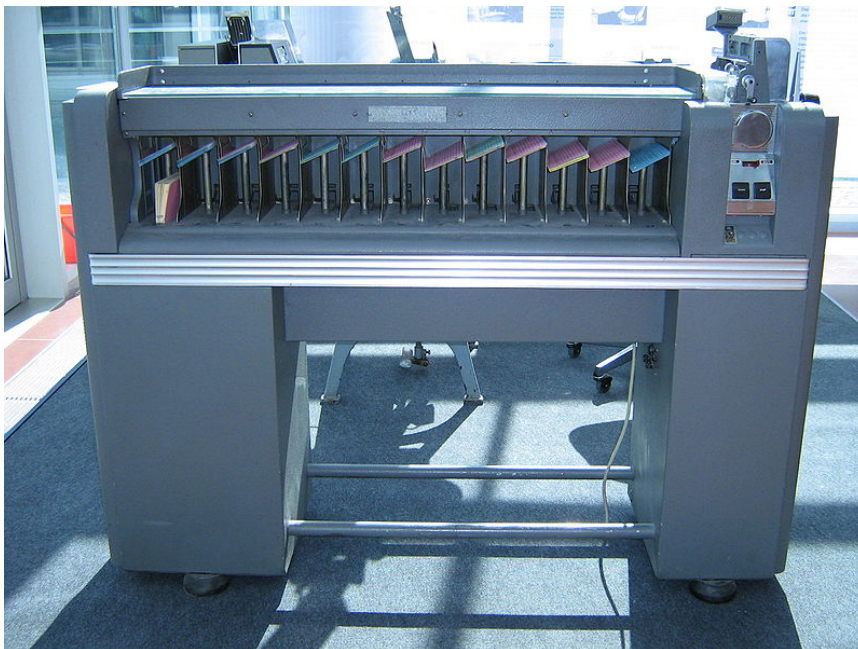
Departments and colleges employed key punch operators to do the task on key punch machines. NDSU ag econ had a statistical clerk who might be willing to enter data for you, if you were really nice to her, and a key punch machine. The most famous key punch machine in the world was the IBM 026.



New, un-punched cards went in the upper tray on the right. Data was entered via the keys, and the finished card was stored in the tray on the left. The cylinder held a card punched with the format you wanted on all your data cards so that successive cards would have the data entered in the proper columns. I spent more hours of my life than I want to remember sitting at a keypunch machine just like this.

The Hollerith card was invented long before the computer, and was first used to record data for the 1890 Census. Punched cards were commonly used by accountants for recording data. Punched cards could be read and sorted by a related mechanical device called a card sorter.

This is the classic IBM 082 card sorter.



NDSU had one of these over at the main computing center. They were useful in sorting and grouping data into categories. All of this pre-dates SAS and PROC SORT:

[http://en.wikipedia.org/wiki/IBM\\_card\\_sorter](http://en.wikipedia.org/wiki/IBM_card_sorter)

Watch the video of a card sorter in operation.

<http://www.youtube.com/watch?v=2RCglrZiC6c>

Card sorters were shipped around to fairs for decades after they outlived their usefulness in data processing. Remember the handwriting analysis booths. You would sign your name on an IBM card, and somehow the card would be run through and analyzed by a device that looked exactly like an IBM 082 card sorter.

I never quite figured out what was going on here, as the card sorter required physical punches not just a signature. But everyone loved to watch the card sorter work whether or not the signature mattered. They would have these machines all decked out with colored lights to further add to the mystery.

I thought this had all was all long past, but at the 2012 North Dakota State Fair, there was a handwriting analysis booth complete with what looked to me like a vintage IBM 082 card sorter!

In addition to the IBM 360, NDSU had an older IBM 1620 computer that they no longer used for batch computing.



Instead they set it up to do mainly scattergram plotting, the kind of thing you would want to do if you wanted to plot variable Y against variable X.

The 1620 was no longer a data processor, as the 360 had replaced it but they connected to a device that allowed it to make scattergram plots. Combined with the 082 card sorter, it was possible to separate data into various piles using the sorter, and then plot each pile of data separately. This predates the pen-and-ink plotting.

So, somehow I managed to complete my Master's thesis and degree at NDSU, from September 1969 to September 1970, using the IBM 360 for running regression equations, and adding scattergram plots with the plotter connected on an IBM 1620 computer, and I was off to Purdue, September, 1970.

### **Chapter 3: Purdue 1970-1974**

The Purdue Agricultural Economics department had a near-ideal physical setup in the then Krannert building. The Krannert building was named after Herman C. Krannert, a businessman in Indianapolis, and the Krannert school of industrial management bears his name. Within the school of industrial management were a combined general economics

department and business school occupying the third and fourth floors of the building. The first floor of the building contains a giant drawing room, including a spiral staircase that leads to a second floor library which includes books and periodicals related to economics, agricultural economics and business. Agricultural economics then had most of the fifth and sixth floors, with a major portion of the seventh floor being a computer lab.

When I arrived, Purdue was operating CDC (Control Data Corporation) computers, a CDC 6400 and a CDC 6500. These were located in the math building, some distance away from the Krannert building. The computer lab was connected to the CDC machines and had a card reader and printer, some terminals, and, of course four or five key punches. These were the improved and more modern-looking IBM 029 versions, as shown below.



Functionally the 029 punches worked much like the 026 unit, but they looked a lot newer. Leave it to Youtube, here is a video of a man running an IBM 029 card punch.

<http://www.youtube.com/watch?v=iXLfiAvkbyg>

The room also had several teletype terminals. They were probably model 33 units, about like this



There is a Wikipedia article on these units at <http://en.wikipedia.org/wiki/Teleprinter>

This type of terminal was commonly used for written communication via phone lines long before they were commonly linked to big computers. They ran at a noisy 10 characters per second, the equivalent of 100 baud. They were noisy mechanical devices. If you would like to see and hear one in action, watch this Youtube video.

<http://www.youtube.com/watch?v=KqTzvpYumQs>

The print head was cylindrical and made a lot of noise as it hit the paper. And they were super slow.

CDC machines were more than just batch processors. They were able to handle 30 or 40 users at once operating from remote teletype terminals. So the students lined up for time on one of the teletype terminals. We would copy data from cards using the card reader to a big magnetic tape, and then create and run our jobs using the tape data from the teletype. But what we entered on the teletype exactly duplicated the data format that we could have punched on cards using the 029 punches. This was just a more efficient way of running multiple jobs. When the job was run the computer operator would get a message to mount one of the big tapes on a drive, and sometimes jobs that required a tape mount did not complete as fast as jobs that were complete using just the cards or terminal.

Convenient storage of large amounts of data, data our research often required, was always an issue.

This all pre-dates SAS for data massaging and sorting, or if SAS existed at all it was only on IBM machines. CDC stuff was Big Ten. I think Michigan State was also running CDC equipment around the same time. The way we massaged and sorted data was to write our own programs in Fortran IV. I got good at that. A number of the Purdue faculty at the time were building computer simulation models and writing code in Fortran IV. The department employed computer programmers whose main job was to help faculty and graduate students successfully write Fortran code.

The story of SAS is a long one. There is a Wikipedia article that tells some of the history.

[http://en.wikipedia.org/wiki/SAS\\_\(software\)](http://en.wikipedia.org/wiki/SAS_(software))

NC State had a long history in Applied Statistics, and the Statistics department there was closely linked to agricultural economics. Anthony Barr, who founded SAS, was a grad student there from 1960-64, and conceived the idea as a simpler method of massaging data and performing statistical analysis than writing raw Fortran code. The basic idea was that the code needed could be simplified by writing predefined code, known in SAS lingo as a PROC or procedure. These procs

would be set up with options designed for user modification to specific tasks.

The original version of SAS was written in a programming language specific to IBM computers, then the 360 and then 370 models. The code would not run at all on CDC machines. Barr was from NC State in the South. Further, the other big universities in the South nearly all had IBM mainframes. That the code would not run on Purdue CDC machines was no big deal. The target audience was other Southern schools, and in particular Land Grant Universities in the South. But Purdue and their multi-user CDC machines were not part of this. We were stuck writing Fortran code, and accessing other than available statistical packs that ran on CDC, such as SPSS.

The other interesting part about SAS, of course, is that the applied statistics people there and the people in the ag college who dealt with statistical modeling were closely tied together, and SAS grew as professors donated code to do new things, so a lot of the early SAS programming has its roots in the Ag college faculty at NC State.

Midway through the 1969-70 school year, NDSU Ag. Econ. had purchased a single digital calculator for the department. About the same time I arrived at Purdue, they managed to purchase a digital calculator for each Ag. Econ. faculty member. I recall some of the details of what these were like, and have

been scrounging the Web looking for a machine that was close to the ones the Purdue faculty had. The one I came up with is the Monroe, 950, as pictured below. In retrospect, I am pretty sure they were Monroe calculators, but I am not certain of the exact model. This is close. .



I've just learned that the display technology was a series of Nixie tubes. These looked like conventional cathode ray tubes, but contained digits from 0-9 that lit up inside. There is a Wikipedia article on Nixie tubes at [http://en.wikipedia.org/wiki/Nixie\\_tube](http://en.wikipedia.org/wiki/Nixie_tube)

There is a nice picture of a single Nixie tube in the Wikipedia article, as below.



They look like a conventional tube, but the article indicates that they ran cold, and are more closely related to how the tubing in a neon sign works. This technology worked fine and the calculators were very reliable. I do not recall one breaking. I'm guessing that each calculator was several hundred dollars.

Calculator prices declined rapidly while I was at Purdue. In early 1972, I bought my first desk-top plug-in AC calculator. It was considerably smaller than the ones the faculty had, and I carried the calculator around in my brief case. If I recall correctly, I bought it at K-Mart, and paid only \$88, well within a graduate student budget. I still have that calculator at the



house, and when I remember where I put it I will take a photo of it to share.

By about 1977, all of these bulky and expensive calculators had been replaced by little slide rule calculators. I paid about \$20 for mine, and still have it.



Purdue Agricultural economics was *the* place to do a doctoral degree, especially for students interested in doing quantitative analysis involving computers. They had built a faculty with several top stars in each of what were considered to be the three main components of quantitative applied economics, Econometric Methods (Joe Havlicek and Earl Kehrberg), mathematical programming (Wilfred Candler and Jim Snyder) , and computer simulation ( Ludwig Eisgruber and Emerson Babb). Then the faculty was intermingled with all the

applied policy people who moved in and out of state and national government with ease.

For example, Carroll Bottom spent part of his time advising the secretary of agriculture, and the rest of his time interacting over coffee with the graduate students. Not only that, you had the constant interaction between the policy people and the quantitative people, and the policy people took advantage of the fact that they could bring the newest quantitative stuff into the policy arena lightning fast. This was all great fun because we could see the results of our Fortran programming efforts hit the field and be used in a policy setting or with farmers literally only months after the work was completed, if that. I was in the middle of all of this writing Fortran, running regressions, and then heading right off to the State capital the next day with my latest results. This was wild and crazy fun, as invariably these meetings would lead to some other idea or new thing that needed to be addressed quantitatively, and I would quickly be wandering down yet another thought trail quantitatively.

If not the Indiana governor or his immediate staff, was also very easy to get an audience with the secretary of agriculture too if your analysis said anything that was useful, and people went back and forth. Several of the PhD students were on leave from USDA appointments in DC, so they had lots of contacts in the Economic Research Service as well, interacting almost daily.

We were all pretty much doing the same thing; that is, dreaming up and then building quantitative analyses that would potentially address an important problem or issue, getting the results, and then putting the results in the hands of the exact people who needed the information to make a decision or implement a federal or state program.

At the same time, Purdue also had made great inroads with the important farmers of the state, and extension farm management was doing much the same kind of work. Wilfred Candler was the real resource behind all of this. He was so good at mathematical programming models that he could do solve LP problems in his *head*—often no computer needed. In the agribusiness area, Emerson Babb was doing quantitative work and using that work with a group of supermarket managers. The list goes on—and on. This integration of quantitative methods with the people who needed the model building was simply unmatched at other institutions. No group of faculty was more envious of what Purdue was doing at this time than those at the two California schools.

Both Berkeley and Davis liked to take pot shots at us on the basis that sometimes our quantitative models were not quite as *sophisticated* methodologically as was then possible to do, but we retaliated by saying that were building models that could be actually *implemented* in making real decisions, not

models that were off in the theoretical ether of mathematical economics, and further, the track record of being woven into the people making decisions was unmatched, anywhere, locally, state-wide, nationally, or internationally. Purdue agricultural economics was everywhere.

Purdue agricultural economics also greatly benefitted from being part of a very highly regarded engineering school. As a result, there was no piece of computer equipment too expensive or too sophisticated not to have available. This meant we got to use a lot of stuff a department at a lesser school would not have had. And we were really on the cusp of making applied economics in all its forms a computational science.

#### **Part 4: Kentucky 1974-1976**

So, after spending 3 ½ years bouncing back and forth between the 7<sup>th</sup> floor Krannert computer lab and the Indiana governor's office, and a shorter 10-month period working on a farmer-focused project for analyzing the role of information in farm-level decision-making, I arrived at the University of Kentucky in June of 1974. Given the Purdue experience, the two major issues facing Kentucky agricultural economics were quite obvious, at least to me.

First off, the computing facility, located way off on the central part of campus, was simply not very sophisticated

relative to what I had been used to. Worse, it was a long walk away. I was used to running literally dozens of computer jobs a day, as I honed my model building. How was I going to do this with such a poorly constructed set up.

The second, perhaps more subtle but less easy to resolve problem, was that the faculty as a group were not nearly as wired into decision making at the various levels. This went way beyond not having contacts in Washington DC or involved in decision making at the upper levels there but was also an issue at the state government level and even in working with farmers.

So, job 1 was convincing the Dean that the setup at Kentucky, computer-wise was sub-par. At minimum, we needed a card reader and printer on the south side of campus so that the faculty and grad students would not have to trek across campus every time they needed to run a computer job. I spend a lot of my first year at Kentucky.

By the following summer, 1975, I had done just that. The political process of getting there is a long story involving me and several other people who were busy swaying administrators, longer than I care to write the details of at the moment. The short version is that I had convinced the ag Dean of the need, but the central campus was going to be a tough sell. If I recall the numbers correctly, we were looking at about

a thousand dollar monthly cost to pull this off, a number the Dean thought was more than doable, given the resources of the College and the number of faculty the setup would support. Further, at that point the department had hired a number of people other than me who were interested in quantitative analysis as well, and the setup was going to support them as well.

So we were a “go” from this end. The Dean (Charles E. Barnhart) and I plus a few others arranged a meeting with the central campus administration people arranged a meeting, I think sometime in the summer of 1975 over on the central campus. I had never seen a guy work a small group quite like Barnhart did that day. The computing center director was completely unconvinced that the Ag college needed such a facility. The engineers perhaps, but at that time they were much closer physically to the computing center.

The unforgettable line that came from the computing center director was “For the kind of money you guys want to spend on this and the small number of computer jobs you all have been running on our machine, we could afford to hire you a limousine with a driver to drive your faculty back and forth on a daily basis to the computing center.”

I rather sheepishly made the case that the small numbers of jobs the ag college was running on the main computer was in

part attributable to the fact that we had such crummy access. What might one otherwise expect under such circumstances?

Anyhow, Barnhart had come up with a method of paying for the card reader and printer out of ag college money. He clearly wanted to do this, and by the end of the meeting it was agreed that the Ag College would have the first remote access to the IBM 370 on campus. We still had to determine exactly where this facility was to be, and there were a number of options,. The idea of putting the facility somewhere in the Ag Econ department was clearly on the table. But, there was largely unused space over in the seed lab building, adjacent to Ag Science North and South. If I recall, the agronomists grumbled a bit about losing a room, but they eventually came around given that agronomy was going to make use of the new computer space as well. So, by the winter of 1975 I think it was, we had a line printer and card reader operating as a remote access point in the seed lab.

Here is a photograph. I am trying to determine if this is the first line printer we had in that room or the second one. I think it might be the second one. The first one was just a printer.



*COMPUTER IS KEY TO NEW PROGRAMS—The farmer can now come directly to the data computing center at UK's College of Agriculture and by supplying the computer with certain information can quickly learn the alternatives he can employ in specific situations and programs on his farm.*

There were a couple things going on at this time. The cards were a bulky, cumbersome way to store data. IBM had recently introduced a key punch that put the data on an 8-inch floppy disk, and it was possible to store a bunch of card images on an 8-inch magnetic floppy. The new 3741 machines looked like this.





There was an 8 inch floppy disk drive on the left, and a cathode ray tube built into the console. In the upper right hand corner of the photo was a flip-up mirror so that the operator could see on the CRT what was being typed. The data went directly on to the 8-inch floppy disks.

A lot of people are familiar with the 5 ¼ inch floppy disks but not the 8 inchers. Despite being physically larger, the 8 inchers only stored a limited amount of data, 250 Kbytes. This photo shows how floppy disks evolved, the 3 ½ inch floppy storing the most data, even though the case was no longer floppy.



At the time, 250 Kbytes seemed like a lot of data. It was purportedly equivalent to the amount of data contained in a standard 2300 card box of 80 byte Hollerith cards, so each 8-inch floppy replaced a box of cards.

[http://en.wikipedia.org/wiki/History\\_of\\_the\\_floppy\\_disk](http://en.wikipedia.org/wiki/History_of_the_floppy_disk)

The data entry people on the new machines entered the data on the floppy and these were read by a floppy disk reader located to the left of the printer. This was a remote replacement for data entry using cards. All of this equipment was introduced in the mid 1970s.

We were off and running, still doing batch jobs mainly using cards, but occasionally taking advantage of the first floppy disk technology for data storage.

But, we had another issue. At the tail end of my time at Purdue I had started to run computer jobs using a new Silent 700 portable terminal like this.



This was a huge development relative to the old teletype machines. They ran at 300 baud (30 characters per second) not 100 baud. They were portable. They had a built-in thermal printer, not a noisy clanger like the teletype. The days of the teletype for computer access were numbered.

Of course, I wanted to be able to sit in my office and submit jobs from there, not have to be constantly carrying around boxes of cards back and forth to the card reader. But, we had a problem, a big problem.

## Part 5: 1976-1979

IBM 370s were cheesy machines compared with the CDC 6400 and 6500 machines I had been running on at Purdue. IBM was a business mainframe computer manufacturer, and they did a huge business selling mainframe computers to businesses for sequentially batch processing of computer jobs. Selling computers to universities was only a sideline to IBM's main business, and they were not that interested in designing hardware for remote use because that is not something businesses did at that point. Businesses had data processing centers run by computer people who processed jobs. Why could University people not be happy with that setup?

Unlike the 360s, which could handle no remote access at all, a 370, if pressed, could deal with multiple users at the same time. But, not too many, and each user had better not be running very big jobs.

But we were thinking that if a single silent 700 would work for remote access from my office, there were probably at least 15 or maybe 20 people in the College who like to do the same thing. The problem was that if everybody got on at the same time from a silent 700, the entire computing resources of the University would be all but consumed. Batch processing via card reader would slow to a crawl. CDC machines were designed to handle multiple users, at least up to 50 or even

100. IBM equipment was sub-par. But, we were not in any political position to tell the computing center to dump the IBM 370 stuff and go get a couple big CDC machines instead. At this point I wasn't sure I wanted that to happen anyways, since SAS was an IBM-only product, and the statistical stuff we had been running at Purdue looked cheesy by comparison.

So, we needed a solution that would keep the 370 in place but allow us to run multiple Silent 700 terminals from remote sites like offices without bogging down the main computer.

Throughout this period, Ed Lindstrom and I were "Partners in crime" so to speak with respect to planning computer facilities in the ag college. Ed kept up on the latest equipment, and I was the one that had the ideas with respect to what we needed to do next. We were both convinced that the UK computing center had no intension of moving forward with remote access directly through the mainframe.

The computing center was scared that we would dream up something that bogged down the 370 for the rest of the campus. They still weren't quite certain that the ag. College was a significant player in all of this.

Ed was studying the latest in computing technologies, the so-called *minicomputer*. There were a couple manufacturers, then seen as only small threats to IBM and their mainframes.

There were a number of players in this game, but particular Data General with their PDP line and Digital Equipment Corporation (DEC). So, Ed told me that what I needed to do what I wanted required a mini-computer which could provide the terminal access via the silent 700 as well as act as a smart, front end to the IBM 370 across campus. The minicomputer could provide simultaneous access by 20 or more terminals operating in faculty offices and provide the card reading and printing access as well. Not only that, we could buy a couple of washing-machine sized disk drives and enter data remotely without using cards or the 8-inch floppy machines.

The only problem was that Ed and I needed \$10,000, perhaps more. We were both thinking that the days of the “dumb” card reader and printer in the seed lab were numbered, and would soon be replaced with a minicomputer providing not only the card reading and printing capabilities, but also direct on line disk storage and give people wanted remote access for submitting batch jobs what they needed. Ed even had a couple of specific minicomputers in mind, and was starting to entertain their vendors in his office.

It was not long before we were ready to sit down with the College administration and explain what we were thinking and why we thought it was important to do. In particular, we talked back and forth with Oran Little, who was the associate Dean for

research at the time. We wanted to be able to give Oran specific dollar amounts that we needed, and Ed's conversations with vendors were invaluable on that front. We were armed and ready to pounce.

Oran was easy to convince. We let Oran convince Charlie that this was the obvious next step. Occasionally we would both pop into a meeting with Charlie but we were mostly there to occasionally reinforce the points Oran was making.

Interestingly, the battle with central computing as I recall was not nearly as messy as the battle to get the initial card reader and printer. They seem to have somewhat given up. It was almost as if Charlie wanted to spend College money on such a silly scheme they were not about to stand in his way.

So, the College must have gotten bids on several different minicomputers from the various vendors and ended up with a PDP 11. Digital Equipment Corporation (DEC) who made the PDP computers was making rapid upgrades to the machines. I think ours was an 11/45, with the latter number indicating the particular version.

Anyway, our computer looked about like this, which is the PDP 11/45 model.



The small circles are small tape drives. Unfortunately, these were not data storage devices, but merely the method PDP used to store the operating system. Think of this as a computer with the primary task of acting as an entry point for Silent 700 terminals, and then shipping jobs from the Silent 700 terminals to McVey hall to be processed by the IBM 370. ON-line data storage came later. The PDP computer did not stay around long, probably about two years, 1977 and 1978, and perhaps into part of 1979.

The PDP machine was replaced with a Hewlett Packard 3000 series II machine. The big advantage was that we were



now going to have on-line disk storage in the College. The HP machine looked like this.



Note the two full-sized tape drives. More importantly, note the washing-machine size device on the right.



That was a hard disk drive. I read that the first of these big units stored only 15 MB. That is not a misprint as MB not GB. The first two we bought each stored 50 MB. So initially, the College had 100 MB of on-line storage total. From a cards perspective, a box of computer cards contained about 250 kb of data. 100 MB would be the equivalent to storing 400 boxes of computer cards on line. That seemed like a lot. We soon got two more drives. They looked the same but each stored 100 MB. So we were up to 300 MB total capacity of on-line storage for the College. (Some of the earliest USB flash drives stored 128 MB.)

This is all pre-Internet. We were building internet-like capabilities using this equipment right in the department. We had this idea to put socioeconomic data on-line with the notion that people in the field could dial up the College computer using a silent 700 computer terminal via phone line.

This was the so-called DISK project, which was an acronym for the Developmental Information System for Kentucky, and, of course, the data tables we created were stored on our new disk drives. This actually worked pretty well. County agents had toll-free numbers into the campus computer.

About the same time, 1979, we started work on the so-called *Visual Data Center*. Ed and I dreamed up that term as we thought about the possibilities of projecting the output from a Silent 700 to a big screen in a classroom-like setting.

Reasonably-priced projection television sets had just come out, most notably, the Advents. The Advents used a curved, reflective screen to increase brightness. It was no big trick to send a video signal from a Silent 700 to the TV. We needed space to put this all in place. We decided it would also be neat to set this up to run conventional videotapes. The result was the room below.



You can see all of the equipment here, the silent 700 (about \$3000), The Advent TV and screen (another \$3000) A full-sized Sony video recorder (Beta not VHS) and a smaller TV.

There were several rows of seating set up with swivel seats. We had not yet progressed to having multiple terminals on the counters, but that was to come later. I was probably teaching SAS when this photo was shot, as I was prone to do. The three-gun convergence on the Advent varied if the TV console moved at all, and made the letters coming off the Silent 700 difficult to read. The technology had its bugs and we worked around them as best we could.

The students shown here are MS student Grady Steele, along with PhD students Orlen Grunewald and B.N. Hiremath. Both of them finished their degrees about 1980. So this photo was probably shot in about 1978.

This was the north room of the seed lab building, another room we had talked Oran Little into allocating for us. We let Oran deal with the politics of taking over agronomy space in the Seed lab. He usually dealt with that by making sure the agronomy department knew they were welcome to use all the fancy equipment too, although I recall a few agronomy faculty were not quite as excited as I was about the whole deal. We were moving forward.

As I look back on this time period, it was really interesting, as there were elements that are very much still with us today. The DISK project was almost like a mini-Internet for county agents interested in community development-related information. The visual data center was really the first attempt at using big-screen computer video in a classroom setting. There were surely lots of things still to be invented, but many of the basics were there.

Not surprisingly, I had also been playing around with computer graphics. The university had a CALCOMP plotter capable of doing pen-and ink drawing (actually India ink drawings) which are very high quality. I dreamed up the idea that it would be fun to make three-dimensional drawings of production surfaces (strange, huh). But, we are in the pre-SAS Graph days.

Hermann Collins, employed as a computer programmer by the department, said “I can write that”. So he wrote a CALCOMP program for doing 3-D graphs that could produce India ink output.

Throughout most of the 1970s, the department had an MTST machine that was primarily used to make departmental research and extension publications. MTST stood for Magnetic Tape Selectric Typewriter. It used magnetic tapes to store typed documents.

[http://en.wikipedia.org/wiki/IBM\\_MT/ST](http://en.wikipedia.org/wiki/IBM_MT/ST)

The problem, of course, is that magnetic tape is a sequential not random-access media. The machines were set up so that typos and other errors involving a few characters could be fixed, but do not ask to move a paragraph around from one place to another. Everything had to be retyped. The machine and tapes looked like this.



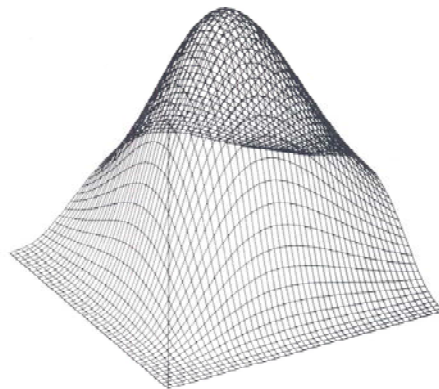
Wanda, the MTST operator, did my first bulletin employing 3-D computer graphics on this machine. The bulletin contained

Wanda's MTST work along with the India ink plots created by the CALCOMP program authored by Herman Collins.

COMPUTER GRAPHICS – A TECHNIQUE  
FOR THE ANALYSIS OF  
AGRICULTURAL PRODUCTION FUNCTIONS

By

David L. Debertin, Angelos Pagoulatos, and Garnett L. Bradford  
Herman C. Collins, Programmer



February 1977

University of Kentucky : College of Agriculture  
Agricultural Experiment Station : Department of Agricultural Economics  
Lexington

The entire bulletin is at

<http://www.uky.edu/~deberti/compgraph.pdf>

This is amazing stuff especially considering both the time in which it was created and the equipment it was created on. The date on this is 1977.

## Part 6: 1980-85

One day, probably early 1980, Milt Shuffett wandered into my office to announce that the MTST was shot, and needed to be replaced. He had been talking to the vendor that sold the department the original MTST machine. The vendor said a suitable replacement could be had, allowing random access on disk (so that paragraphs could be moved around and big chunks added to manuscripts), and that the machine to do that would cost \$12,000. Milt said he had found the \$12,000 and wondered if I thought it would be a good idea to proceed.

I said, more or less, that \$12,000 was a lot of money, and further, for that I thought we could get no less than *four* of the new personal computers that were just coming out, and that I had been talking to the people who sold them. I was enamored with the Xerox 820 machines that each cost about \$3000, including a line printer. They fit right into Milt's \$12,000 budget and supported my contention that we could buy machines for each of the floors in the department and replace the MTST machine with an identical unit for the same budget.



Milt was skeptical of my plan to upgrade the secretaries to word processors. That was an understatement. I think what sold the deal was that the secretaries would all still keep their Selectric typewriters, but the word processor would be on a separate desk on each floor.

All of this predates MSDOS and the IBM PC. All the computers out of this type ran an operating system called CP/M, the acronym for Control Program for Microcomputers.

The IBM PC running MSDOS hadn't been invented yet. One story that floats around the computer world was that IBM was planning on using CP/M as the operating system for their new PC machines, but did not receive the reception that they had hoped from the Digital Research people responsible for writing CP/M. IBM planned to do a 16-bit PC, not 8-bit like the existing CP/M machines, so CP/M was going to need to be reworked for IBM.

IBM was good with the idea of farming out the PC operating system software to another company. They were still thinking that the big money was not in software but in manufacturing the hardware. But the IBM executives and the CP/M people apparently did not go as IBM had hoped, and they ended up at a little startup to talk about writing a 16-bit operating system for their new PC.

That little startup, of course, was Microsoft, and the executive they were talking to was a nerdy guy called Bill Gates. The rest is history. Bill Gates agreed to do a proprietary version specific for IBM called PCDOS, (DOS=Disk Operating System) but he also kept rights to a generic version he called MSDOS (Microsoft Disc Operating System) which he was free to sell to other computer manufacturers.

The rest is history. CP/M struggled with a 16 bit version of their operating system, and soon folded entirely. Bill Gates became a wealthy man, and MSDOS begat a whole series of PC operating systems to the present.

I'm getting ahead of my story. However reluctant Milt was initially, we went ahead and bought four Xerox 820 machines. They each looked like this.



Each machine had a monochrome display (green and black, along with a twin 5 ¼ inch floppy drive unit. Technically, these were 8-bit machines without hard drives. To run the machine you first inserted the CP/M operating system on a disk in the left drive. Once that was loaded the screen would come back with a standard DOS prompt >

After that, you pulled the operating system disk and replaced it with a word processor disk. The program of choice was called WordStar. Everyone used it.

WordStar was a great program in that it made maximum use of the limited computer capabilities of that generation of computers. Wikipedia has a nice write up as to what happened. The WordStar DOS version it still is a great text editor, and the basic WordStar commands remain etched into my brain. The right disk unit was for your document.

The popular printers of the day were called daisy-wheel printers. The wheels contained upper and lower case. The problem was that if you needed a math font the wheel had to be manually changed out. WordStar had a command that would stop the printer in the middle of a sentence when the math font was needed. The wheel would be changed out, and printing of the math would resume. The Xerox daisy wheel printer of the time looked like this.



I had somewhat forgotten what we had but then I saw this photo on the Internet, and it all came streaming back.

Later we got daisy wheels for these that had both math fonts and standard characters.

The department did a lot of work on these machines between 1980 and 1985. I think Milt in part agreed with my scheme because the two secretaries on each floor were still going to be able to keep their Selectric typewriters for routine work. The computers and printers ended up on a separate, third desk.

It was not long before the secretaries realized that for most of their work the word processor had a lot of benefits, and we ended up buying three more Xerox computers. A single

Selectric typewriter got moved to the desk the computer had previously occupied, and the computers moved on to the desks of the secretaries. We were still running WordStar from twin 5¼-inch floppy drives.

By early 1985 I had signed a contract with Macmillan to do a graduate-level textbook in production economics. I was anxious to not have to do this longhand, but rather to take advantage of word processing. Macmillan was too. They were hoping that I could do most of the typesetting work and submit the book to them on floppy disks, one chapter per disk.

I needed a computer I could carry back and forth. I wanted disk compatibility with the Xerox 820 machines, so I could print at work. Under 8-bit CP/M practically every computer manufacturer used a different format for the 5 ¼ inch floppy. The Kaypro II portable computer was particularly interesting to me in part because it read and wrote disks at least semi-compatible with the Xerox 820. It was about a \$2,500 item. It had a small monochrome CRT and twin 5 ¼ inch floppies. Still no hard drive. It used the same system the Xerox used. Load CP/M, then load WordStar in one drive, using the second drive for disks containing individual chapters.

The Kaypro II looked like this. The monochrome screen was about 8 inches, diagonal measure.



Folded up for carrying, it was the size of a sewing machine



The weight on this beast was 26 pounds, compared with 5 pounds or so for a current generation laptop.

I spent most of late 1984 through the summer of 1985 writing *Agricultural Production Economics* at my dining room table. The Kaypro II performed all but flawlessly, and the disks were off to Macmillan.

There were still a couple of issues, however. For starters, we had no graphics capability on the Kaypro. That meant that drawings had to be done by a graphics artist at Macmillan, based on my hand-drawn sketches. Second, equation editors for these machines had not been invented. Formats for mathematical notation had to be created using complicated rules with respect to what got italicized, versus not. For example for a variable  $x_1$  the proper notation has the  $x$  in italics but the subscript 1 in a non-italic font. That is,  $x_1$  not  $x_I$ . The Macmillan typesetters entered all of this on my electronic copy. This issue came back at me a few years later.

The IBM PC was first introduced in late 1981. It was a little faster than the Xerox 820s with the 16-bit processor, but was still a twin floppy driver unit without a hard disk. The hard disk XT model did not come out until 1984. The first hard disk was only 10 MB, but the next version came with a 20 MB disk, probably sometime in 1985. The XT models looked like this. The 5 ¼ inch floppy was still the main storage device for manuscripts, but the hard disk could be used for the operating system and for WordStar, still the dominant word processing software.

The department was in no great rush to replace the 820 Xerox machines that had been serving us well, but gradually we started buying XT machines. A big debate was whether

secretaries needed a color CGA monitor for what they did, considering by some in the department an unnecessary luxury.



Note the single 5 ¼ inch floppy on left, 10 or 20 MB hard drive on right, and CGA color monitor, an option to a green-and black monochrome monitor.

CGA (Color Graphics Adaptor) was a very clunky color display technology. The basic resolution was only 320 x 200 pixels. Even worse, the monitors could display only a limited number of colors at a time, Those of us who went to elementart school with 8 colors in our box of crayons suddenly learned that basic colors were not blue, red and green, but rather cyan (blue and green guns full up, red off), magenta



(blue and red guns full up, green off) and a rather weird-looking yellowish tone that was the result of red and green full up but blue off. Worse, the monitors could not display all these colors at once, and so it was easy to do a bar or pie chart using a subset of these strange colors, do not ask to display an even grainy photograph.

Something better was needed, and that something better was the EGA (Enhanced Graphics Adaptor) and monitors that became available on IBM Clone computers). Remember the deal Gates struck with IBM that allowed his to market MSDOS in competition with IBM and their PCDOS. This is what made it possible for many manufacturers to build DOS-based IBM clone computers. The largest of these clone makers was Compaq.

Compaq got to the market well ahead of IBM with EGA clone PC's. Why this is important is because EGA was the first moderately priced method for not only being able to display photographs, but from an agricultural economics department perspective made Harvard Graphics a practical technology for presentations. Harvard Graphics was really built around the EGA display cards and monitors. The standard EGA display resolution was 640 x 350, a huge improvement over the standard 320 x 200 resolution of CGA.

Harvard Graphics took full advantage of this in their DOS-based graphics program. Harvard Graphics was a good deal more than just a program for creating charts



## Part 7: 1985-1990

So, by 1987 I had wangled a big grant (about \$33,000 if I recall correctly) with the expressed purpose of experimenting with the new high-resolution graphics hardware and software in a variety of teaching and research settings. I had enough money for a couple of computers, monitors, software and display adaptors. The question came down as to what, given that things in the display device arena were moving rapidly.

IBM had just introduced its PS/2 line of computers. The top models were towers meant to stand vertically on the floor. I

ordered up a model 60, which looked like this, wexcept that I ordered mine with a new 3 ½ floppy in one of the disk bays rather than the twin 5 ¼ inch floppies. My machine had a 50 meg hard disk.



IBM recognized they had serious competition from clone manufacturers running EGA graphics adaptors and monitors. The PS/2 line attempted to go one step higher by introducing

VGA graphics. This was a new 15-pin connector which was, conveniently, incompatible with the 9-pin connectors and boards used in the clone computers. The basic resolution was 640 x 480, better than EGA. The top-of-the line monitor was a new 8514a unit capable of displaying resolutions of up to 1024 x 768. The 8514a resolution was unique to IBM. The problem was that there very few software writers out there who wanted to write software designed for a resolution available from only one manufacturer. Of course, I wanted to be on top of all of this, and I ordered one of the 16 inch IBM 8514a monitors.



The 15-pin VGA standard IBM first used was quickly adopted both in and out of the computer world, and the old 9-pin EGA standard quickly fell by the wayside.

At the same time, I also bought a Compaq 286 clone computer with what was then considered to be a huge 144 MB hard disk. I ran two monitors on that, a standard 14 inch EGA monitor and a secondary monitor running at a 1280 x 1068 resolution. This monitor and graphics card was ordinarily sold to engineers interested in CAD design. I was interested mainly from the perspective of the potential to display 3-D graphics of functions. The problem was that the state-of-the-art CAD programs were not well suited for dealing with mathematical functions, being better suited for doing elaborate hand drawings on the computer.

The 8514 monitor was a beast: the 1280 x 1024 monitor was even more of a beast. The \$5500 display adaptor card I put in the Compaq outputted three separate color signals through three wires to drive each of the three color guns in the monitor. This did give high display resolutions, but the problem was that the software I needed to display functions via this scheme was not fully there.

Meanwhile, I was teaching GEN 101, the precursor to AEC 101 as a course in basic agricultural economics, and I was interested in seeing if it would be possible to create the entire course using Harvard Graphics slides. I spent most of 1986 and 1987 drawing and writing on Harvard Graphics, realizing that all

I was need to display the output of my work was a projector of some sort. The IBM PS/2 60 and 8514a became my basic tool.

Harvard Graphics was and still is a unique program in all sorts of different ways. Harvard Graphics does not create a photograph-like image as such, but merely provides the instructions to the computer with respect to how to draw the image. As you sequence through slides, a computer program is being run to prepare the next slide, and there is usually no delay unless you want to sequence through slides in a hurry. Computers were not that fast, and this was the trick to make them appear to be running faster than they were.

As of 1987, the only practical computer projector was a single-lens monochrome unit. This was a huge beast, I think a Barco. There was a large rear projector screen in the basement classroom of the Garrigus building (then Ag Science N). The projector would reverse images via a simple switch. We put the projector *behind* the screen and displayed the monochrome images from the Harvard Graphics on to the big screen.

I taught Gen 100 in that basement classroom using this equipment for two years. After that, it was time to go full-color with a 3-gun color display hung from the ceiling. The first unit we bought was big and heavy too. At least the fixed location limited the convergence problems. I noted in my 1991 AJAE article that the monochrome projector has cost about \$2500,

versus the \$10,000 we paid for the first color unit that had gone in the ceiling of the A-10 Ag Science North classroom.



By 1988 this had all attracted national attention. I was making presentations at places such as the Robert Morris teaching conference in Pittsburgh mostly attended by general economics not agricultural economics faculty. But I was also running around the country doing demos of the technology to other agricultural economists, writing AJAE articles, and so on.

<http://www.jstor.org/stable/pdfplus/1242880.pdf?acceptTC=true>

I was hauling around a laptop computer, a Toshiba LCD unit that looked like this



The monochrome LCD display was a limitation, but it had an output that fed a color signal to an EGA monitor. I could run color graphics in EGA mode with this.

### **Part 8: 1991-1995**

By the early 1990s, these techniques for employing Harvard Graphics in the classroom had attracted a lot of attention. I won the University of Kentucky chancellor's "Excellence in Undergraduate Education award in May of 1991, and followed that up winning the Southern Agricultural Economics Association award for Excellence in Undergraduate Teaching.





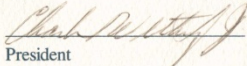
UNIVERSITY HONORS DAY

A CELEBRATION OF ACADEMIC ACHIEVEMENT

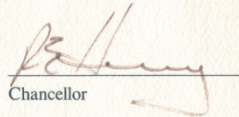
*For demonstrating excellence commensurate  
with the ideals of the University of Kentucky*


**David L. Debertin**

**The Excellence in Undergraduate Teaching Award**  
*is hereby applauded by the University community.*

  
President

*Always to be the best... Homer*

  
Chancellor

Southern Agricultural  Economics Association

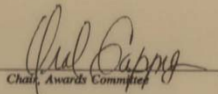
**Distinguished Professional Contribution Award**

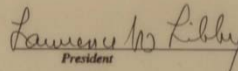
*Presented to:*

**David L. Debertin**

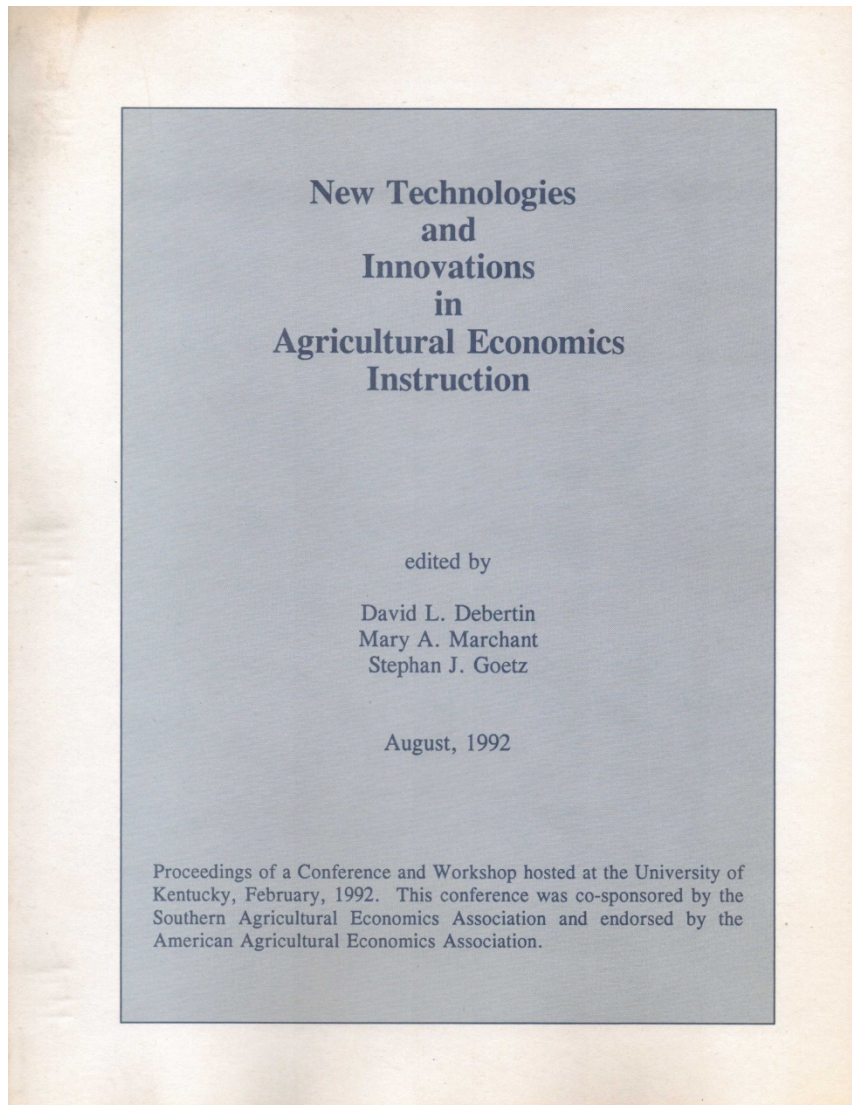
*In Recognition of Outstanding Professional Contributions  
to Agricultural Economics  
In Teaching Programs*

Lexington, Kentucky  
February 3, 1992

  
Chair, Awards Committee

  
President

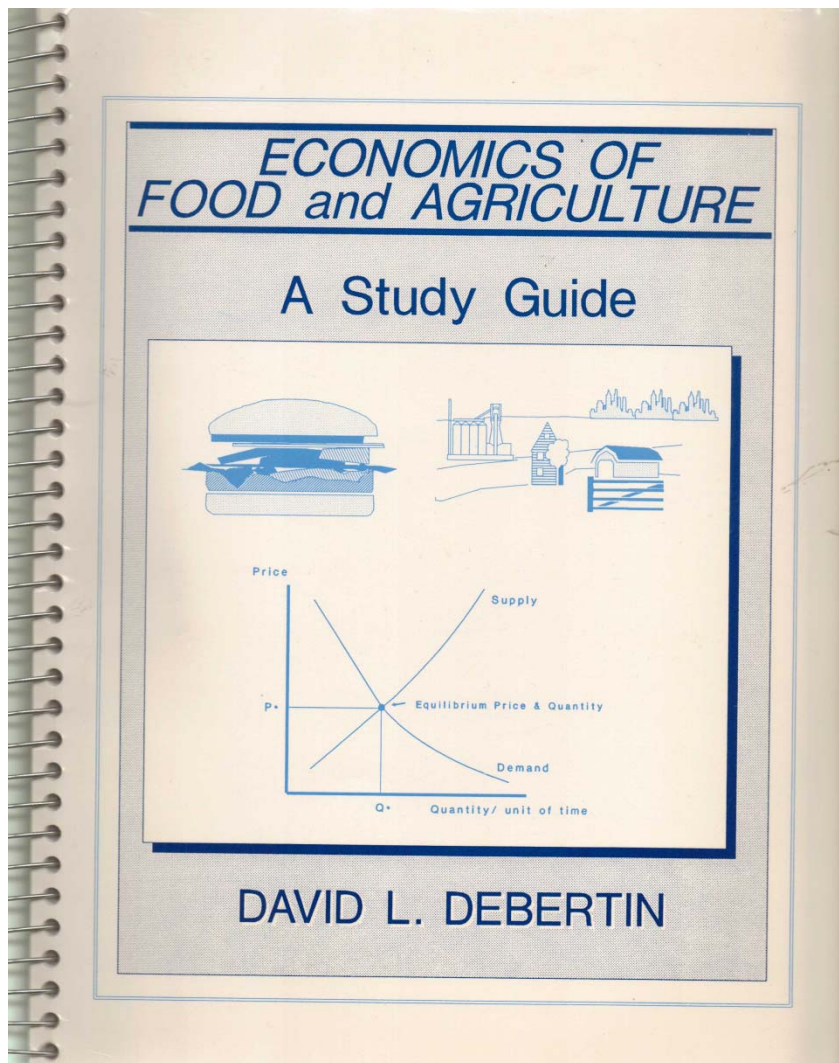
About the same time, we also hosted a conference dealing with new technologies in agricultural economics instruction. We invited people from all over the country to present papers dealing with what they were doing at their particular institution with respect to technology in agricultural economics.



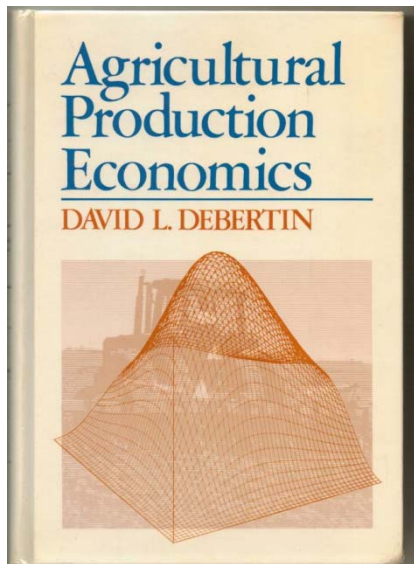
See the entire 1992 conference proceedings is at

<http://www.uky.edu/~deberti/newtech.pdf>

By then, I had also managed to get my Gen 101 lecture notes in print as a book by Kendall Hunt. This was a mixture of Harvard Graphics slides along with camera-ready text I had created.



In 1992 my 1986 production economics textbook was declared out of print by Macmillan after a 6-year run.



I knew I wanted to put together a full electronic version. There were two problems. Problem 1 is that I wanted to replace the hand-drawn figures with computer-generated drawings. The second problem was that the computer files were all sitting on CP/M 5 ¼ inch floppy disk in WordStar. These disks could not be simply inserted into an IBM or clone 5 ¼ inch drive and successfully read. The Kaypro/Xerox 820 formats were incompatible with MSDOS 5 ¼" format.

A piece of computer software called Xenocopy saved the day. It was able to take a disk generated from a defunct CP/M computer and convert the text to something that could be read by the IBM or clone. That part went smoothly, with no problems whatsoever.

Of course, the chapters were still in WordStar format, but via search and replace I could repair each problem using the search in Word perfect. For example, the symbol for an italics font in WordStar was ^I, which I could easily search for in WordPerfect and tell Word Perfect what the replacement in the WordPerfect World should be. The same for greek math characters, subscripts and superscripts.

I was running all of this on the Compaq clone computer. I quickly discovered that I could put together all the chapters into a single large file, and copy the entire book into the internal memory of the computer. WordStar files were THAT small. Further, we were not dealing with messy equation editors. I could search the entire book for the sequence that generated a  $\beta$  in WordStar and replace them with Word Perfect's  $\beta$  all in the space of a minute or two.

Subscripts were a bit trickier. For example a numeric subscript on x such as  $x_1$  was easy to do, but what about  $x_i$ ? The tricky part here was that xi occurs both as a mathematical symbol but as part of the word maximize and maximize shows up very frequently in the text. I could not have  $\max_i$ mimize for sure. So I had to think up more elaborate ways of getting around that problem. After a couple of weeks of effort, I had the disks pretty well cleaned up and into Word Perfect.

Then there were the hand-drawn drawings. By this time I had gotten pretty good at the Harvard Graphics DrawPartner component, having used that to do a lot of the GEN 101 course. So I decided to tackle the hand-drawn figures using what I knew about Harvard Graphics one at-a-time.

The remaining problem was the 3-D figures that we had generated using India ink on the CALCOMP plotter. I wanted to make those editable, electronic files as well. About the same time, the University started letting us run the new PC version of SAS stand-alone, and I immediately set up th Compaq to do this. It was easy to generate 3D graphs using SAS, and I discovered that I could replicate almost exactly what Herman Collins and I had done on the CACOMP plotter over a decade earlier but in my office.

I wanted to be able to annotate the graphs, however, and I thought about the possibility of inserting the SAS output into a Harvard Graphics slide.

Technically, a Harvard Graphics slide is done in a format called CGM. CGM is the instruction set that generates the slide I referred to earlier, not a pixel-based photo of the slide. This is vector-based computer graphics not pixel-based or bit-map computer graphics. Harvard Graphics loves CGM files, which means that it can manipulate vectors generated by SAS Graph, assuming SAS can output a CGM file. This opens all sorts of edit

possibilities on the SAS Graph output, changing colors on lines, adding point and annotations that would be clumsy if not impossible to do with SAS alone, you name it.

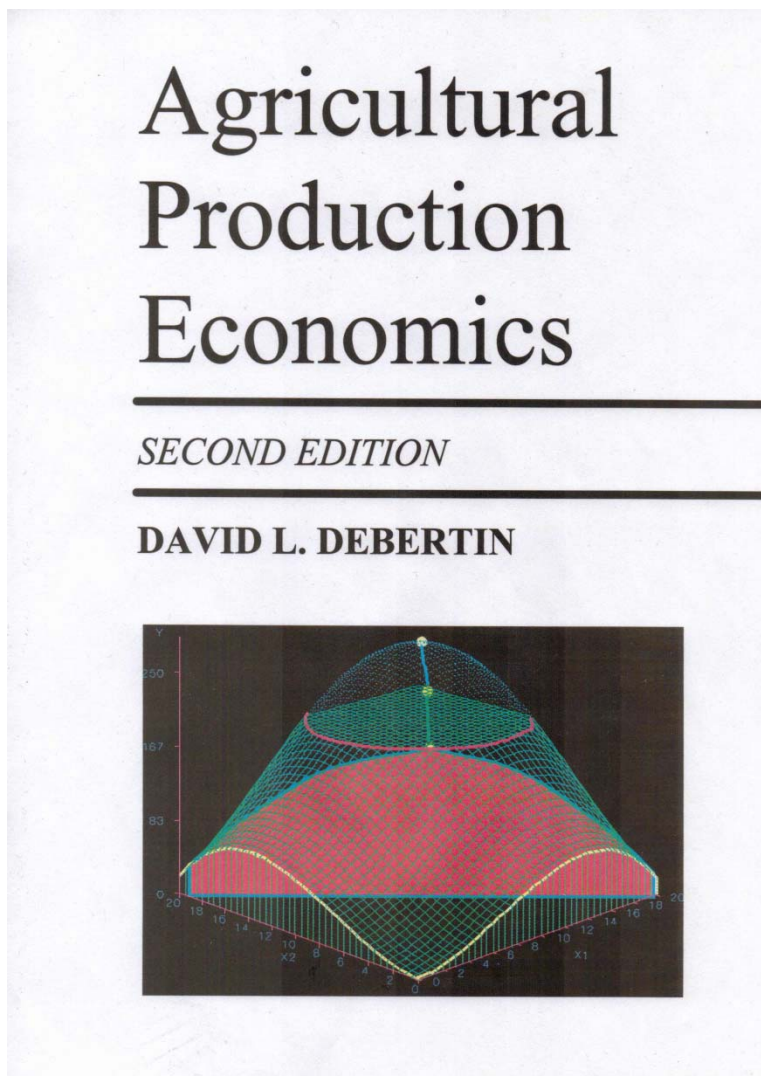
That is exactly what I did. To say that this worked brilliantly was an understatement.

The first version of PowerPoint showed up mid 1990. This would have involved learning how to run a whole new set of drawing software, a risk I was not prepared to make at that point. At this point I have all the charts in my 1986 book recreated electronically in Harvard Graphics (CGM) files.

Realizing that people who were starting to use PowerPoint likely had tons of charts and graphs in Harvard Graphics, the earliest versions of the program had converters that supposedly converted Harvard Graphics to PowerPoint. On some slides the conversion worked ok but often not. A basic problem was that Harvard Graphics had its own internal fonts whereas Microsoft Office uses the Windows fonts. So, annotations on Harvard Graphics slides tended to move around and often to the wrong places. There were other slides that barely converted at all. Fortunately the lines that were vectors seemed to stay in place, but conversions still required a lot of manual labor.

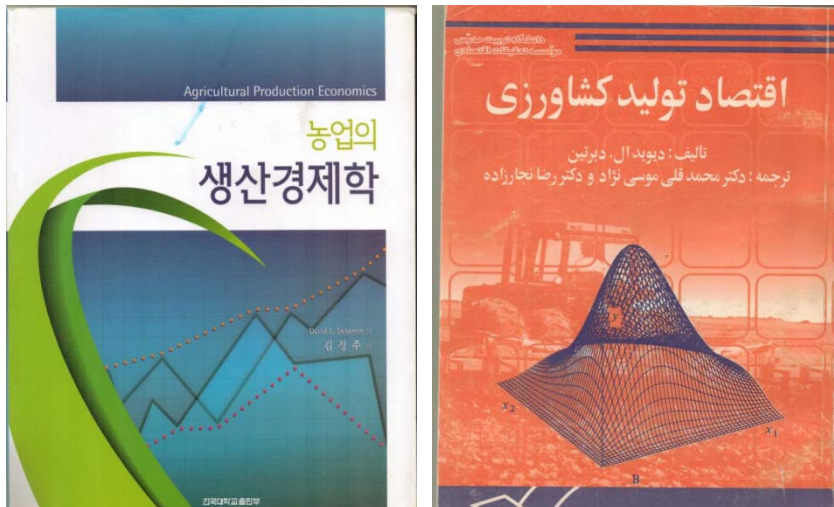
Word Perfect, on the other hand was set up so that it could happily insert a CGM file from Harvard Graphics into a

document: Microsoft Word, not so much. So to this day the core of my production economics text as a series of Word Perfect files not Microsoft Word. By 1992, about the estimated out-of-print date from Macmillan, I had the new, improved Word Perfect version of the entire text completed, at least in second edition I version.



There were translations of the 1986 version in Korean and in Farsi by then as well.





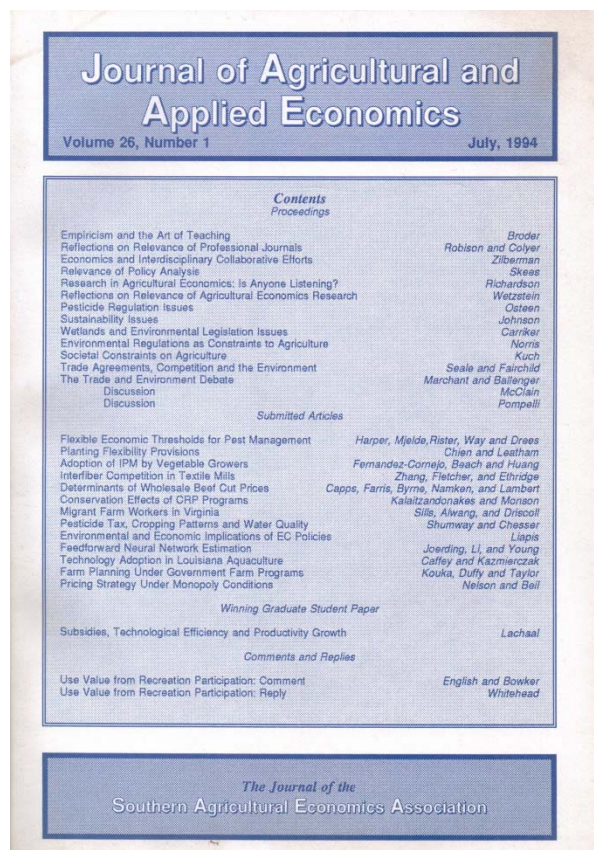
In 1993, Barry Bobst, Angelos Pagoulatos and I took over the editorship of the Southern Journal of Agricultural Economics. It was time for a name change, and the name that was chosen was the *Journal of Agricultural and Applied Economics* in part reflecting the fact that the Journal was accepting articles from all over the US, and around the world. We got to edit the first three years under the new name.

The Southern Association was flat broke at the time we took over the Journal, in large measure because of the costs associated with paying to do doing typesetting from paper manuscript. We were the first to come up with a scheme in which authors would submit finished documents on computer disk.

As I think back on all of this, it was an interesting period computer-wise. Word Perfect 5.1 was so dominant as a word

processor that we had no difficulty at all getting authors to submit completed manuscripts as Word Perfect documents. The department may have not fully appreciated this, but we had a mini-publishing operation going on inside the department. Joan Enerlich would take the Word Perfect files and put them on her machine in sequence, adding page numbers, and converting everything into two-column format for camera-ready printing.

I came up with the new cover design, also done with Word Perfect 5.1. A few of my “trademarks” somehow got worked in, like shadow text and text in boxes. Each issue was delivered to the central campus for final printing.



The Southern Association quickly ended up making money not losing money on page charges and ended the period well into the black. The association has long been indebted to us for turning the Journal from a money-loser to a money-maker during our editorship. We were just doing what could be done at that moment in time.

### **Part 9: 1995-2000**

Angelos Pagoulatos and I had long wanted to edit a more applied, policy-oriented journal. We had enough political capital at that point with the Southern board of directors that they approved a new journal for the Southern Association. After all, we had shown that journals could make not lose money for them, so adding a journal was a plus from a budgeting perspective.

The problem was that the American Association was thinking much the same way. The board there was getting increasing static over the fact that the AJAE had lost most of its links to the real world, and membership was dropping as a consequence.

So, we floated a similar idea to the American board, they agreed, and Southern Association stepped down.

I recall the entire period of working with the American board as some of the least happy and most stressful periods in my entire career. It was a battle from day 1 on all sorts of fronts that never subsided. In the middle of all of this, the North Central department chairs convinced the American board that they should take over the publication of what started as the North Central Journal of Agricultural Economics that had recently had a name change to the Review of Agricultural Economics. Given that drama, they were not about to start running what would have been two new journals. We were asked (required) to use the old Review name for our effort, despite the fact that the name didn't really reflect what it was that we were trying to do.

Worse, there was a backlog of manuscripts accepted for publication under the old regional journal banner. Never mind that many of these did not fit very well with anything that we wanted to do in terms of the new journal we had proposed, the manuscripts had to be published anyway. We were stuck basically running the old regional journal.

Things gradually got worse not better, The American board would have nothing to do with a camera-ready in-house publication, the strategy that had worked so well from a financial perspective. That was good enough for them, and

they wanted to contract the new journal with the AJAE publisher. There was no point in fighting this.

So, each page published in the new journal was losing not making money for the American Association. The then-treasurer of the Association quickly saw this. His solution was to try and limit the number of pages each issue contained. That was difficult to do given that we had already sent out acceptance letters to authors indicating an issue when their article would appear.

We finally negotiated a settlement on that one. But we were doing other things that seemed to anger the board. We invited a number of senior policy-related experts to write topical articles that were not subject to regular review. These were written by very well-known and well-respected people in agricultural economics, and by people who also did not like to mince words. The board became scared that the articles we were publishing were too controversial, and that somehow the board would be taken to task for allowing the work to appear in print.

The Department and College did not help matters at all. The then Dean had decided that editing a journal at whatever level was usually done by faculty who were not very good at research or teaching, and he let his feelings be known in no uncertain terms.

Given the continuing lack of support by the AAEA board, the department and the College administration, I was never so happy to have the term end. We told the board that we were not interested in continuing the relationship “because we no longer had the support of either our Chair or our Dean to do so”, and the board seemed happy that they did not need to go through the process of even looking to renew our contract.

This was a very unhappy period for us, but we learned a lot in the process with respect to how mean-spirited academic politics could be at all sorts of different levels. I’m not certain what advice I would have for any other faculty member contemplating an editorship. We moved from a politically good situation to a very dicey one very quickly.

The odd thing of course, is that the AAEA board eventually did a lot of what we had proposed but they had rejected at the start up years ago. For example the old Review name got dumped. I remain unhappy with the AAEA and with the College with respect to how we were treated over the period.

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The format of the new *Review of Agricultural Economics* has a problem focus directed specifically toward agricultural economics issues. It includes survey, review, and critique articles, analyses and syntheses of previous research, methodological issues, and commentary on current issues. An important criterion for the publication of an article is its potential usefulness to a broad range of agricultural economists.

See the RAE Web site for more information: <http://www.aaea.org/rae.html>

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Information for authors is available on the inside back cover.

Cover by S. Clarke

## Review of Agricultural Economics

Vol. 19 • No. 1 • Spring/Summer 1997

### In This Issue:

#### Articles

- **The Troubled American Economy—An Institutional Policy Analysis**  
*Willard W. Cochrane*
- **Commodity Futures Prices as Forecasts**  
*William G. Tomek*
- **Privatizing Agricultural Services in a Transition Economy**  
*Wojciech Florkowski, H. Szulce, and A.H. Elnagheeb*
- **Have Farmers Lost Their Uniqueness?**  
*Renée Drury and Luther Tweeten*
- **Regulatory Barriers in an Integrating World Food Market**  
*Dawn D. Thilmany and Christopher B. Barrett*
- **Reasonable Value and the Role of Negotiation in Agriculture's Use of the Environment**  
*Richard Kazmierczak, Jr., and David W. Hughes*
- **A Guide to Internet Resources in Sustainable Development**  
*Gerard E. D'Souza and Booker T. Walton III*
- **Survey of U.S. Multiple Peril Crop Insurance Literature Since 1980**  
*Thomas O. Knight and Keith H. Coble*

#### Also, Case Studies and Commentaries

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The transition to modern laptops occurred gradually but accelerated during the latter half of the 1990s. There were a number of attempts to construct useful color laptops using Windows 3.1. The department bought several of the earliest IBM Thinkpads. They were expensive (about \$3500 if I recall the original price), and featured a 10 inch what was called TFT screen.

The one I worked with looked like this, with a 3 ½ inch floppy (no CD drive yet).

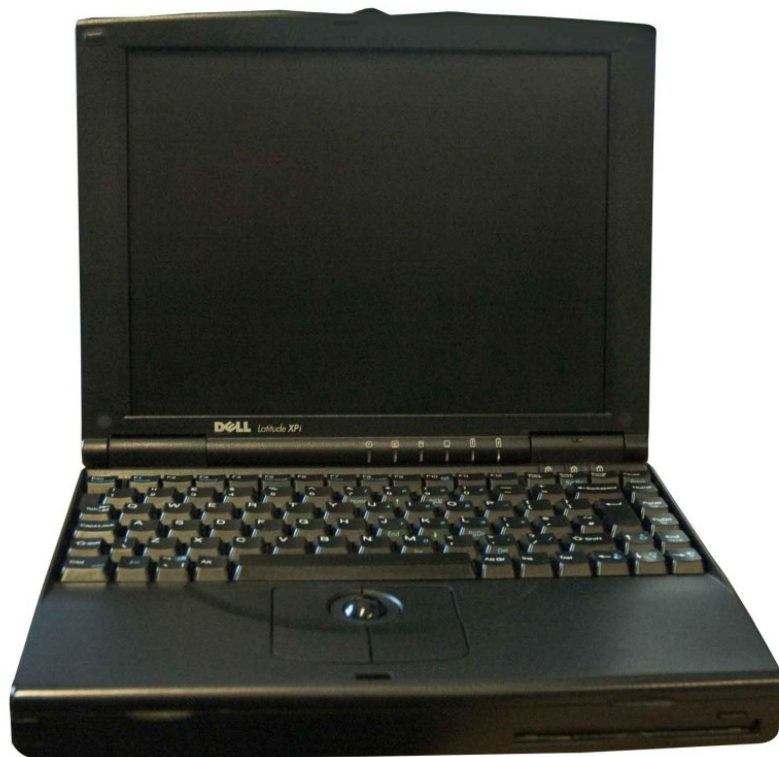


These were quite portable, and did feature a bright, clear screen. The issue in retrospect was the Windows 3.1 operating system, which was cheesy compared with the much more modern Windows 95 that followed. The Thinkpads ran Harvard Graphics 2.3 But this ushered in the era of much more practical laptop computers first running Windows 95.



Laptops were quite expensive. In the late 1990s I bought my first home Desktop running Windows 95. I paid about \$1,500 for the machine itself, plus several hundred dollars more for a 14-inch CRT monitor. It had what I considered to be a huge 4 GB disk.

Fortunately, used laptops could be picked up on ebay for 25 about of what they cost new. Windows 98 was just out, so there were a lot of used laptops running Windows 95 available at bargain prices. At this point there was a CD reader (no writer yet) and a 3 ½ inch floppy on nearly every laptop. My machine, an XPi, looks like this, and it still continues to operate beautifully.



These machines were physically somewhat larger than the Thinkpads, with a 14 inch 4:3 screen. In retrospect the major missing item to come was proper support for USB. There are no USB ports on this machine. This machine was about \$3500 new. I bought mine used on eBay in great condition for about \$450. The machine “feels” like a lot more money than a modern-day laptop. It shows no sign of wear whatsoever.

I also have a laptop running Windows 98. Even though Windows 98 potentially supported USB, that machine lacks a USB port a well. USB ports did not show up with regularity until Windows 2000. The typical Windows 2000 machine had but one USB port, and you still found standard parallel and serial ports.

## **Part 10: 2000 and Beyond**

The first decade of the 21<sup>st</sup> century brought about a number of important improvements. Let me list some of the important changes.

1. Rapid decline in the cost of hard disk storage. A typical modern laptop computer would have at least 500 GB of storage: in 1979, the entire COLLEGE was operating on a TOTAL of 300 MB (NOT GB) of storage. The technology needed to drastically lower the cost of data storage has got to be at or near the top of important developments in the past decade

2. Opportunities offered by USB support. Think of all the ways USB support is now used. For example:
  - a. video cameras
  - b. external sound cards
  - c. musical keyboards
  - d. 3 ½" floppy drives
  - e. DVD and CD read/write units
  - f. external hard disks
  - g. dial-up modems

USB support makes it possible to add things to computers one would not have dreamed possible.

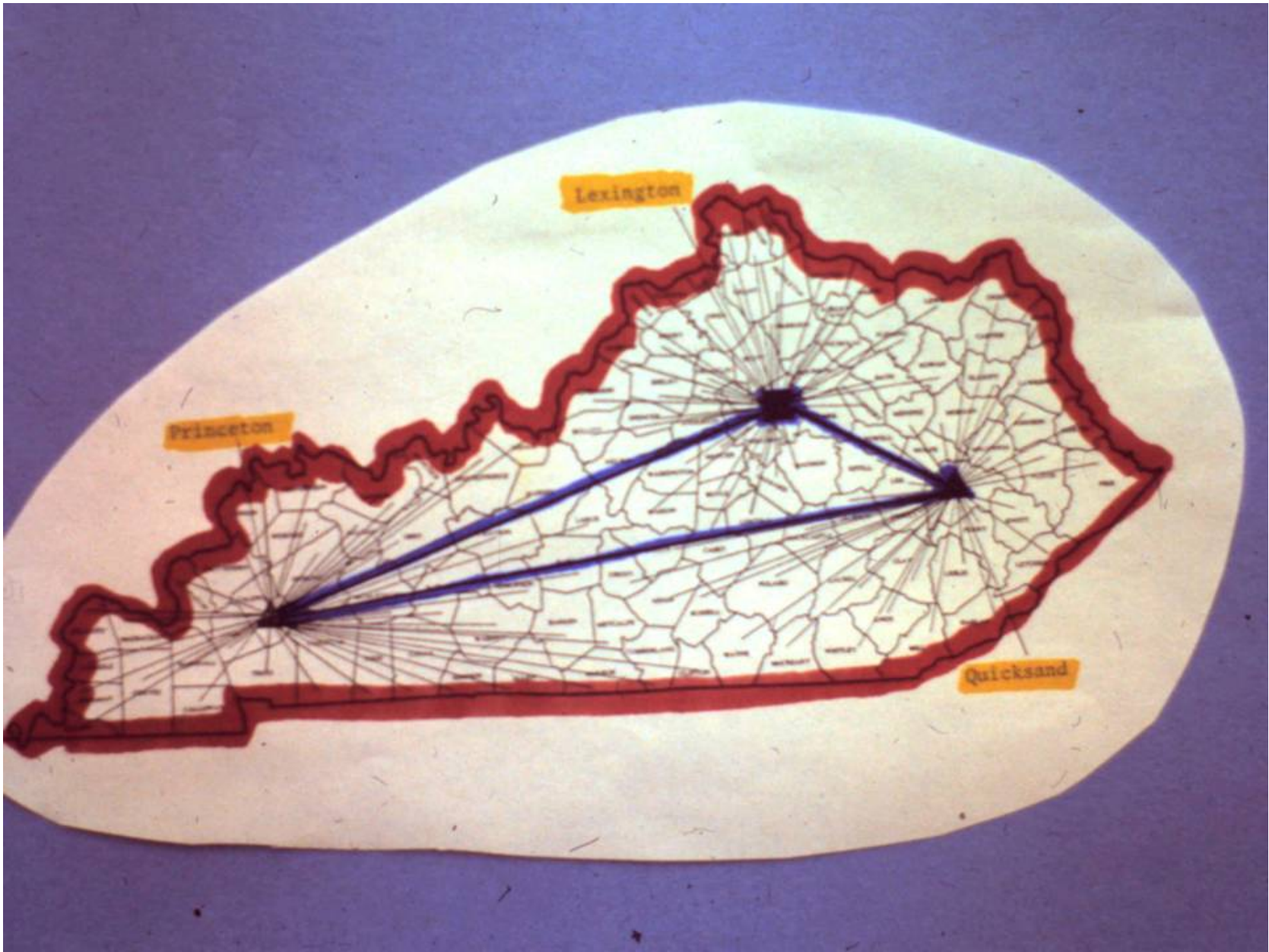
3. Low-Cost external flash memory storage. The fact that you can carry 64 GB in your pocket is nothing short of amazing.
4. Much lower cost laptops (and desktops) A fully-capable laptop with a 500 GB hard drive and at least 4 GB of memory can be had for under \$400, a tenth of the nominal price 25 years ago.

**Color Sides of University of Kentucky  
College of Agriculture  
Computer Equipment and Software Programs  
for 1978-1980  
Signs are Hand-Lettered (no PowerPoint!)**

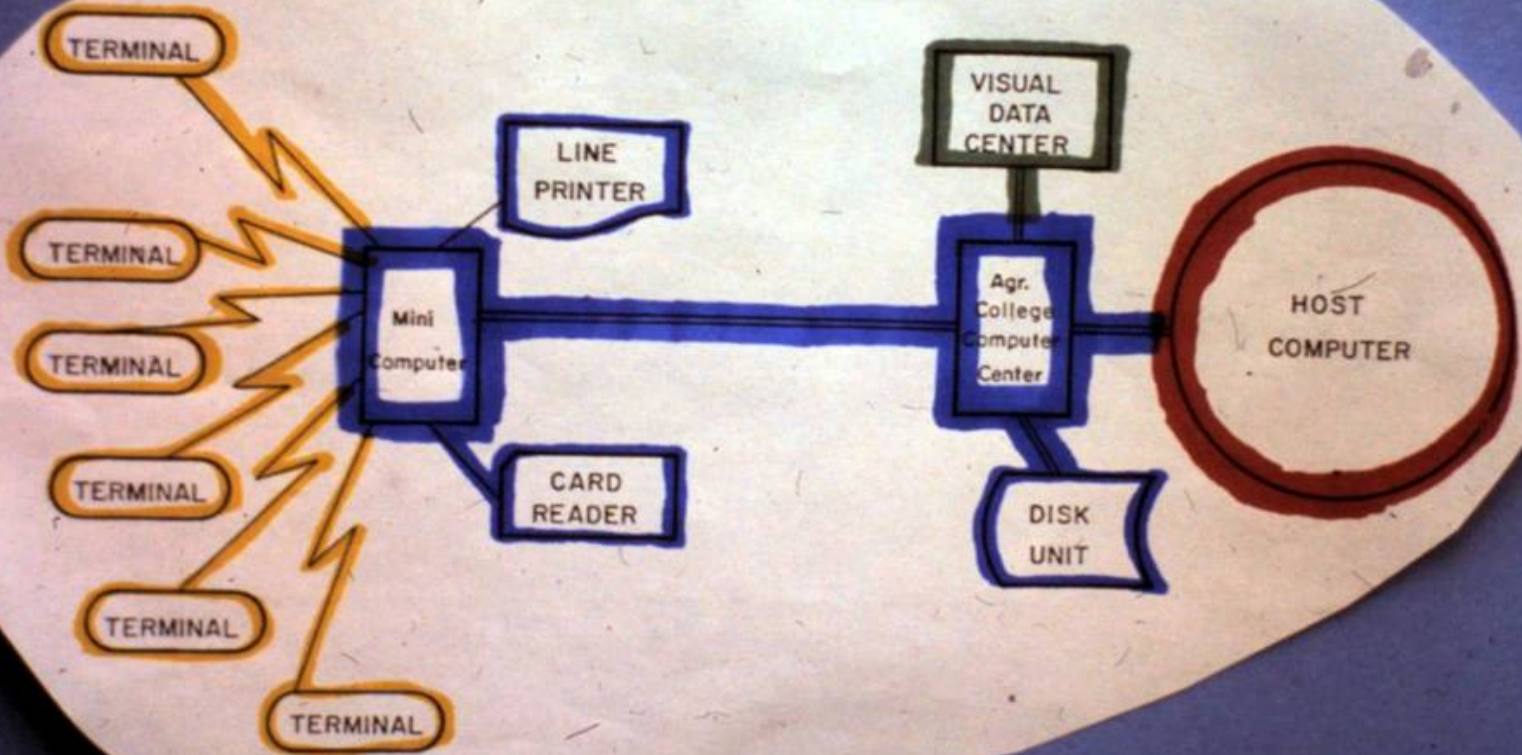
KENTUCKY'S

ANSER ...

AGRICULTURAL NETWORK  
SERVING  
EXTENSION & RESEARCH



The Host Computer and the Terminal System.



Batch

Processing



**TO LIST CARDS**

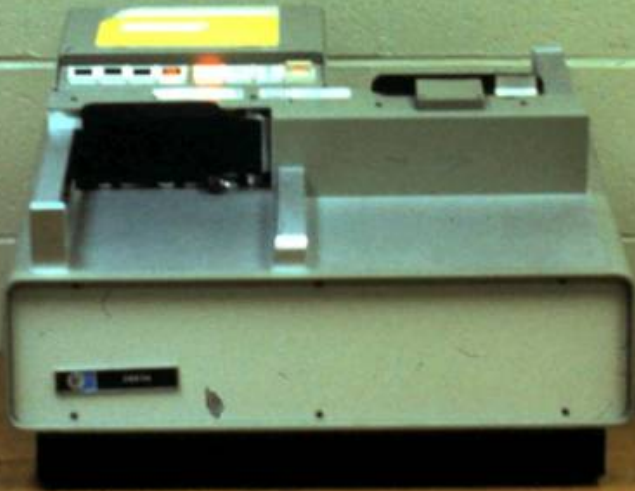
!JOB LIST FOR S370  
!RUN FCOPY.PUB.SYS  
FROM:; TO:  
(YOUR CARDS GO HERE)  
!EOD  
!EOJ

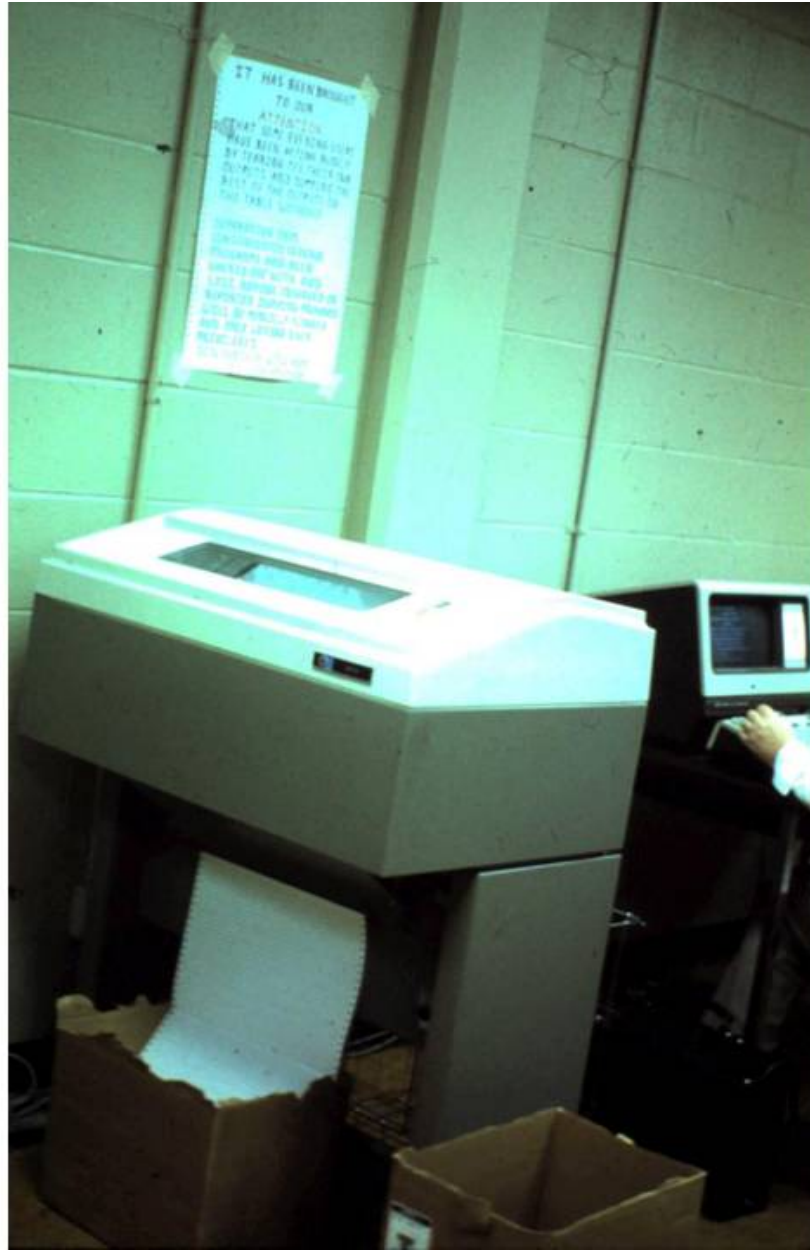
\*\*\*\*\*  
IF YOU NEED HELP  
FROM SOMEONE WHO  
KNOWS HOW.  
\*\*\*\*\*

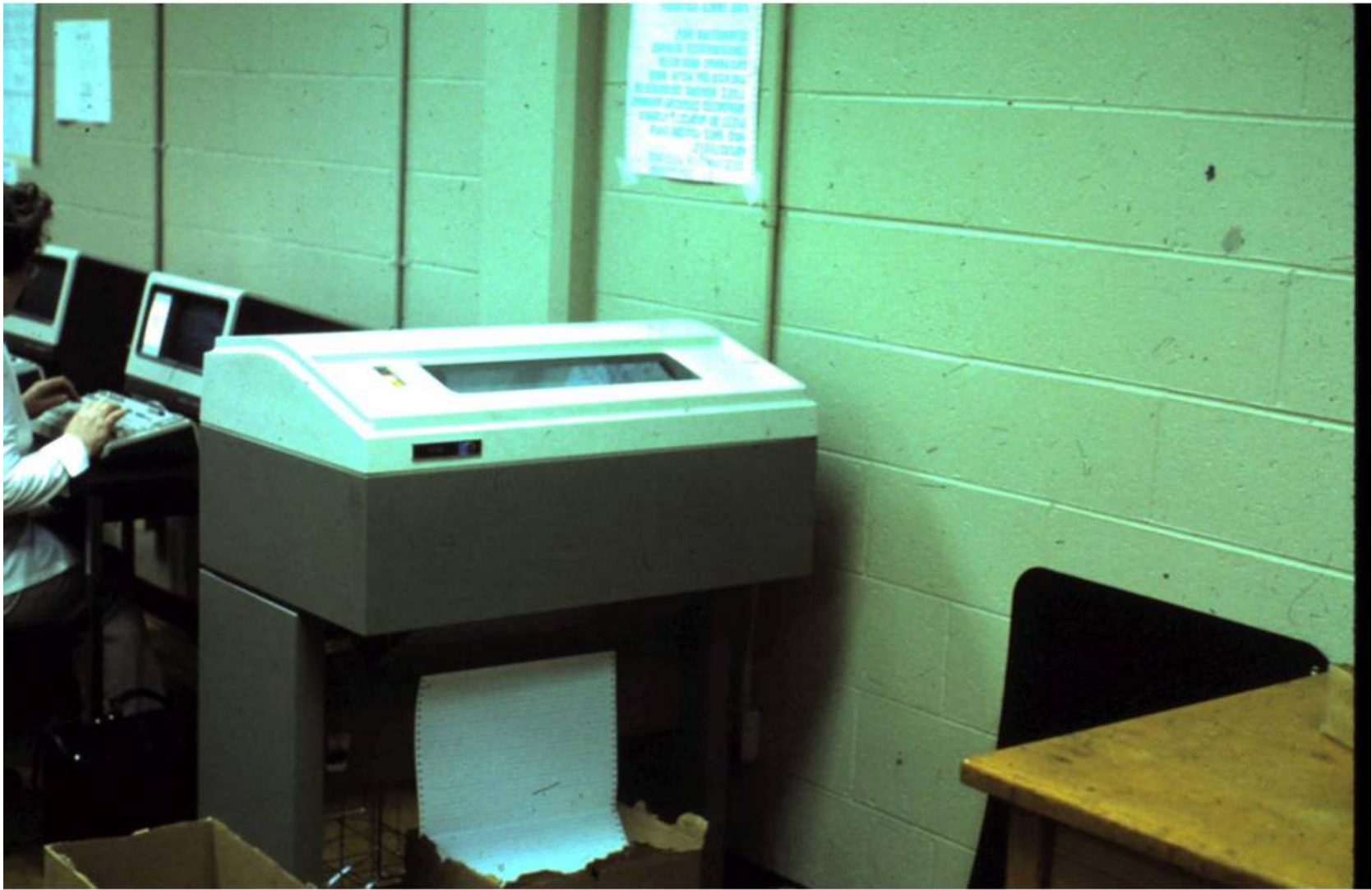
**TO PRINT OUT AT MEY HALL,  
USE THE FOLLOWING CARDS**

/N PRIORITY V-6  
//JOBNAME JOB  
/K PASSWORD  
/K JOBPART  
/K ROUTE PRINT LOGS  
(THE BEST OF YOUR PRINTOUT)

The following cards are to be used with the printer  
in room 1008. The printer is a 1008. The printer is a 1008.  
The printer is a 1008. The printer is a 1008.  
The printer is a 1008. The printer is a 1008.









Central

Hardware

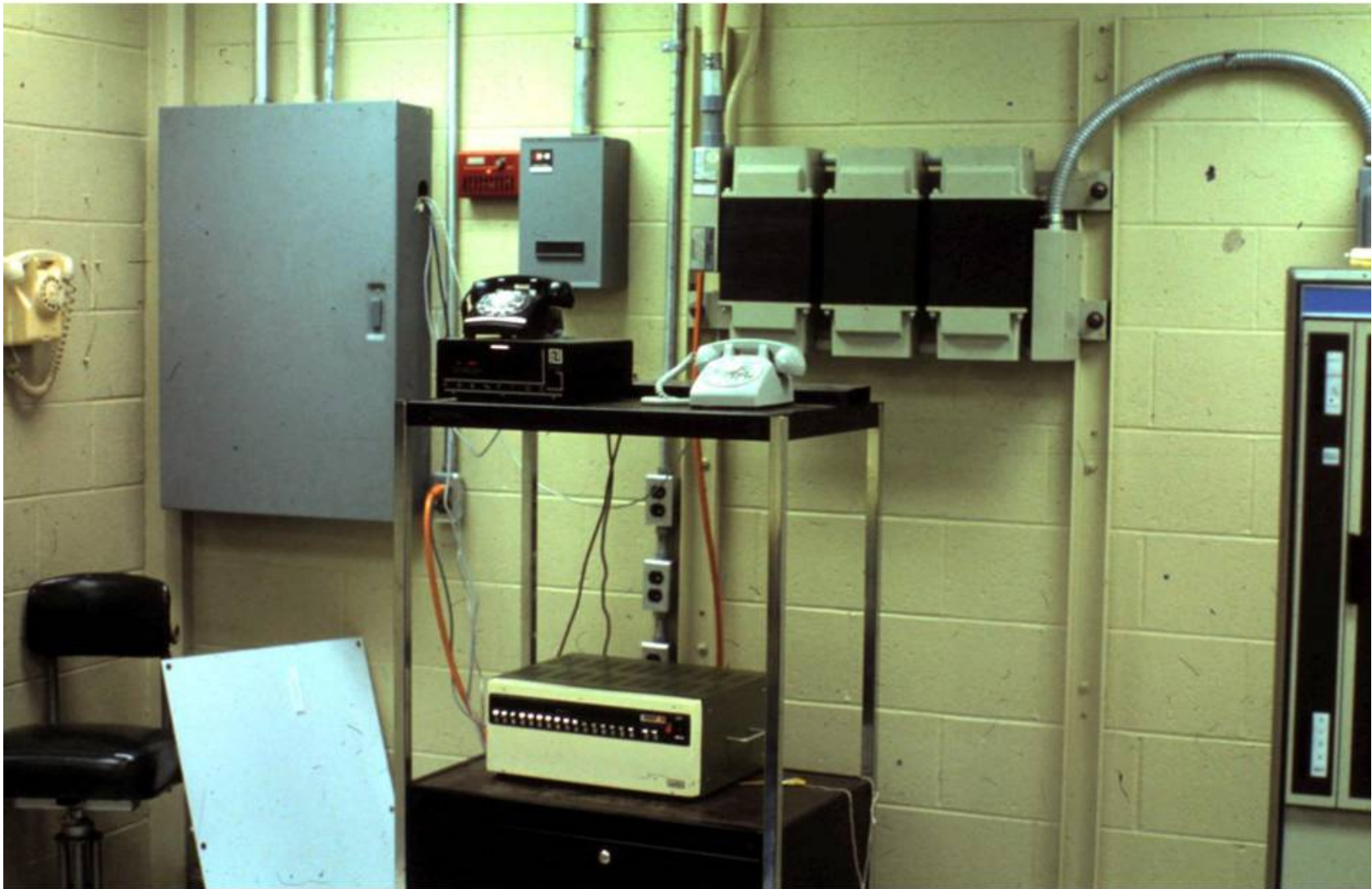


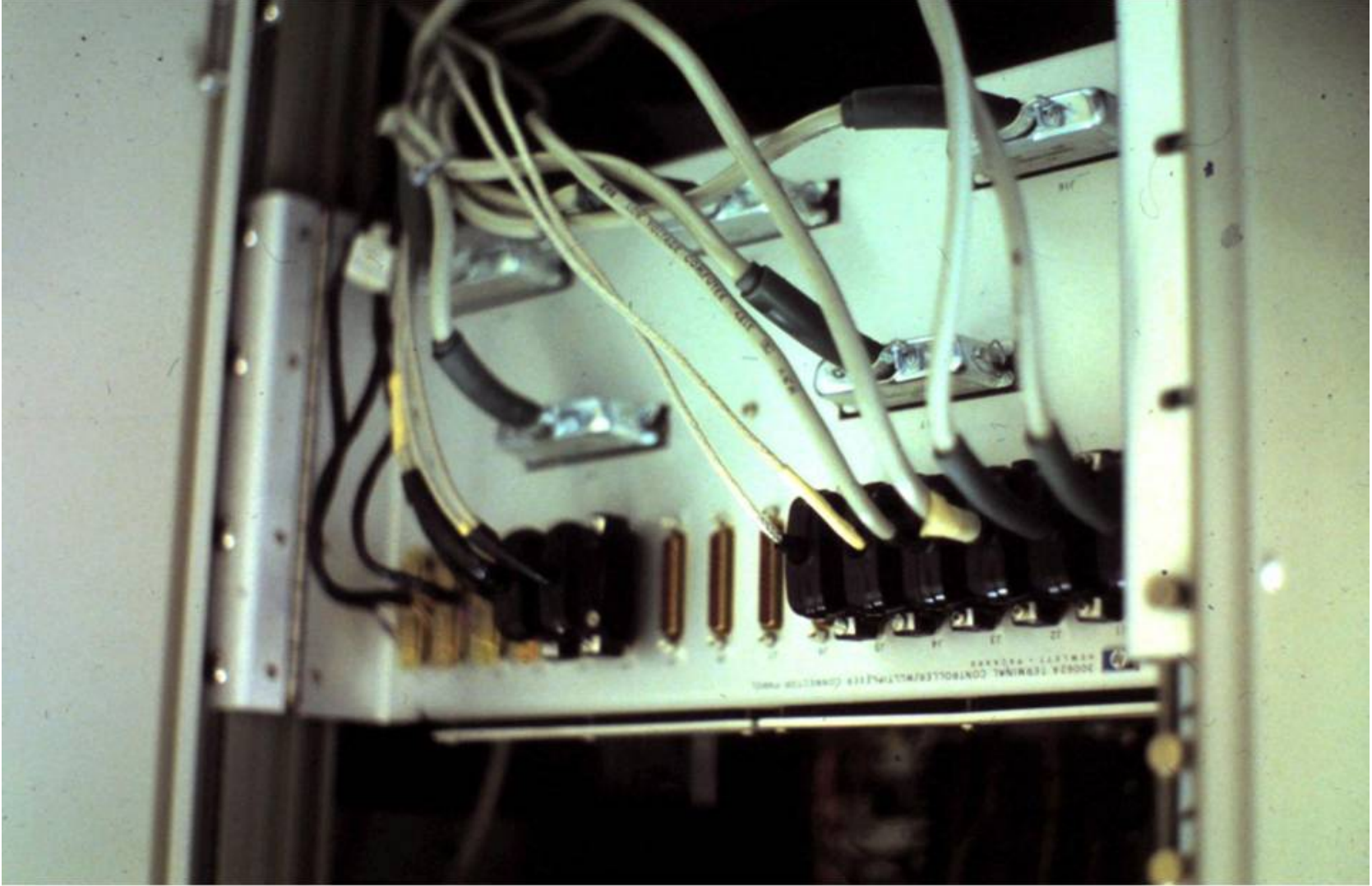


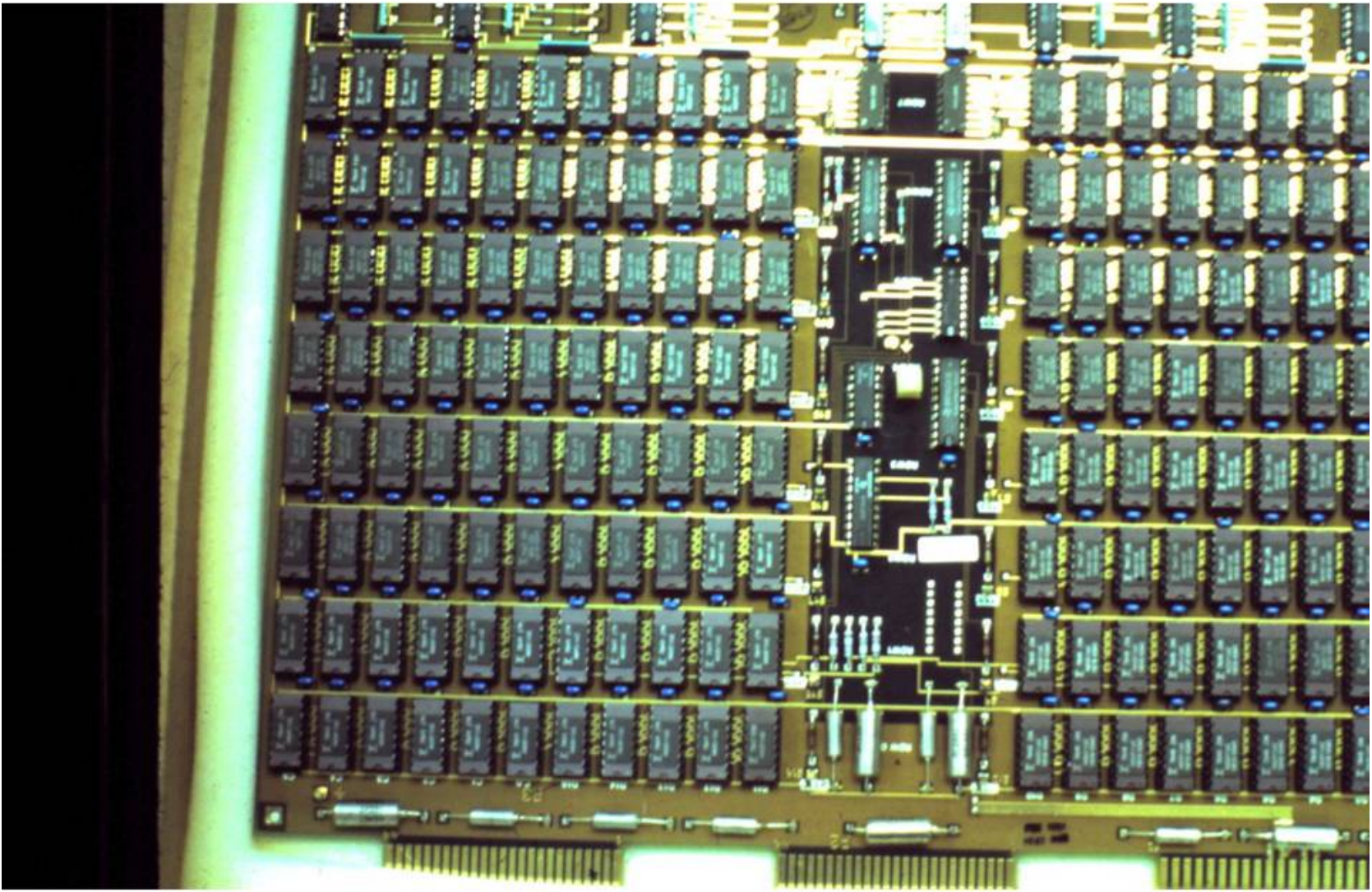




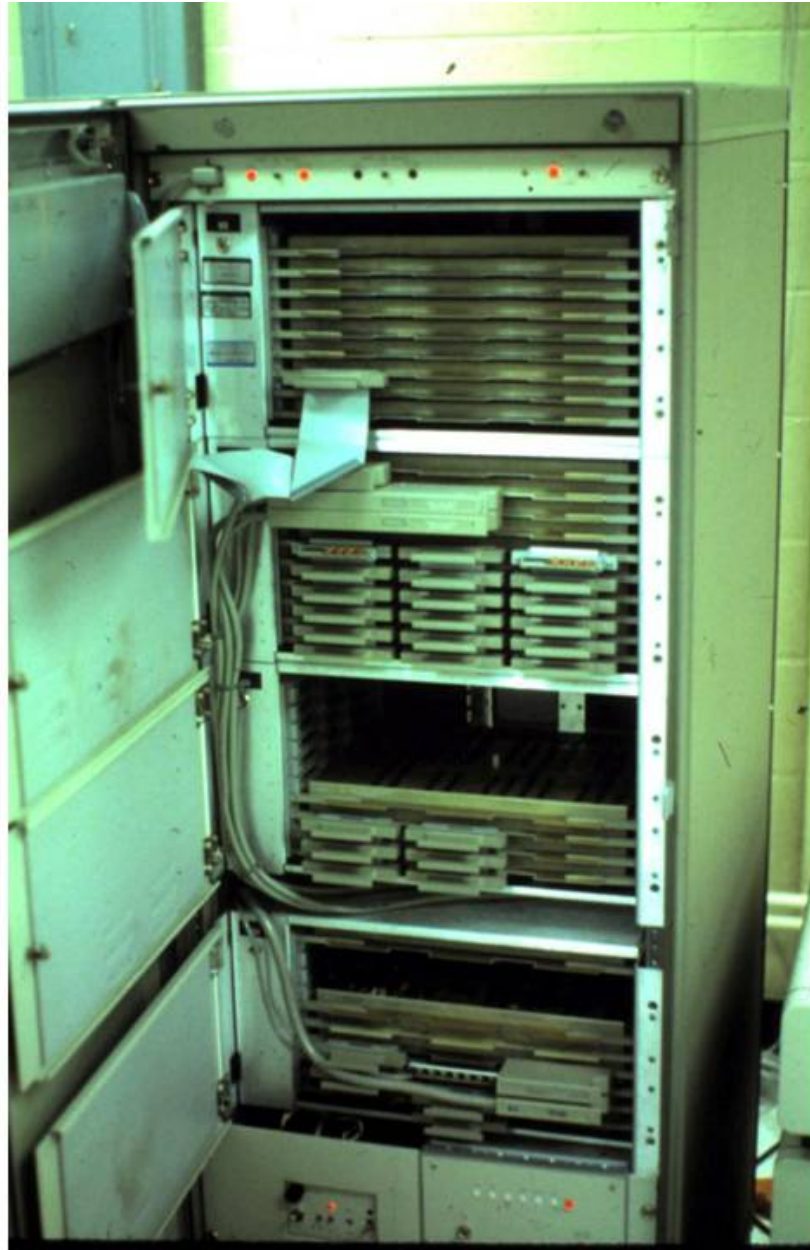


























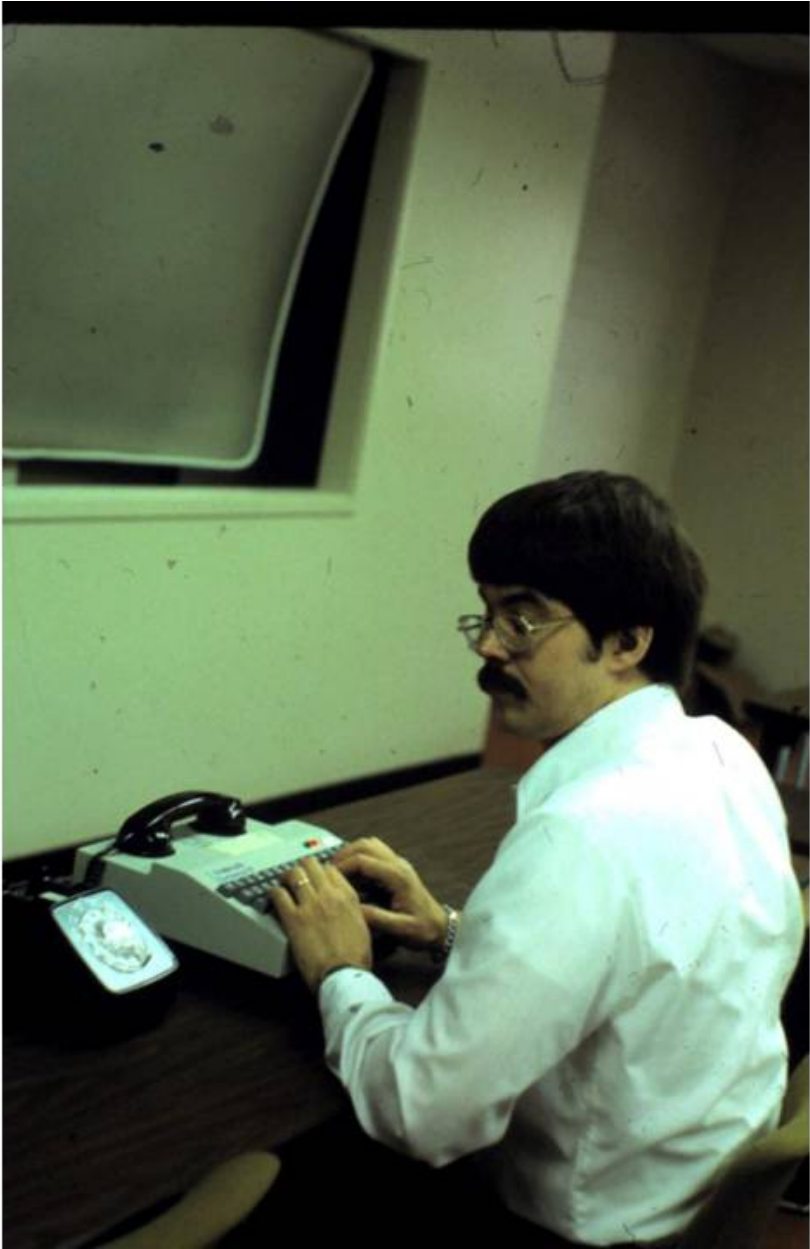
Visual  
Data  
Center







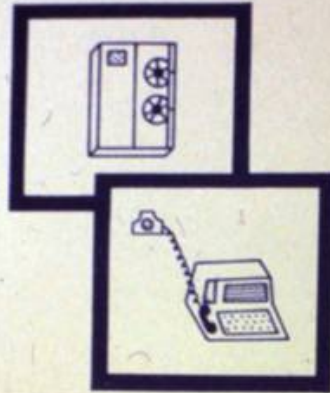






Software

Components



TAKING COMPUTERS  
TO THE COMMUNITY:  
PROSPECTS AND  
PERSPECTIVES

Edited by  
Carol A. Chapman, Craig L. Infanger,  
Lynn W. Robbins, and David L. Debertin

Proceedings from the Conference Held  
January 12 & 13, 1978

Sponsored by  
University of Kentucky  
College of Agriculture  
Cooperative Extension Service

**D I S K**  
**IS A COMPUTERIZED**  
**INFORMATION SYSTEM**  
**THAT CONTAINS**  
**SOCIAL AND ECONOMIC**  
**INFORMATION ON EACH**  
**COUNTY IN KENTUCKY**

**WHAT:** A COMPUTERIZED  
SYSTEM OF SOCIAL  
AND ECONOMIC  
CHARACTERISTICS  
OF EACH COUNTY  
IN KENTUCKY.

**WHY:** TO MAKE AVAILABLE  
INFORMATION FROM  
VARIOUS FEDERAL  
AND STATE SOURCES.

**WHEN:** AVAILABLE RIGHT  
NOW! TRY IT!!

BUT

**WHERE:** WILL BE AVAILABLE  
IN COUNTY EXTENSION  
OFFICES & ACCESSIBLE  
THROUGH COMPUTER  
TERMINALS IN THE  
NEAR FUTURE.

DEVELOPED BY RURAL SOCIOLOGY AND  
AGRICULTURAL ECONOMICS

DIALUP USERS: THE PHONE LINE IS RESERVED  
WEDNESDAY, APRIL 11, FROM 10 TO NOON FOR  
A DEMONSTRATION OF THE GREEN THUMB BOX.  
THE LINE IS RESERVED ALL DAY FRIDAY FOR  
THE SAME PURPOSE.  
:RUN DISK

.....  
\* D I S K - \*  
\* DEVELOPMENT INFORMATION SYSTEM \*  
\* FOR \*  
\* KENTUCKY \*  
\* A SERVICE OF THE KENTUCKY COOPERATIVE EXTENSION SERVICE \*  
.....

IF YOU NEED TO SEE INSTRUCTIONS, ENTER "Y" AND PRESS "RETURN".  
IF NOT, PRESS "RETURN".

TABLES & CHARTS FOR EMPLOYMENT ARE:

- T1 - LABOR FORCE STATUS BY SEX; 1950, 1960, 1970
- T2 - LABOR FORCE STATUS, NONWHITE POPULATION BY SEX; 1950, 1970
- T3 - TYPE OF WORKER BY SEX; 1950, 1960, 1970
- T4 - GENERAL EMPLOYMENT BY SEX; 1950, 1960, 1970
- T5 - GENERAL EMPLOYMENT, NONWHITE POPULATION BY SEX; 1950, 1970
- T6 - TOTAL EMPLOYMENT BY INDUSTRY CATEGORY; 1950, 1960, 1970
- T7 - EMPLOYMENT BY INDUSTRY CATEGORIES BY SEX; 1950, 1960, 1970
- T8 - POPULATION IN LABOR FORCE BY AGE AND SEX; 1950, 1970
- T9 - INDUSTRY AND CLASS OF WORKER BY SEX; 1950, 1960, 1970
- T10 - EXPERIENCED UNEMPLOYED POPULATION BY OCCUPATION & SEX; 1950, 1960, 1970
- T11 - LABOR FORCE & UNEMPLOYMENT CHARACTERISTICS; 1970, 1975, 1976
- T12 - NONAGRICULTURAL EMPLOYMENT BY INDUSTRY BY PLACE OF WORK; 1975, 1976

• TABLES CURRENTLY AVAILABLE

T2 PLACE OF RESIDENCE  
1950 - 1976

FAYETTE COUNTY

	URBAN	RURAL NONFARM	RURAL FARM	TOTAL
1950	75358	18829	6606	100746
1960	111988	14257	5672	131906
1976	159854	11861	3489	174323



1  
YOU SELECTED TABLES & CHARTS

2. ENTER THE SUBJECT AREA NUMBER:

H

THE SUBJECT AREAS ARE:

- \* 1 - POPULATION
- \* 2 - EMPLOYMENT
- 3 - INCOME
- 4 - INDUSTRY & COMMERCE
- 5 - TRANSPORTATION & COMMUNICATION
- 6 - HEALTH & SAFETY
- 7 - RECREATION
- 8 - EDUCATION
- 9 - HOUSING
- \* 10 - GOVERNMENT & COMMUNITY SERVICES
- \* 11 - LAND USE
- \* 12 - AGRICULTURE & FARM MANAGEMENT
- 13 - NATURAL RESOURCES, ENERGY, & ENVIRONMENT

\* SUBJECTS CURRENTLY AVAILABLE

2. ENTER THE SUBJECT AREA NUMBER:

ALL TYPES OF WORKERS BY SEX  
1974-1988

1987

	1974		1984		1988	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
WHITE COLLAR	9950	8791	14812	9907	23887	17929
BLUE COLLAR	9295	1468	11489	2894	15094	2807
FARM	2738	2848	2827	875	3755	8154
SERVICE	211	148	1473	1817	88	88

NOT REPORTED

1974 & 1984 TYPE OF WORKER INCLUDES ALL EMPLOYED 15 YEARS OF AGE AND OLDER. 1988 TYPE OF WORKER INCLUDES ALL EMPLOYED 15 AND OLDER.

DATA NOT AVAILABLE OR NOT REPORTED

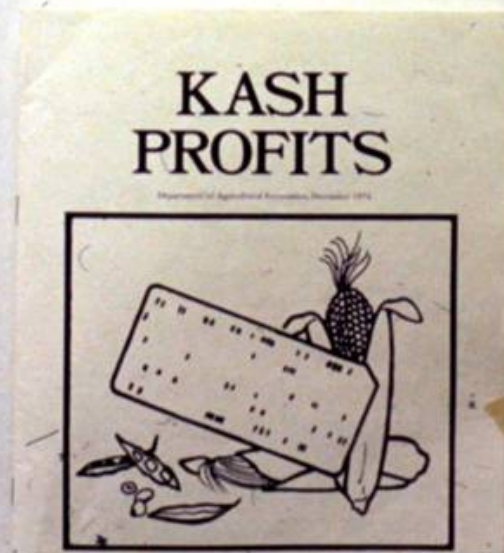
ENTER TABLE OR CHART LETTER AND NUMBER

PRINT  
COPY  
FACSIMILE  
STOP  
STOP  
POWER ON  
STOP

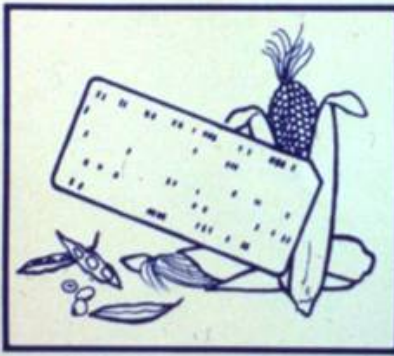


# KASH PROFITS —

*an aid to farmers in  
managing their corn,  
soybean, and wheat  
production.*



# KASH PROFITS



Kentucky's Advanced Systems Approach  
for Improving Corn and Soybean Profits  
with Computer Software

Some Questions That Can Be Answered  
with KASH PROFITS

- ( 1 ) How much money am I currently making from my cropping operation?
- ( 2 ) Given today's crop prices, or the expected crop prices when I sell this year's harvest, how much of my acreage should be planted to corn, how much to soybeans, and how much to wheat?
- ( 3 ) Given my own machinery and labor, when should I plant my corn and soybeans?
- ( 4 ) If the price of soybeans goes up 25¢ per bushel, and corn stays the same, should I plant more soybeans?
- ( 5 ) Will double cropping be profitable for me?
- ( 6 ) Am I underinvested, or overinvested in machinery?
- ( 7 ) Will a larger tractor or combine make me more money?
- ( 8 ) What can I afford to pay for hired labor during planting and harvest?
- ( 9 ) Is it more profitable to hire extra labor and run my present equipment, or buy larger equipment?
- (10) Should I hire custom work for harvest?
- (11) Given my present labor and machinery setup, is it profitable to rent an extra 80 acres?
- (12) If I rent an extra 80 acres, how much more machinery and labor will I need?

THE 370 VERSION

TABLE 1.  
NET RETURNS TO MGT.  
ACRES CORN GRAIN  
ACRES CORN SILAGE  
ACRES SOYBEANS  
ACRES WHEAT  
ACRES DOUBLE-CROP BEANS  
ACRES NOT USED  
ACRES RENTED OUT  
HOURS CUSTOM COMBINE HIRED OUT

U OF M CROPPING BUDGET

	PRESENT PLAN	OPTIMAL PLAN
	28915.	47358.
	300.	25.
	150.	720.
	50.	250.
	40.	250.
	0.	0.
	0.	0.
	0.	0.

THE FOLLOWING RESOURCES LIMIT THE EXPANSION OF YOUR FARM AND HAVE THE FOLLOWING VALUES. (FOR AT LEAST SMALL AMOUNTS)

RESOURCE	VALUE PER ADDITIONAL UNIT (1/UNIT)	
	PRESENT PLAN	OPTIMUM PLAN
OWN LABOR HOURS		
1. APR. 26-MAY 2	4.00	2.00
2. MAY 3-MAY 9	4.00	4.00
3. MAY 10-MAY 16	4.00	2.00
4. MAY 17-MAY 23	4.00	2.00
5. MAY 24-MAY 30	2.00	2.00
6. MAY 31-JUNE 6	2.00	2.00
7. JUNE 7-JUNE 13	2.00	2.00
8. JUNE 14-JULY 10	2.00	4.00
9. SEP. 13-SEP. 26	2.00	2.00
10. SEP. 27-OCT. 17	4.97	4.00
11. OCT. 18-NOV. 7	4.00	2.00
12. NOV. 8-NOV. 28	4.00	2.00
13. NOV. 29-MAR. 14	4.00	2.00
FIELD HOURS TO PREPARE LAND		
14. MAR. 15-APR. 4	0.71	0.0
15. APR. 5-APR. 25	0.71	0.0
16. NOV. 8-NOV. 28	0.71	0.0
17. NOV. 29-MAR. 14	0.71	0.0
FIELD HOURS-PLANTING		
18. APR. 26-MAY 2	94.61	0.0
19. MAY 3-MAY 9	92.33	46.91
TRACTOR HOURS		
20. APR. 26-MAY 2	0.70	0.0
21. MAY 3-MAY 9	0.70	0.0
22. MAY 10-MAY 16	33.33	0.0
23. MAY 17-MAY 23	0.70	0.0
24. SEP. 27-OCT. 17	0.0	5.87
25. OCT. 18-NOV. 7	0.71	0.0
LAND ACREAGE		
26. ACREAGE CONTROL	0.0	190.96
LAND RENTED		
27. LAND RENTED OUT	60.00	0.0
28. LAND RENTED IN	0.0	88.96
CROP ACREAGE CONTROL		
29. CORN ACRE	154.75	0.0
30. SOYBEANS ACRE	177.70	0.0
31. WHEAT ACRE	152.18	0.0
32. D.C. SOYBEANS	100.38	0.0
33. SILAGE	190.41	0.0

Compa



Green

Thumb

Box







SELECT & ENTER FOUR SCREEN #'S





- 16 IRRIGATION
- 17 HAYING
- 18 WEED CONTROL
- 19 ALFALFA WEEVIL
- 20 INSECTS ON TOBACCO
- 21 ARMYWORMS ON SMALL GRAINS
- 22 EUROPEAN CORN BORER INFO
- 23 APPLE SCAB CONTROL INFO
- 24 BARLEY YELLOW DWARF DISEASE
- 25 FUTURES - SOYBEANS
- 26 BASIC FUTURES CONTRACTS
- 27 PRECIPITATION 24 HOURS
- 28 PLANTING INTENTIONS REPORT
- 29 HUNTS POINT PRICES
- 30 SHIPPING POINT INFO.
- 31 AG NEWS
- 32 N.Y.C. RAIL & BOAT
- 33 CLOSING PRICES
- 34 NEW PUBLICATIONS
- 35 COMPARISON METAL, OIL, SOYBEAN
- 36 LONDON METAL MARKET
- 37 CASH PRICES
- 38 U.S. ELECTRICITY PRODUCTION
- 39 SPOT COAL
- 40 SPOT LUMBER & PLYWOOD
- 41 CORN MARKET REVIEW
- 42 CHICAGO BOARD
- 43 CHICAGO MERCANTILE
- 44 COMMENTS ON USDA HOG OUTLOOK
- 45 USDA HOG OUTLOOK
- 46 CASH GRAIN PRICES TODD
- 47 CASH GRAIN PRICES-SHELBY
- 48 FUTURES-LIVE CATTLE
- 49 FUTURES-LIVE HOGS
- 50 FUTURES-FEEDER CATTLE
- 51 FUTURES-CORN
- 52 FUTURES-WHEAT
- 53 FUTURES-SOYBEANS
- 54 FUTURES-COTTON
- 55 SHELBY COUNTY POPULATION
- 56 TODD COUNTY POPULATION
- 57 KENTUCKY POPULATION





CDW  
CHICAGO FUTURES PRICES  
MARCH 26 1979

MONTH	HIGH	LOW	LAST	CHANGE
MAR				
MAY	2.504	2.492	2.503	+002
JLY	2.538	2.512	2.524	+016
SEP	2.554	2.536	2.546	+020
DEC	2.610	2.594	2.606	+024
MAR	2.690	2.672	2.684	+022
MAY	2.744	2.732	2.744	+028

PRICES IN DOLLARS PER BUSHEL

SONY





|SONY|

TRINITRON

TRINITRON

# TYPES OF INFORMATION TO BE PROVIDED

## MARKETING INFORMATION

- LOCAL CASH PRICES
- REGIONAL AND NATIONAL CASH PRICES
- FUTURES PRICES
- OUTLOOK INFORMATION
- CURRENT DEVELOPMENTS

## WEATHER INFORMATION

- RADAR WEATHER MAPS
- CURRENT WEATHER MAPS
- SHORT AND LONG TERM FORECASTS
- AGRICULTURAL ADVISORY
- SEVERE WEATHER WARNINGS
- WEATHER OBSERVATIONS

## EXTENSION RECOMMENDATIONS

- PEST MANAGEMENT
- IRRIGATION DATES
- PLANTING DATES
- GRASS TETANY ALERT

## ADVANTAGES OF GREEN THUMB

INFORMATION WILL BE MORE CURRENT

INFORMATION WILL BE MORE  
LOCALIZED

DATA WILL BE PRESENTED IN A  
CONDENSED MANNER

USERS CAN OBTAIN DATA ANYTIME  
THEY DESIRE

EXTENSION RECOMMENDATIONS CAN BE  
DELIVERED TO USERS MUCH FASTER

REQUIRES NO KNOWLEDGE OF  
COMPUTERS

ADAPTABLE TO A WIDE VARIETY  
OF DATA NEEDS

# COMPUTER NETWORK

MARKET  
INFO

WEATHER  
INFO.

EXTENSION  
RECOMMENDATIONS

SHELBY  
COMPUTER

100 FARMS

TODD  
COMPUTER

100 FARMS

UK  
COMPUTER

