tek talk

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COVER—Generations of progress separate the civilization of the Masai warrior in the African bush country, from the sophistication of the Tektronix model 422 oscilloscope that has attracted his curiosity. The scope, with a half-ton of other scientific equipment, was used in an expedition to Kenya, made to collect physiological and behavioral information on baboons in their natural habitat. Several Masai were visitors at the camp, obviously curious about what was going on in the 20th century. (Story is on page 10)

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A TEK TALK SYMPOSIUM

This century, two technological breakthroughs have been termed major enough to mark turning points in history. One is the atomic bomb.

The other is the computer.

Barely in its babyhood, the computer already has an awesome involvement in our world. It promises to leave no area of human life untouched.

In 1956, computers numbered in the hundreds. Today, there are over 30,000 just in the US. (One company has a backlog of 12,000 orders for its newest model alone.) The nation's computer power now is enough to make about **five billion** computations per second. Should that power falter, the result would be chaos.

One large computer can do more calculations in an hour than a stadium full of scientists could do in their lifetimes. A computer can do the arithmetic of 500,000 men using desk calculators.

On the other hand, computers are electronic idiots: They can do nothing at all unless some human instructs them to. Still, their list of achievements is a formidable one:

Operating at the speed of light, computers navigate ships, schedule airliners, run refineries.

They can, with some limitations, translate languages; read articles and summarize them; turn an engineer's sketch into an exact drawing, and show the design from any perspective, immediately; compose music; write poetry; beat anyone but experts at chess; trigger—or avert—an H-bomb holocaust.

Linked together, they help man do centuries worth of calculations in seconds, making possible the impossible—

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like orbiting a spaceman and bringing him back.

They control much of our electricity flow; route long-distance phone calls; set type; mix sausage, and cement; forecast weather, elections and the stock market.

The trite word "revolutionary" has been applied to the computer's activities in two areas: Information processing, and automation. It can not "think," but it does faster and better some of the processes we've loosely **called** thinking.

In tribute to the computer's role, ours has been called the "cybernated" generation. In it, the US has hit an all-time high in employment. Yet, because they do away with the need for human "intervention" in so many business, technical and social applications, computers are looked on with some apprehension. One government report says that each week 35,000 persons lose or change their jobs because of computerization.

Because of computer-aided automation, you'll find three men running a 36-acre oil refinery in the South. Fourteen men in a single glass plant can produce 90 per cent of the US' needs for light bulbs—plus all its demand for radio and TV tubes (other than picture tubes)! Some sociologists foresee the day when only a wee percentage of the "work force" will have any work. Of course, similar dire predictions have been made many times before, to no avail.

Whether its net effect will be to enhance man's abilities or to supplant them, one thing is clear: The computer is helping force a solemn look at what is man's work to do, and what is the machine's.

What about Tektronix?

It is a **highly** computerized company. Computers write your paychecks, doing in hours what would take a manual system days. They predict our needs for parts and materials. Our credit program is automated; the computer selects the proper letter to delinquent customers, and writes it. (Or it may notify our credit manager: "You have a serious collection problem with Jones Company . . .")

Computer tapes run multi-punch presses in our Metals building. In Engineering, 30 to 50 circuitry engineers have learned to write computer programs. And in the near future—experimentally—computer units will be installed in one assembly plant to "capture" production information.

But today's achievements are as nothing compared with the vast role computers will assume tomorrow—when they'll "think" in English.

They'll land planes without pilots, run laboratories and supermarkets. Home telephones someday will be linked to a global computer system providing services ranging from banking and travel facilities to library research and medical care. You'll converse with computers as easily as you now talk on the phone.

Computers will keep updated medical profiles on each person from birth—and on every known ailment, for physicians' immediate reference. Computers will tell the farmer when to plant, when to fertilize and when to harvest.

The most profound changes will be in education. Personalized in-depth instruction through "learning machines," like those in science-fiction stories, will soon be a reality.

Using computers, man will be able to capture and catalog virually **all** information, and make it instantly retrievable. The mass of obtainable computerized data about each person has raised worries about invasion of privacy, and the fear that **machines** will make "decisions" about people (whom to hire, whom to promote).

Despite the computer's complexity and cost, its use is growing at a fantastic pace. It may enable an advance in the thinking process more radical than the invention of writing. The computer promises a **millionfold** increase in our ability to handle information!

It is taking new forms, including desk-top keyboards and TV-like rereceivers. Already, through "time-sharing," the capacity of a giant computer system can be simultaneously used by large numbers of people.

Already, computers control some plants' billing, shipping and warehousing; order materials; calculate how much of what to produce.

Already, computers tell some department stores who the best prospects are for certain merchandise; tell a food company when to offer special "deals"; help select advertising media for proper audience coverage.

Already, some computers can "learn" —from their own mistakes.

People, while applauding computers' growing exploits, also voice some nagging fears: "Will we be forced into lives of idleness? Will we grow resentful and maladjusted in a computerized society? Will computers be watching us? Will we become machine-like ourselves? Will we become obsolete?"

Is the computer a master or servant? Clearly, it can become either. Will it make decisions? That depends on how you define "decision." Can it really think? It depends on what you call "thinking."

"The potential for good in the computer—**and the danger inherent in its misuse**—exceed our ability to imagine," says Dr. Jerome Weisner, MIT Dean of Science. "Our only hope is to understand the forces at work, and take advantage of the knowledge we find . . ."

continued

A FORCE TO RECKON WITH

The following discussion — among Vice-President Bob Fitzgerald, Components Manager Derrol Pennington and Data Services Manager Dwain Quandt —is a step in the direction of understanding.

DERROL PENNINGTON and BOB FITZGERALD

What are some ways Tek now uses computers?

Derrol—Tek's uses fall into neat categories: (1) Routine things, like payroll; (2) Non-routine operational information, which fluctuates and requires new reports from time to time; and (3) Automation and mechanization.

Dwain—Some uses are: Production reporting information, payroll processing, Accounts/Receivable and Accounts/Payable, inventory control, parts requirements explosion, many accounting processes . . . .

Derrol—To Manufacturing, data processing is a means to handle information. It has two tremendous advantages:

It can cope with huge masses of information, and it can do so in an extremely short time.

Fitz— . . . . And it sorts, clarifies and relates the data.

Derrol—Data processing provides information in time to make a decision. Computer people define "real-time" systems as those providing instant information. But for Manufacturing, in many cases, information within a week is adequate.

I try to get through to our employees that data processing is a tool—not a savior. It won't make them wiser, or give them better judgment.

Sometimes people want to use data processing without first defining their problem. All they'd get would be a report with the same built-in uncertainties, inadequacies and confusion—but they'd get confused **faster.**

An inexperienced person tends to read a data-processing report—much as we sometimes read the newspaper—as if it attained some virtue by having gone **through** data processing . . . .

How does our computer use compare with that of other companies?

Dwain—We spend proportionately less than most. But we're definitely ahead, both of local companies and of similar manufacturers. Our systems are more advanced; we get more information; and we're more automated. Still, we're in our computer "infancy".

Fitz—I, too, feel we're well out in front —in diversified use of computers by **all** segments of the company. Not just

purely accounting operations, like many companies, but **strong** use in material control and manufacturing support.

Probably we're less advanced in computer use in Engineering. (I'm not sure this is bad. Some companies are advanced in this use, but it doesn't necessarily improve their profit-and-loss statements.)

Derrol—When Tek was small, we operated—pretty efficiently—by "seat-of-the-pants" management. A competent, knowledgeable manager could personally grasp all the input needed to make decisions. The guy who made decisions often made the **right** ones intuitively.

Now, each top manager depends on information from a number of systems. For Manufacturing, data processing is one of the most important.

DWAIN QUANDT

We may have gone too far sometimes, and too slow other times—but we've learned from our errors . . . . I think Tek looks at the computer fairly objectively. We're not afraid to use it. Neither are we obsessed with what it can do.

What does the future hold, as far as Tek's computer use goes?

Dwain—Ten years ago a computer could add two four-digit numbers 40,000 times a second. Today it can add them **eight million times a second.** Tomorrow . . . . ?

In the past we've tended to think of machine applications as independent. Today, the output from one system is the input for the next.

Our "third-generation" 360 computer is oriented toward an **information system**, to gather all information into a "data bank" with remote input-output stations throughout the company (typewriters at first, display devices later.)

With display devices, a person will be able to seek information instantly—say to check records and tell a customer where in the plant his on-order instrument is, and when it will be ready. Now, it takes lots of paper work and telephone calls—and it takes **too long.** In three to five years we'll have **many** devices, providing this information in 10 to 30 seconds.

Derrol—A company with 7000 persons has **no alternative** but to use automatic devices to collect and disseminate information.

We're really talking about how to achieve decentralized management. In a centralized system, all information comes into one point; decisions are made, and orders issued. You need information there only. In such a system, people down the line are not "managers," but sort of administrators, carrying out a set of orders. Whether these orders come from people or machines hardly matters . . . .

Tek is basically a decentralized company; we encourage decision-making at the lowest appropriate point. And the thing people overlook is this: The need for information in a decentralized company is far greater than in a centralized company. All information must be available to managers at all levels so they can make decisions. It's been said that "The price of autonomy (or "decentralization") is full disclosure."

The advantage of a centralized system is that the need is less critical for high-caliber middle and lower management. The **disadvantage** is that the strength is all at the top.

Dwain—Someday an order from the field may come direct to a computer programmed to see what instruments are in the warehouse. It tells the field office if instruments are available. The field says to ship, or not. The computer notifies the warehouse; it updates inventory records, reducing the on-hand quantity of instruments; it triggers the invoice, and sends it to the customer.

If the instrument is **not** available, the computer sees what the in-process situation is, checking against other orders, and notifies the field. Also, it **could** look at the parts inventory and (if parts are **not** available) issue purchase orders to a vendor. It could look

at the Tek-made parts inventory and issue work orders to a plant to build those necessary. It could even notify a numeric-control machine to begin producing—and it **could** do production rescheduling.

Who licks the stamps?

Dwain—It does sound like the computer is doing the entire job.

But people will always have to make the final decision. The field office decides "yes" or "no" on shipment; the warehouse may reject the shipping document. The buyer may question the purchase order—he may know a better vendor . . . .

How long would the process you've described take?

Dwain—About half a minute. This is considered a "real-time" (continuously updated) system. Often a "right-time" system is all that's needed—to yield information, as Derrol said, in time for a decision.

In 15 or 20 years, maybe **all** systems will be classified as "right-time." Field offices will be able to interrogate the computer itself.

Probably in 10 years many TelStars will be available for data-processing rental. We'll be able to transmit data overseas without using phone lines or trans-Atlantic cable.

What are some major worries about the computer's role?

Dwain—People may feel that everything gets wrapped up in the computer, and can't see what's happening—they've lost the ability to look at information when they feel like it. But, once we have remote terminals, they'll be able to find out information—more than ever before, and far faster.

Fitz—I happen not to be terrified by computers, having worked fairly closely with them. But I sure understand the feeling of people who **are**. The inside of a ship perturbs some people. Others feel uneasy in engineering or production areas. All that complex equipment doing something they don't understand makes some uncomfortable.

"...there's nothing more inhuman than tedious work; we want the qualities of a human being..."

Derrol—Some people feel computers restrict their freedom. This means to me they don't understand what data processing ought to do. It doesn't make decisions, which would be a true restriction of freedom, but **increases** freedom by providing better, more timely information for decision-making.

How about the freedom to play a hunch?

Derrol—A guy still will be able to do this. A manager's job is to assimilate all the input he can get. Data processing is only one input.

Fitz—Some people **will** have less "freedom" in their option as to how (and often whether) to record, classify and analyze information.

Information a manager formerly might have been able to keep in his head, he now exposes to others' scrutiny. Then, in his reports, he could be subjective in how he presented information—and sometimes in **what** he presented. But mechanized information systems mean his subjectivity is weighed against the requirements of machine logic. Other people are exposed to his conclusions. The consequences of his acts are "quantified," and judged.

A subjective manager can be damn good. But my premise is this: Data gives you an opportunity to do a better job than you'd do without data. The system may take away some managerial prerogatives, but with disclosure to others comes true freedom. The manager, because his moves are exposed to people who will be able to help, is unencumbered to do a job freely.

We need systems that promote full disclosure. Our 25-manager Council is a sort of example. We **could** set up strict rules so no manager could get into trouble. But we prefer to have a system of meeting often enough to exchange information that he can't get **too** far in trouble.

Some people worry about insidious regimentation going along with computers—something you don't suspect until you're sucked into it. The company **doesn't** want that to happen.

We try always to have jobs that expand. A person tends to look at his job in terms of his abilities **as a person**. And that's proper; a broad job helps him learn about his human capabilities.

We give considerable study to **any** machine project. Part of that study is to look at the **human** consequences of new moves—such as source reporting. Also, a company can safeguard against poor use of computers—or of humans—just by having alert managers.

Dwain—In the near future, we'll have a data-collection system in one plant on an experimental basis—using devices that capture production information without the employee spending undue time reporting. Some people feel the time they take in reporting detracts from their main job, producing. These devices will make reporting easier.

The employee will simply insert a card into the data-collection machine to report the quantity (of parts or whatever) worked on. The data is captured on tape and processed on a computer that evening. Reports are on the manager's desk in the morning, telling him the status of his workload.

Fitz—This whole business of reporting is hard to get at. Reporting each single move you make would be onerous; on the other hand, having **no one** know what you're doing would be intolerable to you.

Dwain—People need to realize that these devices are not "machines watching people". The systems that computers serve are designed by people—people who will need information from you, in some form, in any case. We feel the better the information, the better for the company—and for the individual.

Derrol—We once thought having inspectors would insult the workers. But most employees now see them as aids, not policemen.

How about the much-discussed "technological unemployment"?

Fitz—Nobody has proved to me that society has been more harmed than benefited by increasing technology. Certainly some are out of work through "technological unemployment"—but a lot more are out of work for **other** reasons.

And, non-advanced countries are characterized by **much** unemployment. You won't find technological unemployment in New Guinea . . .

Dwain—People "replaced" by computers are "invisible"; that is, they're people whom, had we not been computerized, we **would** have had to hire.

Fear that computers may do away with your job is a legitimate concern. But people who **have** this concern have it because they don't understand.

No one has lost a job at Tek because of computers. This year—computers and all—we've looked hard for more employees. Including clerical ones . . .

Derrol—We'll always need clerical jobs. You **never** want to plunge into a machine project until you've gone through it manually. Intermediate experimental manual systems are flexible and efficient—and machine programs can be expensive.

Dwain—It takes a long time to set up programs. Implementing computer systems takes a **very** long while — six months to a year, or longer. But processing time is very short—a half hour to a day. This is just the reverse of manual systems, which you can change, say, in a week.

If you compare a machine program with hiring enough clerks to do it, the cost might be twice as much for the latter.

Once a system is set up and "debugged," chances of machine error are slim. (This is not always true of people).

Derrol—In the case of automated tooling and milling machines, we're supplementing skills that are in **very** short supply already. Numeric control merely extends the skills of available tool and die makers. Insertion machines and automated circuit-board drilling replace tedious, monotonous operations.

Fitz—But automated manufacturing processes are somehow looked on differently. A computer-tape-driven milling machine doesn't bother people as much as a machine that gives information—and sometimes instructions.

In almost no time, a computer could tell you the best possible sequence for putting a tape-driven machine through a dozen milling steps. That way, one technician can set up problems so **many** people can solve them.

A high degree of skill is required to do one part—but to use the **same** skill on 20 is highly wasteful. (Compare this with a designer drawing a separate design for each of 20 identical parts.)

Do you foresee a decline in number of Tek employees as computers continue to make inroads?

Dwain—No. I look for continued growth. Some people will accept other positions at Tek—including some jobs that don't now exist.

What about those people whose jobs vanish?

Dwain—Their responsibilities will change, or they'll assume **other** responsibilities. This requires that they gain a better understanding of what the computer can do—for them.

In five years, most of our company systems will use computers. Everyone will be indirectly affected, more in contact with the machines. Responsibilities will change, and opportunities to advance will be upgraded. Not just managers, either—potentially, everyone.

Derrol—I don't think we need to worry greatly about technological unemployment here. We're still a state-of-the-art company. Parts, processes and materials are changing rapidly, limiting our use of automatic techniques.

Data-processing equipment is merely an extension of the pencil, just as earth-moving equipment is an extension of the shovel. But we still have a heck of a lot of shovels. And pencils. The computer is essentially no different from other tools. I see no social, or other, revolution coming.

Fitz—In the Electrochemistry building, a number of people now make etched circuit boards; thus, fewer people in Manufacturing are building and assembling components and ceramics onto mounting boards. We're replacing other manual tasks with the automatic-insertion machine and the automatic soldering machine.

We get **tremendous** "technological unemployment" exposure—constantly. Diodes, transistors, integrated circuits are facts of life. Sure, some people lose or change their jobs as technology changes—but a heck of a lot more **gain** jobs.

The **worst** technological unemployment is when the **competitor** comes up with one of these new techniques, and we don't. There go all **kinds** of Tek jobs . . .

What have been the major effects of the computer so far at Tek?

Fitz—It's been an enabling tool, although sometimes aggravating (in that computer errors, when they occur, are **massive** errors.)

It's hard to express in a meaningful—or general—way, but I think we **have** upgraded jobs here already. I've had experience as a buyer, doing computations—the **same** computations, essentially, for five years. Hardly a fruitful long-term human prospect. The time a buyer spends doing that, he's not doing something more expanding.

We **should** enable a machine to take over such routines. For a person to prefer tedious daily routines is not healthy. We **want** the qualities of a human being. In that sense, you'll never have "technological uemployment".

This seems to counter the fear that machines, being inhuman, will make people more machine-like also.

Derrol—There's nothing **more** inhuman than tedious, monotonous work.

Fitz—That's true. The person who is really machine-like is the person who gets into a rut. If you come to love routine, you'll never get out of the routine. On the other hand, a person with new experiences—even unpleasant ones—is growing. And growth helps him maintain his human capabilities.

People also seem to fear that computers will make their jobs suddenly and radically **change.** I believe their jobs will change—and grow—far more because of their own personal development than they possibly could through some technological process.

Our lives are increasingly involved in computerized records: Fingerprints, tax returns, miscellaneous information . . . Yet the change this represents hasn't been felt suddenly—and it has made our lives "better," however you interpret that term.

Popular magazines talk about computer programmers as the "new priesthood." Is that concept valid?

Derrol—We haven't made a "priesthood" of tool and die makers, although we depend on them greatly—or even engineers, on whom we depend totally.

The data-processing field **will** be a good entry into upper management—for those people broad enough to grasp the significance of management decisions. Middle and upper management must develop a feeling of how data processing should be used. They'll depend on technical assistance to do this, since there's nothing simple about computers.

Dwain—Today there is a shortage of computer programmers but, in 15 to 20 years, programming will change drastically. "Richer" languages are being developed to ease the communication problems between man and computers.

Today's programmer's job will definitely change in the near future, just as other professions have done and will continue to do.

Will these "richer" languages be our own, or a " Me Tarzan - You Computer" jargon?

Dwain—Our own conversational language. The programmer will become a systems designer—far more problem-oriented. Also, in 10 years we'll have a display unit by each manager's desk so he can "talk to" the computer and see the answers.

What requirements will the computer place on employees?

Dwain—A manager must sit back and think: What does he want to get out of the system? It's hard to have second thoughts when the system is so costly and uses so much time to set up or change. The average report now may cost $500 or $1000 in setup time alone.

Derrol—The manager's job is to use all resources at his command to achieve some economic objective. The computer has given him a valuable new resource—but it's not his **sole** resource.

Information processing is costly if the information is not needed, or not accurate. A lot of times, also, a manager already has **made** his decision. If he's at that stage, he doesn't **need** more information.

Dwain—The manager **will** need to be more analytical. He'll rely on information from the computer (put into it, remember, by people). He'll often have to ask, "What effect would this decision have on company profits?" I'm

"...the worst 'technological unemployment' would be if a competitor came up with new techniques and we didn't..."

speaking of the computer's ability to simulate—to ask "If we had certain information, would it be useful?" To simulate, by machine, a number of ways to handle a theoretical, or future, problem—and study the "consequences" of each.

Derrol—Simulation **will** become more and more important as we get into more sophisticated management. But, for us in Manufacturing, data processing will continue to be most helpful in dealing with huge numbers of parts, requirements, planning, scheduling, loading and —recently—interactions between parts and raw materials. Things we can't handle by manual calculation.

Fitz—Among Tek's expectations of its employees, as the computer expands, is that they get an appreciation of what it can do—and of its limits. The more directly they're connected with a computer, the more they need to appreciate it.

The depth necessary will depend on your degree of involvement. Most people can appreciate the telephone, but have no appreciation of the complexities involved in getting phone service. And they don't **need** to . . .

Derrol—It's essential that young managers "on the way up" understand this tool—not look on it with awe but, just as I use a slide rule, acquire familiarity with, and master, it. Most of our plant managers have been to IBM for a computer seminar. We'll see that the rest get there.

Do you foresee a changing ratio of managers to non-managers?

Derrol—I **do** see a growing number of technicians in areas like Data Processing—not necessarily management, but adjuncts to it—and a growth in indirect employees.

For example, automated machines will require fewer direct-labor people, but additional programmers, and more maintenance technicians to keep this complex equipment running. Probably also they will require more (and more skillful) schedulers and loaders.

How far down the line should people become computer-oriented; to what degree; and how should they go about it?

Derrol—Our idea now is to direct our training and expectations at those who will assume higher roles—or **broader** roles. But **all** employees need to be aware of the computer. For one thing, they'll provide input to the system.

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They must appreciate the need for accurate and timely information. Carelessness could make the whole process fail in.

Dwain—Helping the employee inform himself is a problem for management. We **must** provide training. For our part, we'll continue our own data-processing courses. And an employee can read articles on computers to find out how they perform and their capabilities.

Derrol—Actually, managers have no reluctance to use data processing. I suspect most of them overuse it.

The need is to convince them it's not an automatic solution to all difficulties. Sometimes data-processing people add to the problem, if they assume the manager **has** identified his needs. If you don't talk through your problem, no program writer can save you.

Fitz—Some things, once you have them, you can use and use, with increased unit value—like highways. The computer isn't one of those things.

I think Derrol has the key: Overuse is when you do a job more because computers **can** do it than because such data analysis has value. I'm sure we do a lot of reports on machines that we wouldn't do had we analyzed better. And even if a manager does think out his problem, he's not always in a position to evaluate how much the company should spend to **give** him his information.

It's easier to measure the value of something tangible, like a desk, than the value of timely information, or someone's use of it.

Do you intend, in the Data Processing committee, to make this kind of cost as "visible" as, say, the desk?

Fitz—That's a good point: The invisibility of this kind of decision and its cost—even to considerate people. On the other hand, if you hire a person, that's immediately noticed.

Computer people say, jokingly, that if machines ever start to take control, you can always pull out the plug—a negative approach. What WILL the ultimate man-machine relationship be?

Derrol—Even machines with social impact are tools—doing things that have been done before (although clumsily, by machine standards). I don't see the computer as being as revolutionary as, say, radio or TV—which did things that **weren't** ever done before.

Science-fiction accounts of machines taking over are written by people who lack understanding. (I'm not saying that data processing can't be misused—by people, for instance, who put in inadequate information and then base their decisions on the machine's output.)

The day a manager does something just because the machine said to would be a sad day. It the answers came from machines, there'd be no need for managers.

Maybe that's one of the manager's worries.

Fitz—But an unrealistic one.

The computer does let man do jobs he couldn't do even with a large number of people. The logic required to calculate force and direction of earth satellites requires immense computer systems—and centuries' worth of computation. Still, the success of our astronaut program has rested with **human** judgments. As to the worry about machines giving us instructions, I disagree that this is always bad.

For instance, in an air terminal, a "machine" tells you flight such-and-such leaves at 10:02. That's very helpful information—whether or not you consider it an "instruction" to get on board.

There is a difference between looking at something that **tells** you what to do and something that gives you information on which you act in full confidence. A whole lot depends on your attitude toward information; it's the difference between "instructions" and "orders".

Derrol—I think the thing is this:

Not only would an organization in which machines give orders be undesirable from a human standpoint; it also would be ineffective—too rigid and too inflexible to work.

No matter how far we go with computer technology, the manager will assimilate all information—and make the decisions.

One mark of civilization was the beginning of the use of tools. Man now has control over more and more sophisticated tools. The machine **can't** have mastery—unless we all quit thinking.

TEKTRONIX' NEWEST COMPUTER, the "third generation" IBM model 360, may be used for both business and scientific applications. It's shown with Dwain Quandt.