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User-Centered Deployment; or, What to Use Them For and How

"Fleet Financial Group, a Providence, R.I. bank holding company built a consumer service center . . . to handle all customer inquiries from any of its seven subsidiaries in six states. Operating 24 hours a day, it gets 1.5 million calls a month—80% entirely handled by computer. Despite the longer service hours and wider range of inquiries handled, it now has 40% fewer customer service people than the separate banks did" (Wall Street Journal, *March 1, 1993).*

In its June 1993 issue, *Business Week* ran a feature article, "The Technology Payoff," trumpeting a turnaround in IT's contribution to productivity. They cited Brynjolfsson and Hitt (1993) to support a thesis that industry had finally learned to use computers effectively. A table showed how the top forty-six "productivity champions" among major manufacturing firms had improved their sales revenues per employee in the previous five years. Indeed, many firms showed much better growth on this measure from 1987 to 1992 than they had in the previous five years, and the average growth rate for all Fortune 500 laureates was up a notch. Unfortunately, the same data show that half the champion firms improved their productivity more *slowly* in the last five years than in the previous five.[1] Were the most successful ones just lucky, or were they doing something better, something we can identify and other firms can imitate? In particular, were they using their computers better, and, if so, how?

The *Business Week* authors suggested that many of the improved results followed business process redesign in which IT played an important

supporting role. This is a common theme among business consultants of the nineties. They are telling managers to worry about the way they run their operations first, and *then* think about new IT.

What Can You Do with a Computer?

After managers finish redesigning, what should they think about using computers for? There are four ways to use computers to increase productivity:

1. Reduce unnecessary and duplicate work by storing and transporting information electronically.
2. Improve the coordination and synchronization of work by better planning, monitoring, tracking, and analysis.
3. Support new high-productivity products and services that depend on powerful information processing.
4. Help individuals perform information work more efficiently.

Almost all the widely reported successes have gone down route 1. Typically, close examination reveals a processes in which many paper records are produced for one basic transaction, say, the purchase of a truckload of oranges. There is an order, a package list, a bill, an invoice, a payment, a receipt, each in multiple copies, routed to different file cabinets and later compared with each other. A new process is designed that requires fewer entries and fewer comparisons. The computer helps by storing all the information in one place.

Success by the other routes appears to be less common. There are examples, though. Airlines optimize their routes and schedules so that planes are full and get the pilots and cabin attendants to their starting places with minimum shuffling, a nice bit of coordination—route 2. Perhaps the most widespread computer-based reorganizations have been centralization of functions. By using telecommunications and electronic data storage, all the bookkeeping for a multibranch bank can be done in one low-rent place, saving facilities and managers—a combination of routes 1 and 2. Federal Express has made a business of delivering packages in a shorter time than the post office imagined possible; Dialog and Lexis offer scholarly journal abstracts and court decisions instantly to

every college library and law office—route 3. Engineers can design computer chips and airplane bodies much more quickly—route 4.

Reengineering and Eternal Hope

Across America meeting rooms are fully booked. Teams of suited executives are feverishly plotting radical revolutions. The Karl Marx of the movement is Michael Hammer, and its rallying cry, "Don't automate: obliterate." The revolutions, when pulled off, are radical redesigns and reorganization of parts of a business. The Fleet Financial group story is typical. More examples are cited in a compelling book by Hammer and James Champy, *Reengineering the Corporation.* They have convinced CEOs everywhere to take a new look at how their organizations operate.

The coordination of ocean shipping is an ancient nightmare. One company operates dozens of huge ships, collects thousands of items from hundreds of shippers in scores of ports, and tries to pass the right ones on to hundreds of importers scattered across the globe, all the while keeping holds as full, sailing as little distance, and moving cargo as infrequently as possible. SeaLand contracted a computer network to replace the manifests, bills of lading, and ledger sheets. A $1 million annual tab is said to save $25 million in labor expenses. (Source: The CEO of the network company, an anonymous seat partner on a flight from Pittsburgh to Newark.)

The time is ripe for such soul searching and reform. Most business processes, developed before electronic data handling, were evolved to make people and records regular and efficient when the only technology was ink on paper. Jobs were subdivided into specialties that would maximize practice on what each person had to do and minimize what each person had to know. Information was collected and distributed through a tree of paper reports by subordinates to superiors and memos from superiors to subordinates. At least half the work merely copied, checked, compared, or approved what other people had already done. Each person was another opportunity for a typo or sick day. Between people the paper stood in stacks for hours or weeks.

Many poor business processes are ingrained in habit and tradition, entrenched in the self-interest of departments and their managers. Rethinking can work wonders, especially in time of economic distress when upper management has the nerve to face down internal imperialism. If the route to success is process reform, only small additional IT investments may be required.

Process redesign as being practiced is not all that's needed. Certainly the redesign movement is likely to have substantial effects as more and more companies revise their information handling methods, but the movement is likely to play itself out rather quickly. While there are many places where reducing duplicate paperwork and information handling delays can contribute to increased productivity, experience suggests that the usual gain is modest and local, confined to one or a few component operations.

Moreover, sadly, most reengineering efforts fail. One candid consultant told me that less than a third of redesign efforts are able to identify and exploit opportunities for significant improvement. More often, the old process was pretty efficient after all, or the new process ideas are organizationally, politically or technically impractical. Indeed, even its most ardent proponents, Hammer and Champy, come up with only a small handful of cases with large effects. Others are a quite mundane one-time 10 to 30 percent efficiency improvement. Many of the examples that Hammer and Champy cite—Federal Express, Ford, Taco Bell—have previously been advertised as examples of other management fads like total quality or lean manufacturing. Others, insiders tell me, were still in the "we expect" stage when written up. Certainly some companies have turned themselves around, but as Hammer and Champy themselves make clear, many have failed, and each success has been accomplished differently.

However, there is one common denominator of success: where IT is used, it is used well rather than blindly. So far, in almost all the widely advertised victories, IT's main role has been to help reduce duplicate work. Each worker turns out the same amount of work, but there are fewer workers because work gets done once instead of thrice. Centralization is the usual method. It has been widely employed by telephone companies, which is why the operator who helps you charge a call from

Brooklyn to Oakland may have a Texas accent. Blue Cross and Blue Shield of Virginia deployed a system that let insurers send payments directly to doctors and hospitals. One hospital, the University of Virginia Medical Center, reduced the number of people keying in payment requests from 14 to 7. Salomon Brothers revised its record keeping system so that traders in New York key their own trades into a computer in Tampa rather than handwriting paper tickets to be copied in—with added errors—by an entry clerk.[2] Centralization of another sort is also mentioned often: making it possible for a single worker to handle more of the business so there are fewer handoffs, less confusion and error, smoother service.

Few of the success stories tout improvement of individual worker efficiency as such. Hammer and many others assert that simply automating jobs is futile; trying to make individual workers more efficient has no effect on the firm's performance. They have drawn a false conclusion. From the fact that vast computer application to individual jobs has not paid off, they have inferred that individual worker productivity gains don't help. Their reasoning assumes that computers have actually improved individual worker efficiency materially, they are unaware of the meager effects that IT usually produces. None of the analysts refer to the direct evidence on work efficiency reviewed here. Few mention the striking exception of telephony where greatly improved worker efficiency produced impressive productivity gains.

The second National Research Council report (1994b) falls into the same trap. Although accepting the productivity paradox as real, its authors focus on the linkages between individual work and the productivity of organizations. They insightfully analyze ways in which slack, inability for one part to use the output of the last, efforts misdirected to unimportant problems and unproductive uses, negative motivational consequences, high training costs, social barriers to information sharing and cooperation can keep gains in individual productivity from getting out the door. The theory is that computers have strong productivity shoulders but are pushing rope.

Two problems undermine this position. One is that other individual productivity inventions have had big effects: electric motors, textile machines, farming methods, telephone switches, and telecom databases. We

are being asked to believe that things are totally different in the services now using computers. Perhaps transforming worker efficiency into enterprise productivity is harder in offices than factories; the special issues are certainly worth thinking about. However, the fundamental problem is that there are no big shoulders, at least not very big and very many. So the weak linkage explanation of productivity failure isn't needed just yet.

I claim that the reengineering movement is both right and wrong. It is quite right in calling for a reexamination of business processes and looking for better methods of dividing and coordinating work with the help of computers. It is right in placing emphasis on the team activities where communication and data storage have been roadblocks. However, it is dead wrong in giving up on worker efficiency. Improved worker efficiency has been the great engine of progress for two centuries. Moving from muscle to information work need not—and should not—mean that we cannot help each worker do more and better work.

Finding a Road from Here to There

Computers that multiply work efficiency can be designed through UCD. So that better systems are used, and used right, the people who buy, use, and manage IT must be able to choose and deploy wisely. As things stand, they are severely handicapped. Purchasers are given too much information about hardware and features, almost nothing reliable about usefulness and usability. They have few effective tools for finding out whether what they've bought has helped. Some big businesses do hypothetical cost-benefit projections before computer purchase; almost none do serious evaluation afterward to check their assumptions (National Research Council 1994a). On the other hand, we know that empirical testing, measurement of success, observation of accelerators and inhibitors, and revisions can bring large improvements. The problem is to get them applied and extended into the practical world of business.

An Underwriter's Lab for Usefulness and Usability?

Some popular trade magazines, ones with "PC" in their names, have recently begun doing their own user testing. For years, benchmarking has been part of the process on which they have based the opinions and quality ratings in their product reviews, but their empirical measurements

have been exclusively concerned with speed, size, and features. The average product review mentions usability twelve times, but there is no objective evaluation behind the remarks. Instead there is the opinion of an overqualified user—a reviewer who has tried dozens of different products and therefore has a seriously warped view of how easy they are to use. Readers of these reviews, mostly managers of work groups who use computers, increasingly demand firmer information about usefulness and usability; they want to know how the product will affect productivity, not just how it operates.

The most dramatic tests reported so far were evaluations of notebook computers by *PC World* in its May 1993 edition. With the cooperation of American Airlines and its usability staff, they had six representative users try a variety of tasks on each of five different laptops while seated in coach seats of an airline training simulator. One test user found the passenger in front trying to recline his seat too far for comfort. He tried to jam his machine between the arm of his own seat and the encroaching back. It didn't work—and it added a new feature to the desiderata list.

Insiders at several computer companies say that management and marketing often reject proposals for efforts to measure and improve productivity on the grounds that neither reviewers nor buyers can tell the difference (as figure 13.3 shows, they're probably right). The introduction of trade magazine tests may push the manufacturers toward paying the same attention to usability that they give to raw speed.

So far the tests have been minimal. They have not included whole jobs of real people. They have been done in artificial situations; even *PC World*'s simulator tests did not include air turbulence or large seatmates with weak bladders. Another magazine's standard evaluations use only three subjects. Fortunately, as we've seen, that's enough to tell a UCD-perfected system from one that's not. The head tester says flaws of the latter simply jump out.

I have great hopes for reviewer testing. More objective reviews will help to filter what gets into use and thus gradually improve the efficiency of computer users. But the backstream effect on design, development, and peddling will be even more important; it will force manufacturers to do UCDdevelopment, if only to avoid embarrassment.

Still, much more is needed. The functional adequacy of trucks, beams, and milling machines, not to mention drugs, condoms, and TV sets, is

appropriately tested by manufacturers. Wise purchasers will find ways to enforce customized testing of the usefulness and usability required by their own firm or their own customers. Tests will be done by the suppliers, on the model of drug companies, by consulting groups, on the model of structural engineering firms, or by the buyers themselves, on the model of the telephone companies.

Better Management?

An aircraft instrument manufacturer installed a computer-based resource management system. The goals were clear, the economic analysis sound, the implementation thoroughly planned. Ten months later, there had been no efficiency gains. The problem? Use of the system was rigidly governed by management rules. Workers were reluctant to override the system's decisions even when manifestly wrong. Local shortcuts and workarounds remained secrets. "Learning from mistakes was limited because effective job performance for the system designers was measured by adherence to best technical practice, not to shopfloor reality." [3]

The most popular diagnosis of the ills of computers, aside from underrug sweeping, has been improper management of their use, and the favorite prescription is that upper management pull up its socks.

Clearly, successful reform needs to make each process mesh with the rest and contribute to the right overall outcomes. Dertouzos and Thurow go even further.[4] They propose that computers will boost productivity only when they are integrated in a national and international fashion. Banks need to get rid of checks, not just read the maker numbers automatically. Important goals like these require organizational decisions and negotiations by managers with clout.

But the good management that is so easy to urge is not so easy to do. Take the admonition that rather than simply automating jobs, managers should first reorganize work flow in efficient ways. If managers could make business operations much more efficient, what's kept them? If you have to do it before you bring in the information technology, why didn't you do it before there was information technology? I know companies that are on their third try at redesigning the same processes.

The task requires teams of creative people that combine thorough knowledge of the functions of the organization with knowledge of hardware, software, and, particularly, evaluation techniques. Getting people and teams to do this work is not easy. There are virtually no stars to hire or emulate; few if any have had repeated successes sufficiently impressive to assume that they could do it again. But neither is the task impossible. There are many superb computer programmers and computer project managers, many managers who truly understand the work of their own organizations and are open to change. And there are a growing number of usability specialists. The experiment of bringing them together in effective teams has only begun.

Automating Old Jobs

A West Coast clothing company introduced an advanced computer system so sales representatives could enter orders directly in handwriting, using new OCR technology to shortcut the labor-intensive card-punching operations that had slowed order delivery and caused customer complaints. The system "works"; there are actually fewer input errors than expected. But questionnaires answered by sales reps before and after the change indicate significant decreases in the quality of order filling and customer service, which in turn are associated with lower job satisfaction among the sales people (Lucus 1978).

We can also expect to get some help directly from the technology itself. I strongly disagree with the notion that old jobs should not be automated. With proper design, jobs that are time-consuming or error prone can be made much less so. We've seen many examples. If the jobs that are improved have important economic consequences, so will their improvement. The pundits have erroneously taken the fact that augmentation for individual jobs has failed so far to mean that it is hopeless.

Better Uses

Yesterday my wife, a lower-upper manager in a giant company, was late for dinner. She'd neglected to save a long memo she was typing herself, and a bug hung the program, forcing her to redo the work.

Strassmann estimated that 64 percent of total IT costs went for management information but was unable to show any general benefits of computers in productivity or competitiveness, despite valiant and imaginative efforts. Weill (cited by Attewell 1994) estimated that only 22 percent of IT goes to support transactions, despite the fact that these were the only uses he could show were significantly useful. Pentland (cited by Attewell 1994) found that IRS agents with their infamous laptops believed that the quality and authority of their work was better. Objective studies found no such effect—but did find much diminished productivity. Attewell himself reports a survey showing that average internal output per hour went up by 78 percent but that internal work volume, mostly reports, went up by the same amount, while the output of the firms he studied apparently stayed constant. Attewell also remarks that the huge increase in what-if experiments by spreadsheet users is not justified; a large literature shows that the resulting decisions are usually no better. The use of paper in offices has gone up twice as fast as GNP. Many observers have commented on the increased aesthetic appeal of carefully formatted casual memos and charts and the explosion of unnecessarily detailed business cases.

We need to find service business activities where computers can help people do things that help more. Weill's hint about transaction applications (point of sale and order taking), a similar finding by Strassmann, and the successes of the telephone companies suggest that more concentration on operations and customer service applications and less on toys for professionals and managers is in order.

Augmentation and the Organization

Many experts have been predicting that computerization would revolutionize organizations. The most popular prediction is flattening of management hierarchies. The claim is that hierarchy is obsolete. With local area networks, each person can communicate with each other almost instantaneously. The CEO can ask every one of her hundred thousand employees a question and get an answer in minutes. "I'm going to Sweden. Anyone know a large customer in Stockholm?" Computer databases give every employee access to the same information. To find out how many T-shirts Bob Jones Inc. ordered last year, neither the salesperson nor the boss needs to ask anyone.

Peter Drucker and MIT's Tom Malone say that the increasing technical depth of most organizations means that managers and troops alike have much more need of each other's expertise. Thus, not only does modern technology bring the means for more direct communication between people but the necessity as well. The CEO needs the advice of a computer expert, a financial analyst, and an engineer and can make better use of them without the delay and distortion of intermediaries. Since modern business work is so fast paced and information dependent, access to information, in employees' heads or in databases, needs to be much more rapid and cannot, it is contended, put up with creaky old hierarchies.

This analysis is all very compelling—so compelling that it must have come to pass. But the total number of managers doubled between 1972 and 1988, and there were *more* middle managers in 1992 than ever before. The prophecy failed for three reasons. The most benign is that a chain of command is an efficient way to allocate responsibility, make decisions, and divide expertise. A less cheering reason is that command chains maintain political power that is not easily surrendered. A last explanation is that computerized information sharing is just not good enough. It is still too hard to use and insufficiently useful. Most large organizations do not yet have electronic mail networks that reach all employees, so the kind of communication that requires a permanent readable, processable, storable form cannot yet be sent electronically by everyone to everyone. Where such facilities exist, they are too cumbersome to attract all the crucial players. Few high-placed executives have terminals on their desks. Few employees have direct access to either databases or electronic messaging systems other than the telephone. Most message systems are too difficult to use for people who use them only sporadically. Even when they are usable, their usefulness is diminished by awkward addressing and by the information glut they can spew out. (A contrary view is expressed by Attewell. He says IT is too good; it tempts managers to spend too much time, money, and attention on messages and numbers.)

Interestingly, another prediction about computers and organization seems to have come true: that IT would produce smaller companies because electronic coordination lets firms turn to others for general functions like maintenance and travel. Brynjolfsson et al. (1994) have found evidence that using more IT is associated with subsequent decreases in

firm size, an especially interesting finding because it is mostly large firms that have appeared to improve productivity in recent years. Is it possible that IT encourages forms of organization that miss out on economies of scale, specialization, and control?

Overcoming Problems

Part of the job of improving productivity returns from IT will be to overcome some long-standing sources of ineffective deployment. Let me mention a few.

Piece-Wise Design

Most software packages are invented and sold one at a time. They address one task—seldom the whole job of any one person, never all the work of a whole organization. But effective information workers don't spend their whole day at one task. Well-used secretaries make appointments, answer telephones, make records, find information, and type. Software companies do try to make different programs compatible, so that the output of one can be the input to another, and some icons and commands have the same meaning in different places. But whole systems that aid the full activities of any one person or the full functionality of any office or factory are rare.

Specialization and Information Work

Piecewise development has also pushed management into dividing jobs into specialties that use the computer facilities, often physically separating interrelated workers. This blind mimicry of the labor specialization of the first industrial revolution saves steps and maximizes expertise in manufacturing. But in information work it can increase communication costs, delays, misunderstanding, error, and duplication of work.

Sometimes, as in database applications, and especially in computer-aided design, specialization happens because computer systems are so hard to learn. Once somebody has been trained, management doesn't want to waste her time doing anything else. But the tail is wagging the dog: systems should be designed to fit efficient labor division, not require inefficient new specialization.

We got a request to design a graphical user interface for a system that helps dispatchers schedule field repair jobs. A visit to the workplace revealed that dispatchers spend most of their time making telephone calls to get needed information and copying information from one system into another. This results in frequent errors, like wrong IDs for faulty equipment, that can compound themselves into a gummy mess. Did the clients need a GUI? Maybe. Did they need a less error-prone, less time-consuming information collection scheme? Certainly.

The essence of information work is the assembly of knowledge. When information workers are overspecialized, they lose command of what is going on. Information about the boss's schedule is unknown by the pool wordprocessing typist who is writing an answering letter to someone who wants an appointment, and thus an error—not a typo, but an error in judgment—goes out in an envelope.

Worst of all is what piecewise specialization does to work life. The wordprocessing typist who knows nothing about the writers' goals or even how to spell their names garners little satisfaction. It's worse than an auto assembly line, where workers at least know what their parts do, whether a job's done right, and what is being built. Maximizing the number of words someone types during the day is an indecent goal. We have to keep the kind of productivity effects we are really after in sight. The true goal is not productivity in dollars per hour just to have dollars per hour; somewhere we need to factor in the satisfaction and pleasure of the working day. To put a crass economic slant on it, disaffected employees tend to goof off, call in sick, and work elsewhere. Thus even the most uncaring Henry Ford ought to care that phase two makes employees like their work.

Piecemeal application also causes problems for customers. If the billing function is taken over by a different program on a different computer from the order entry function, then it is tempting to have different people enter orders and manage billing. The person to whom you complain that you never ordered the clown nutcracker responds disdainfully that it is "in the computer." The checks and balances of the amazing human brain have been denied to the organization. *Quality,* the business buzzword just before *reengineering,* has not been served.

Piecemeal specialization also brings extra coordination. One large corporation has a special office to handle complex orders. There are seven databases. A customer's name and addresses often don't match. (T. K. Landauer, Tom Landauer, Thomas Landauer—a human knows they're all me.) The company employs order shepherds.

Fragmentation

Consider a large university. The accounting department computer has data on salaries paid and tuition bills due, the registrar's on courses and students, the personnel department's on faculty particulars. Is scholarship money going only to students who maintain a B average, who are not also employed by the university in high-paying jobs or getting faculty family benefits? To find out, you need to run all over campus, log into a computer in the administration building, another in the accounting department, and still another in the registrar's office. With luck, each one hands over a fat paper printout that has to be compared by eye and pencil.

This fragmentation happens not because someone is stupid or because management is on holiday but because it is an almost inevitable consequence of the way computer applications are, or at least have been, deployed. To get a system in place requires a whole battery of resources: funding, staff, space, management, techie stuff. Doing something compatible and good for even two different functions is probably four times as hard as for one.

Nonproductive Uses

A popular business case taught at Denver University's business school is about the demise of Colorado's once-proud Frontier Airline. The story runs that Frontier pioneered computerized reservation systems and used its IT effectively for internal accounting, route, and personnel management. United buried Frontier by using the information in its reservation system, Appollo, not just for efficient booking but to pry business away from its competitors. United made it easier for customers to book their own flights, searched out its competitor's best customers and offered them deals, analyzed everyone's usage patterns, and tuned their own routes, schedules, and fares to appeal to everyone's passengers.

To prepare for the writing of this chapter, I immersed myself in the management literature on the use of information systems. Innocently, I had assumed that the primary goal is to produce better goods and services at lower prices. But for every article that even mentions that aim, there are at least ten whose sole ambition is to tell how one company can take business away from another. A favorite example is American Hospital Supply, which beat its competitors to the punch by installing direct-order terminals in hospitals. The scheme gave the organization a kind of de facto monopoly but did nothing for productivity.

I find this style of advice especially puzzling. What is the point of telling everyone how to compete unproductively with everyone else?

The examples given earlier of successes in the telephone businesses point a better way. Could it be that the regulated monopoly telephone businesses, which by law could not be interested in taking business away from competitors, were better motivated to deploy computers productively? Under rate-of-return regulation, public utilities were told how much they could charge. The rates were set every, say, five years. Between rate settings, the companies keep increased profits from improved productivity. Thus, they were motivated to make their service workers' salary dollars and equipment purchase funds go further, and they did it.

Learning

OOPS, I MUST BE ON MY HOME MACHINE<NOW WHERE IS THAT "CAPS LOck," oh there it is!

My son-in-law, Tom, a high school special education teacher, wanted to produce a simple form to record student grades—a page with columns and dates. He thought his easy-to-use computer should be just the thing. But when he tried to print out the sheet of columns, they didn't line up. It seemed easy to fix so he tried again. At 1:00 A.M. he surrendered and did it by hand.

Fortunately there is somebody in his school to whom Tom can turn for computer help—Joe, the local computer guru. This unofficial job is found everywhere except in budgets and BLS statistics, usually performed by a computer amateur who is supposed to be doing something else. (I know

a world-famous statistician who has taken on this role. He spends most of his time writing useful small programs for his colleagues, leaving little for the intellectual pursuits for which he is famous.)

Computer systems are rarely easy to learn. An average engineer takes over nine months to be proficient on a CAD system. My graphic artist says she's still learning two years into her latest formatter. Because of equipment changeouts, job switches, and software improvements, most computer users learn a new system every few years. I'm on my *eighth* text editor. In the olden days, vast numbers of employees knew how to operate a standard typewriter that was the same everywhere. Not so anymore. The QWERTY keys are still in the same place. But where is the Enter key? Or do you use Return instead? Where is the Backspace key, or is it called Delete? People can't jump into each other's shoes and often can't advise each other. The cost of training and retraining is substantial. In today's constantly reorganizing firms, this friction is significant. And because systems change so fast, education can't help much.

Unintended Consequences.

My wife picked out a dress at Upscale Department Store and took it to the checkout. The item number made the terminal display "Belt $17.50." No cure was found; she had to take the dress at $17.50.

Remember the English supermarket chain that installed a state-of-the-art point-of-sale device? The intent was better inventory control, speedier check-out, fewer employees, a smaller car park. Throughput at checkout counters was improved, and more personnel were assigned to bagging, but none of the other expectations was fulfilled. Equipment maintainers and managers replaced the redundant stockers and markers. Inventory couldn't be improved because it was more efficient for suppliers to send mixed lot cartons and too much trouble to count in single products. Because produce requires memorized codes, operators often put courgettes in the customer's string bag unrung (Cutler and Rowe 1990).

Cost

While the price per megathing has plummeted, the cost of computing has oddly stayed nearly constant. An equivalent machine today costs a frac-

tion of what it did just ten years ago, but you couldn't buy one, and your employees wouldn't stand for it if you did. Instead you get one with ten times the flops and bytes at about the same price. The price of software has not dropped much either, partly *because* the hardware has become so much more powerful. It is now possible—and irresistible—to write very much bigger programs with many more features.

There are also disastrous expenses. The literature on computerization is filled with stories of companies that computerized at great expense, only to find that their system never got up, had terrific overruns, or didn't do what people wanted. A $4 billion transaction processing facility for Bank of America was much bigger than needed and too expensive to operate. The officer in charge resigned and the CEO retired. The system included a vast array of new services that customers didn't like.

And Back to Test-and-Fix

"The Tone for this chapter has been set succinctly in the internal memorandum of the International Center for Information Technologies: '. . . How to measure the business value of information technologies is one of the most difficult problems management faces in planning for computer investments. Information technology budgets have exploded over the last few years even if other cost elements are flat or even shrinking. . . . These conclusions are increasingly echoed by executives trying to deal with economic justification of computers. A 1986 survey of 71 chief executive officers from leading U.S. corporations considered information systems (IS) the most difficult corporate staff to manage and the most likely to increase in cost' " (Strassmann 1988).

Proponents of quality, such as Juran (1989) and Deming (1982) emphasize measurement and feedback. Juran's definition of quality, "fitness for use," is very close to what I mean by usefulness and usability. The urgings of this book could be fairly restated as a special case of the quality approach, the case of phase two computer applications.

All concerned believe that the sine qua non of progress in IT is better measurement of value. Strassmann, citing an IBM source, says that less than 20 percent of data processing costs are supported by business case analyses. The business cases, in turn, represent MIS justifications of new

computer costs, not analyses of what computers have been good for, where they have failed, and how to make them fitter for use.

Purchase justifications always include auspicious assumptions about outcomes, about work and process efficiency. Cases of successful applications are marshaled. In one how-to book (Meyer and Boone 1987), the authors report that an error was committed in preparing a proposal for a Defense Department allocation. The error was discovered using a spreadsheet program, saving $10 million. They claim the $150 program was worth 60,000 times its cost—but the same program was used to make the mistake.

What is missing here is a control group. The only way to be sure that technology has helped is to compare performance with and without it. This is neither as easy nor as hard as it might appear. It's deceptively easy if one just looks at a bottom line before and after. But business is never so simple. When systems are introduced, many other things usually change too, either intentionally or by chance, and people react with enthusiasm or resistance. To get beyond such problems, it's necessary to do the experiment several times in several places and to give the organization time to settle afterward before judging the outcome.

People often contend that controlled studies are impractical in real businesses, but this is just knee-jerk pessimism. Most changes are too expensive and difficult to do all at once in large organizations so are instituted one or two departments or branches at a time. Add to that appropriate measurement, and, if possible, pick which departments come earlier and later by rolling dice, and you've got it.[5]

I once participated in a marketing study done this way (Doob et al. 1969). We wanted to know whether low-price introductory offers lead to brand switching and lower total sales when the price goes up, as certain psychological theories predict. The CEO of a chain of discount stores let us pick half the outlets for this kind of promotion on a series of house-brand introductions—items like razor blades and cookies—leaving the other outlets to start them at the regular price. The result was clear proof that the low price offer *caused* lower sales in the long run, a question that had been fruitlessly argued ad nauseum before the experiment.

The study by Kraut, Dumais, and Koch (1989) of introducing automation in telephone company business offices was done the same way. It

produced much more reliable conclusions than anecdotes, individual case studies, guru impressions, and surveys of manager opinions ever can. The investigators were able to show that the particular automation actually caused increased output per hour, and, more important, to discover that there were other effects and determinants. For example, the new technology caused more work and headaches for managers in most offices and was associated with good or bad changes in quality of work life depending on whether the technology was used flexibly with employee input or according to rigid top-down rules.

Just what and how to measure are very important questions. Two slightly contradictory principles reign. The first is that what we really want to know is the overall result—the bottom line on dollars of stuff sold for hours of labor toiled. I call this end-to-end measurement. It's easy to measure the number of sheets of paper coming off the printers in word processing, the number of transactions handled by ATMs, or the number of service calls scheduled. But if, as often happens, the sheets of paper are minor revisions that don't really matter, the ATM transactions are for smaller amounts in addition to, not instead of teller activities, the service calls the result of new kinds of database errors, the good-looking results are mere mirage. We want to look instead at how much is brought in by the whole operation with how much effort, before and after.

But the second principle is that end-to-end quarterly bottom-line figures say almost nothing that will help improve purchase decisions and deployment methods. Deming complains that American managers are preoccupied with numbers about final results, to the exclusion of paying attention to the people and processes that produce them. The point is that two kinds of measurement are critical. Only end-to-end bottom-line figures can show whether the whole effort has succeeded, test whether apparent local improvements have synergised each other or have been thwarted, diluted, or frittered away. But only detailed measurements of component processes, and all the right component processes, can illuminate what's happening.

The difference is exactly the contrast we saw earlier between summative and formative evaluation in usability assessment. Summative evaluation determines whether the goal has been reached; formative evaluation tells what is going well and badly and informs the designer—here the

manager—about what to change. And just as in UCD for individual usability, in UCD for organizational deployment, close observation, both formal and informal, is the secret of turning evaluation into understanding and creativity.

In the Kraut, Dumais, and Koch studies, the summative evaluations of number of customers served showed overall success, at least of one kind. Simultaneous surveys of employees and managers, and observations and conversations, unearthed hypotheses about the management styles correlated with varying degrees of success and about the workarounds that effective employees used to improve the value of the technology. For example, where not forbidden, productive service reps subverted the system design by using fake customer records to pass notes to each other, thus overcoming a serious barrier to cooperation that the system had unwittingly imposed. Clearly the next release should provide a usable useful message facility, and supervisors should encourage its proper use.

The techniques for UCDeployment mirror those for UCDesign and UCDevelopment. Start with task analysis, then design, then try, then design again. The only difference is that the task analysis needs to be of the total task of the organization, or at least of complete functional groups, and the evaluations need to be observations of activities and measurements of their inputs and outputs, the fixes aimed at improving waste control, coordination and transfer as well individual efficiency. The process engineer or manager has to look closely at what people are doing and what is being produced, and exercise judgment about its value. The check on those judgments is the end-to-end evaluation.[6]

A New Scientific Management?

I am urging the application of the scientific method to business decisions—not the scientific management of Taylor but the more fundamental scientific method of controlled comparisons. In IT deployment we find ourselves in an arena where intuition and experience have proved poor guides. We have not done well at predicting the consequences of IT investments aimed at productivity. The way out is to improve our ability to know what works. The surest way to such discovery is the controlled

experiment, and the time has come to use it. We want not deep truths about physical nature but merely little practical truths about what helps people and organizations do better work faster. We're after engineering experiments like the ones the Wright brothers did by the hundreds, to see if new designs help us fly farther, but also, and more important, to garner observations of where they wobble or need better controls, so that the next attempts will be better.

V

What Then?