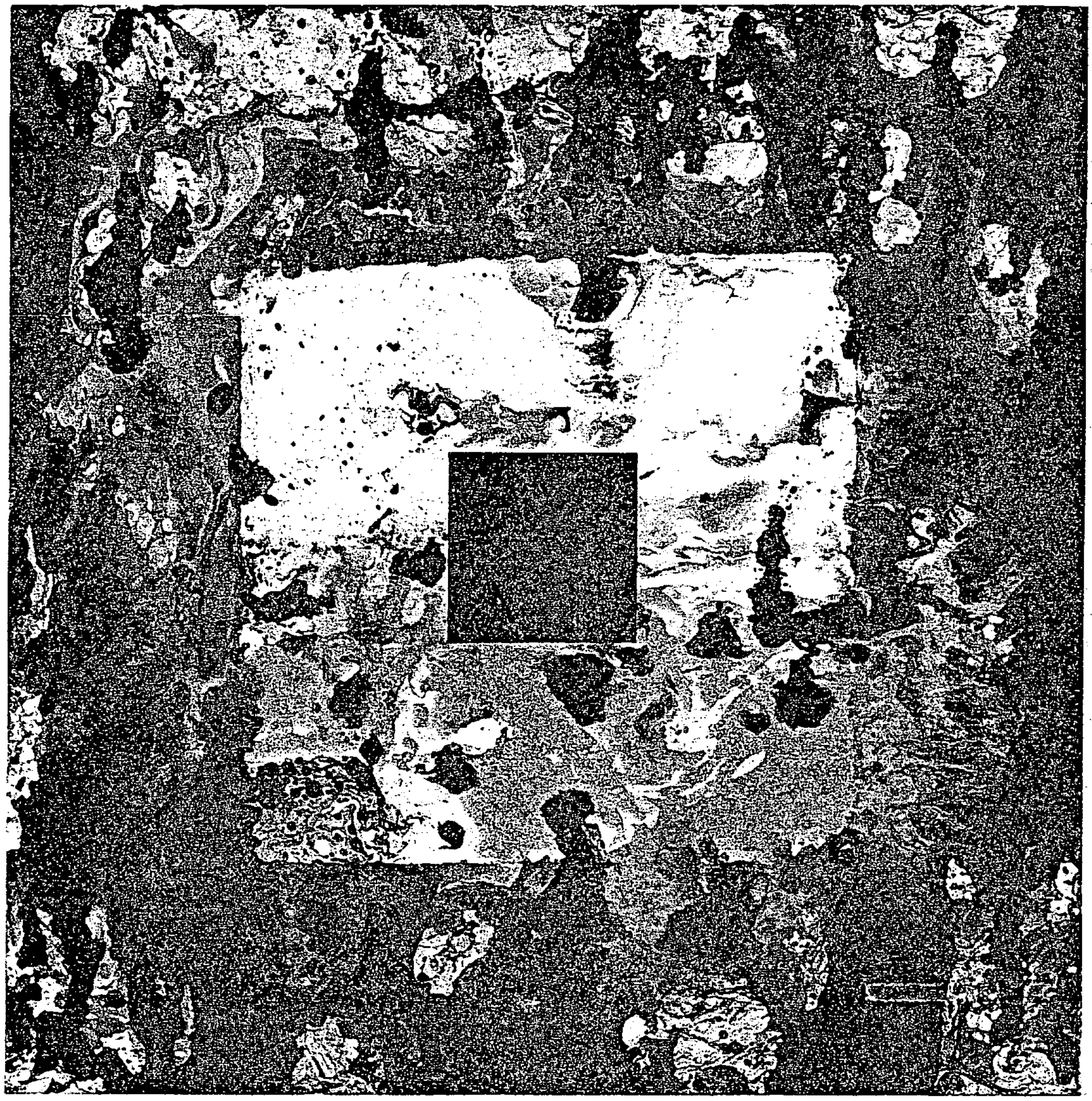

Stages of Growth

by Paul A. Strassmann

Information system projects should be chosen, and scheduled, to maximize positive cash flow. Today's best opportunities for doing that may lie outside the present scope of data processing, due to dp's relatively high level of maturity.

The idea that organizations, nations or cultures evolve through predeterminable stages of growth has attracted historians and scientists alike. Understanding the "stages of growth" is only second best to possessing the magnificent gift of prophecy, because it endows the individual who has such an insight with ability to anticipate what comes next.

"Stages of Growth" in information systems relate to the systematization of all new investments needed to improve the productivity of people engaged in information processing. To understand this evolution requires insights that stretch beyond computer technology. Telecommunications, word processing, administrative systems, decision systems are some of the classifications that may become useful in comparing experiences in diverse organizations, at comparable stages of development.

"S" is the shape of growth. The "S" curve can be used to apply to the origin and growth of anything. It reflects the outcome of the underlying structural conflicts and balance from the conception to the maturity of any phenomenon. It can be found to represent histories of societies (as expounded by Spengler to Toynbee), success patterns of organizations, market penetration patterns of products, as well as life cycles of technologies.

Though much effort is expended in describing the conditions that prevail during various phases of growth, the really worthwhile insights come from an examination of those elements that would allow us to explain the delicate relationships that drive the growth process and make it ultimately obsolete. We can try to describe the current status of our understanding of the computing environment, and its growth, as seen through various "stages" theories.

Nolan's four stages

The spokesman most articulate about the cyclical growth pattern in dp is Professor Richard L. Nolan from Harvard. Perhaps the best summary of Nolan's analysis is that the dp budget for a number of companies, when plotted over time from initial investment to mature operation, forms an S-shaped curve.

Based on this insight, Nolan proceeded to segment the growth history into four "stages" (Fig. 1), each with unique characteristics. For instance, it appears that many organizations have developed a pattern for growing applications as they move into more advanced stages of development. Similarly, increased personnel specialization can be found in organizations as they progress from functional simplicity to more complex forms of division of labor. Most importantly, a shift in management focus, control methodology and presumably the successful leadership personality type changes as costs escalate and the role of dp matures. (See Table 1.)

Withington's five stages

Ted Withington starts with the same objective as other "stage" theorists. He points out that "few executives have a clear picture of each of the generations of computerization and of the ways in which these succeed each other." However, if stage theory is applied, "such an overview . . . permits rational long range planning; management can plan for each generation with a clear idea of the goals it ought to be able to achieve . . . and how to prepare for transition to the next generation."*

Withington's view of the evolutionary process is that it is essentially technology-driven (see Table 2) and that rapid reductions in technology costs have the decisive impact on variables such as: new applications functions brought into the dp fold; and organizational structure for managing the dp environment with the resultant effect it has on organization structure.

Most of us today follow Withington's reasoning process treating technology as the dominant enabling factor that paces the rate at which computers enter into the life of an economy.

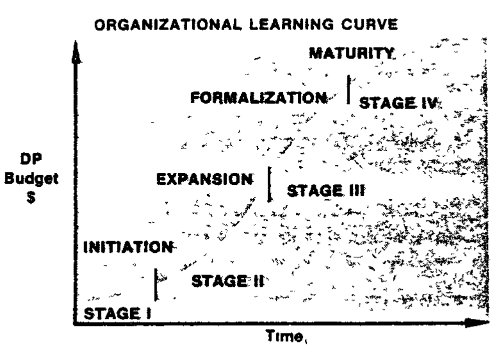

Fig. 1. The "S" curve can be used to depict the beginning, growth, and maturity of anything whatever, including dp budgets.

*For the sources of quotations and for details on points made by other authors, refer to the bibliography at the end of this article.

Limitations of stage theories

Many organizations are now entering Nolan's Stage IV or Withington's Stage V and must be experiencing some anxiety about what will follow. The basic "S" curve also seems to have different shapes depending on industry or geography. For instance, dp budgets for many government agencies are barely keeping up with inflation, and investment funds are not available. When viewed from a global standpoint, we also find some major anomalies in the stages of development. For instance, we can find Withington's "Stage III or IV" equipment engaged in execution of rudimentary applications.

Another peculiarity of the current environment comes from new opportunities for organizations to "jump" stages of development by acquiring sophisticated packaged applications either from computer service organizations or from minicomputer system contractors. Suddenly, the entire information processing scene has become open to quick leaps from "no experience" to advanced computer uses.

A difficulty in explaining observed phenomena leads to a re-examination of assumptions. We should be asking questions such as:

- Is the dp budget the most important variable to watch when tracking the growth of information systems?
- What happens after the data base phase becomes successfully assimilated?
- What makes the "S" curve of one

	APPLICATIONS		
STAGE I	STAGE II	STAGE III	STAGE IV
Cost Reduction-Accounting	Proliferation In All Functions	Emphasis On Control	Data Base Applications
Payroll Receivables Payables Billing	Cash Ledger Budgets Inventory Personnel Orders Sales Production	Project Control Scheduling Cost Analysis Chargeouts	Simulations Planning On-Line Inquiry On-Line Order Entry
	MANAGEMENT		
STAGE I	STAGE II	STAGE III	STAGE IV
Lax Management	Promotional Management	Control Management	Resources Management
In Accounting	In Finance Systems Analysis Decentralized	Independent Function Steering Committee	Independent Unit Systems & Programming Decentralized
Control Lacking	Lax Control Few Standards Informal Project Control	Standards Project Control Chargeouts; Audits; Operate Controls	Chargeouts Services Pricing Design Controls
Loose Budgets	Loose Budgets	Strong Budgets	Long-Range Planning
	PERSONNEL		
STAGE I	STAGE II	STAGE III	STAGE IV
General Specialization	Applications Specialization	Control Specialization	Data Base Specialization
Operator	Systems Programmer	Development Programmer	Data Base Programmer
Programmer	Scientific Programmer	Maintenance Programmer	Teleprocessing Programmer Operating Systems Programmer
Analyst	Business Programmer	Functional Analyst	Data Base Manager

Table 1.

	HARDWARE	FUNCTIONS	ORGANIZATION
Stage I	Vacuum tubes	Experimental Batch	Controller's Department
Stage II	Transistors	Full Range	Proliferation
Stage III	LSI	Networking RJE	Consolidation, with terminals
Stage IV	Large Files Satellite Computers	Integrated Files Transaction Processing	Satellite Processing
Stage V	Distributed Systems Exotic Memories	Private Information Simulation	Interconnected networks to all parts of organization

Table 2.

organization differ from that of another?

• What is the intrinsic driving mechanism that makes it possible for us to observe the end result in the form of "S" curves?

Make-up of growth curves

If one has held a job long enough to analyze the development of dp in a single organization over 10-20 years, he finds that budgetary increments that make up a firm's smooth "S" curve history are actually made up of a multitude of individual learning curves. (See Fig. 2.)

If projects are initiated in quick succession and completed successfully, dp budgets rise rapidly. *The aggregate curve levels off if the project initiation rate slows down.* As a matter of fact, if the innovation rate stops altogether, it is conceivable for the top of the "S" curve to decline as cost reduction activities made possible by a rapidly improving technology drive overall expenditures down.

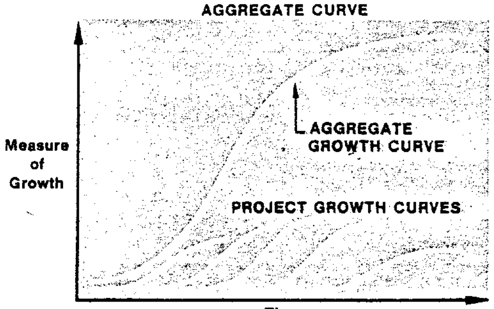

Fig. 2. The dp organizations budget curve is actually made up of a multitude of learning curves for individual projects. The aggregate curve levels off if the project initiation rate slows down.

The key to the analysis of the stages of growth in information systems lies then in a careful examination of individual events causing project authorization as well as the overall timing of successive projects.

Look at the cost curve generated by a typical computer project (Fig. 3). As a rule of thumb, the operating expense for a set of applications (including maintenance and enhancements) will equal or exceed the expenditure rates during development. Or, to put it another way, once an application is automated, it permanently adds to the fixed costs of the computerized (systematized) sector of an organization. Technology improvements do not subsequently contribute much to cost reductions without investing further development funds, since technology "locks in" costs by tying the application into a particular technology configuration.

Insofar as labor constitutes a major part of the cost anyway (it typically accounts for 50%-70% of any dp budget), inflation guarantees that the costs of all computer applications will grow with time. Watching the cost curves is therefore not the most significant fact in judging the speed with which an organization evolves through stages of growth. Project profitability—the cost/benefit ratios—are more likely to give us a cue about the desirability of new dp projects.

Project profitability

The shape as well as the ultimate size of an organization's "S" curve will be the result of several conflicting forces. Fig. 4 shows a characteristic pattern of cost/benefit relationships where the gain or loss is defined as the positive or negative cash flow as result of the computerization. Several rules can be gleaned from these relationships:

• Project development phase time should be short for an unstable environment. Otherwise expenses for maintenance and retrofits for enhancements defer the breakeven point until the project becomes uneconomical.

• Projects should be selected primarily on their capability to generate positive cash flow. New projects should not be funded until a substantial portion of old projects is successful, because a quick succession of new project starts would simply keep piling up negative cash flows.

• Technological uncertainty in dp project execution calls for a highly conservative approach to project selection. Since 100% overrun on development expense and 200% overruns on operating expense are not uncommon, return-on-investment targets well in excess of comparable capital budgeting targets are desirable. For instance, if a manufacturing corporation uses 20% return-on-investment as its minimum target for new equipment, its dp projects should have a minimum cutoff of 40%.

• High returns on investments become extremely sensitive to the realization of estimated benefits. To return ROIs in excess of 30%-40% before taxes requires very attractive targets of opportunity indeed. Consequently, benefits planning, benefits validation, and benefits assurance should receive the same, or perhaps more attention than systems planning, systems definition, and computer expense evaluation.

Characteristically, technical project planning and control should consume 5%-8% of total development costs. Clearly, we need to spend at least this much on the benefit side of the cost/-benefit equation.

We have now in our possession the concepts that permit us to answer new questions concerning the dynamics of a "stages" evolution in a specific organization:

1. Maturity in the introduction of computers occurs when the rate of innovation ceases.

2. The rate of innovation for information systems projects is defined by new projects having attractive cost/-benefit ratios. Insofar as technology succeeds in lowering the cost element of the ratio, it permits consideration of projects previously deemed unaffordable.

But technology alone does not dictate the stages of growth. All factors that have a bearing on a high project ROI (such as organizational capabilities, cost displacement opportunities, development risks, project sequencing, etc.) have equal or higher importance.

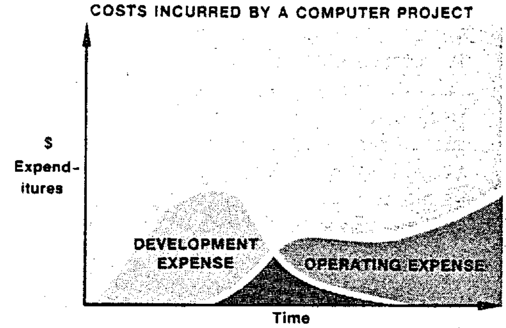

Fig. 3. The operating expense for a given computer application will generally equal or exceed the development expense. Operating costs become fixed costs, usually not much affected by technology developments.

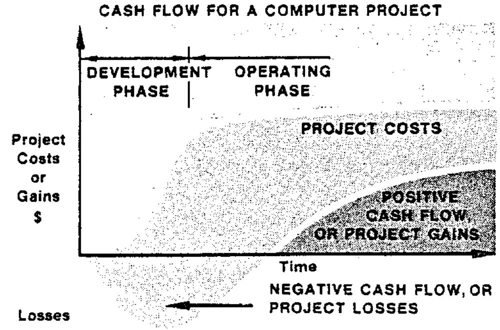

Fig. 4. In its development phase, a computer project results in a negative cash flow, naturally, which will hopefully become positive when it is operational. New projects should not be started until old ones are becoming successful, otherwise it is possible to keep piling up negative cash flows.

3. The overall strategy of project sequencing and thus assuring positive cash flows is of greatest importance. Otherwise the organization will not be willing to engage in innovation through successful office automation investments. Consequently, management control and planning to detect, propose and manage attractive cost/benefit ventures will dictate the shape of an "S"

curve in a specific situation.

4. The primary concern of the top information systems executive is management of ventures that improve organizational effectiveness and/or profitability.

5. The top information system executive cannot concentrate exclusively, as is currently the case, on just managing technology costs. His job is much bigger. To budget new project investments optimally, he must be able to help in setting investment priorities by giving greater attention to expected benefits.

6. With increased scarcity of capital—whether it is defined as investment in buildings, tools, R&D or systems—organizations must begin redefining the role of their top information systems executives primarily as capital venture managers.

With systems development budgets typically broken down in the 10%-30% range for development and 70%-90% for on-going expense, and with systems expenses in the range of 0.5%-1.5% of total revenue, systems development budgets frequently equal one-fourth to one-half of a company's R&D budget.

Money for innovation is scarce and therefore attracts top management attention. Also R&D or systems development investment share the common characteristic of having great leverage on on-going expenses or revenue. This is why the organizational characteristics of the information systems budgeting process change not as a function of technology, but as its importance to the investment management process becomes apparent.

Predicting

These new insights allow us to examine a broader range of realities than previously was the case. For instance, Nolan is much concerned about the "fifth stage" of development. Since we believe that any aggregate "S" curve can be composed of several subsidiary curves, what happens after Nolan's Stage IV can be drawn as a new and major technology venture consisting of projects in assimilating data base technology. (See Fig. 5).

Most important, the new "stages" analysis based on cost/benefit maximization, profitability and innovation permit us to define the shape of an "S" curve possible for a specific organization, within a defined geographic and planning context.

Simply put, the drawing up of office labor automation long range plans becomes the generator of a particular "S" curve. The "stages of growth" theory then becomes a planning aid, because it allows a long range planner to map against his own curves those insights that experience has proven out elsewhere.

What is most attractive, however, is the fact that the "stages of growth" analysis can provide a helping hand in probing the limits of what is realizable. For instance, the technology forecaster would tell us that firms will ultimately evolve toward "semi-automatic operating decisions, plans initiated by many individuals, systems capabilities projected to all parts of organization; interconnected networks; interactive languages; simulators, etc." Applying the cost/benefit maximization criteria to an individual situation may reveal that it is unlikely that payoff could be realized from such an approach and that a relatively rudimentary technology would suffice for a 5-10 year timeframe.

I believe that the "stages of growth" approach is especially relevant to the analysis of long range plans and strategies of organizations that have gradually arrived at the end of their dramatic growth experiences in dp. The flattening of their budget curves has been almost equally caused by a loss of justifiable new investment opportunities

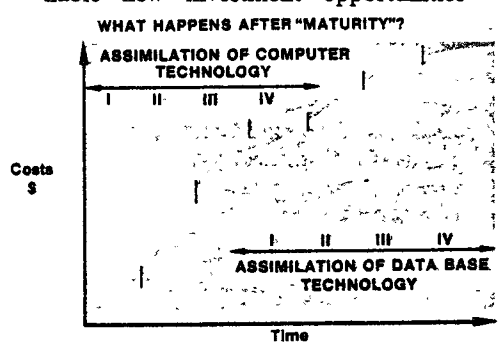

Fig. 5. What happens after an organization's "S" curve reaches its maturity level? That's when major developments in technology, such as data base technology now, can be expected to alter its shape.

and the increasingly stringent resources allocation processes in the last five years.

The lack of attractive new investment opportunities in productivity improvement applications is partially due to a narrow concept of dp missions and charters. When one views the extent of office automation, the rate of growth of the "white collar" sector in the economy, the increased complexity of information handling demanded by our society, and the high rate of inflation in labor rates while the cost of technology is dropping radically, it is hard to accept the idea that we have reached maturity in growth of office automation.

For example, an estimate of the costs of U.S. office expenditures for 1973 shows 84% of costs ($373 billion) spent on office labor, 10% ($42 billion) on administrative processing, and 6% ($26 billion) on dp. The extent of office automation is far from a saturation level since the average investment, per white collar worker, rarely exceeds $4,000 to $6,000. If we contrast this with capital investments needed per agricultural worker (about $50,000/capita) and factory worker (about $25,000/capital), we can quickly understand why the productivity for the agricultural and manufacturing sectors is so high (in the 6%-8% range, per annum, in real terms) while the productivity of our economy at large hovers within an unsatisfactory 2%-3% range.

The task of finding profitable and productive opportunities in information processing is not just a way of safeguarding job opportunities for computer people. It is an objective calling for national economic priority because our society is finding it increasingly desirable to migrate its labor force into information intensive occupations.

Redefining "Stages of Growth"

I suggest that the way to define "stages of growth" for any organization is to consider that organization's total information processing expenses, including clerical and administrative labor, as the base against which progress should be measured. The big divide is then that portion of the total information processing expense that is subject to systematized control, measurement, and management. If, for instance, an organization spends about 1% of its revenue for dp, this will show only a relatively small penetration into areas remaining "unsystematized."

As a rule of thumb I estimate that for every $1 of dp expense at Nolan's stage IV there will be an additional $5 falling into unsystematized activities, including the work of typists, secretaries, order entry clerks, administrators, switchboard operators, accounting analysts, budget specialists, file clerks, claims examiners, credit specialists, expediters, etc.

For typical organization we will then find coexistence of several technologies and of several investment opportunities simultaneously at various stages of development, where dp may be at Stage IV, telecommunications in Stage II, word processing in Stage II, and general administrative systems just beginning to emerge. This means that dp, as we define it today, is only one facet of the information processing environment and the overlapping dp are many other dimensions for tackling the overall problems of "white collar" productivity (Table 3, p. 50), at various stages of their respective "S" curve development.

The purpose here is not to dwell on

the attributes of the various "stages" that go beyond dp. It is important to note that I see great opportunities for improved cost/benefit performance in these new areas because of their latent potential originating from the fact that they have been largely neglected in the last 10-20 years when most energies were diverted to the glamor of dp. As increased understanding takes place concerning these opportunities, I can see how project development resources will be shifted where the potential is greatest.

To illustrate my point, I would like to show results from a test of several word processing installations using word processing equipment (Table 4). The financial results are really dramatic. The improvement ratios are certainly better than just about any dp project I have seen recently.

Before my colleagues in computer management abandon their dp projects and shift their personnel to word processing, I would like to warn them that success in this new field is hard to come by. Planning the human factors for successful word processing is of substantially greater complexity than just about anything encountered in dp except perhaps in large scale on-line terminal networks.

The issues are sociocultural—both on the part of the users as well as by the word processing operators. Word processing requires a reorientation of job attitudes, career path perceptions, status, work habits, measurements, accountability, and a redefinition of what is meant by secretarial services. In terms of organizational structure, the establishment of a network of word processing centers requires an approach that differs materially from the ways we implement computer projects. It is a challenge that I recommend for each information processing executive because it contains all of the elements of complexity that will be encountered someway as we move toward automated administrative systems.

Two remarks about attractive cost/-benefit opportunities outside of the conventional dp sectors: the involvement of the information systems executive in the telecommunications area. I consider the need for integrating telecommunications planning (voice, data, facsimile, administrative messages, teleconferencing) an absolute requirement for achieving any semblance of cost effectiveness. In most organizations we find telecommunications systems management broken down into small pockets of control, without any integrative planning. Advancing into future growth stages calls for identification of profitable new projects in this area.

With regard to "decision systems," the best we can say is that this discipline can be expected to improve the productivity of management personnel in the same way as administrative systems were targeted at improving the productivity of clercial and administrative staffs. The theory of what constitutes the "stages of growth" in this area is yet to be written.

Summary

The driving force behind evolutionary growth is profitable innovation—the ability to find new project investment ventures. For future growth in information systems, the executive will have to reach increasingly into more difficult areas requiring major changes in organization and in work relationships. In this environment attention to techology matters will not be as important as the ability to secure the benefits arising from automation. As advanced stages of growth are attained, the dp executive will be left to grapple with technology. His boss—the information systems executive—will manage the new opportunities leading to dramatic improvements in overall organizational performance.

FUNCTION	STAGE I	STAGE II	STAGE III	STAGE IV
DP	Cost Reduction	Proliferation	Control	Data Base
Telecommunications	Telephone Company Supplies	Interconnect Devices	Individual Networks	Integrated Switched Networks
Word Processing	Private Secretaries	Typing Pools	Word Processing	Text Management
Administrative Systems	Mechanization of Tasks	Machine-Aided Transactions	Work Redesign	Work Enlargement Computer Aided Instruction
Decision Systems	Analytic Generators	Planning Models	Interfunctional Simulation	Hierarchical Heuristic Models

Table 3.

BASIS	SALARY/PERSONNEL SAVINGS PRE-IMPLEMENTATION	CURRENT	CHANGE
Annual Salary Average Per Installation	$ 3,647,000 331,000	$2,804,000 255,000	−23%
Number of Employees Average Per Installation	264 24	203 18.5	
Annual Supply Budget	$ 203,000	142,000	−30%
Temporary/Contract Labor (Annual Budget)	$ 129,700	40,500	−68%
Output in Lines of Text/Month (For Five Installations Monitored)	$ 51,834	70,000	+35%

Table 4. Great potential for cost/benefit improvement now exists in areas outside of traditional data processing, largely because these were neglected for the past 10 to 20 years while energies were diverted to the glamor of dp.

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