WORKFLOW TECHNOLOGIES

Peter J. Denning
George Mason University

Raúl Medina-Mora
Action Technologies

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Eighty percent of the US economy is service work. During the past fifteen years, US service-sector organizations have invested over $1 trillion in information technology. Yet their productivity has been flat for most of that time with a small recent increase of 1.5% a year. In contrast, automation of the factory floor has fueled productivity gains exceeding 4% per year over the same period. Why is our return on investment so poor for information technology in service-sector work? What is different about the factory floor?

We will not find answers to these questions by focusing solely on either business or technology. Productivity comes from the *interaction* between the business and the technologies it uses, an interaction that depends heavily on language and on actions performed by humans and machines. Consequently, these questions will bring us simultaneously to theories of human coordination, definitions of work, and designs of systems. (Dertouzos, 1989; Drucker, 1993; Redenbaugh, 1994; Woronoff, 1994). From the older traditions of the factory floor we have inherited a mechanistic view of work that is fundamentally at odds with work in the office. On the factory floor, work appears to be the routing of assemblies and parts to stations where they are combined and manipulated; human beings appear as a kind of machine that carries out task steps. The central notions -- objects, routing, and processing -- are part of a machine-centered view of work that served us well for nearly a century. These notions are incapable of describing important human actions such as negotiation, fulfilling commitments, and satisfying customers.

The persistent inability to translate machine-centered notions into consistent service-productivity gains has motivated many people to question whether the traditional methods are sufficient for service work. A new industry -- the workflow industry -- was born around 1990 to investigate new methods and build new tools to assist people in observing, measuring, tracking, and completing their office work in the Age of the Internet. They hold annual conferences, give best-system awards, propose curricula, and work toward standards in their $2B industry.

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The term "workflow technologies" is being used for two categories of information technologies specifically designed to assist service work:

(1) *Information-Automation Technologies* are concerned with routing, tracking, storing, and processing forms, images, and documents.

(2) *Coordination Technologies* are concerned with recording roles and responsibilities, negotiating agreements, and helping workers track and complete mutual commitments.

In what follows, we focus our attention on the second category, which presents a human-centered view of work. Coordination theory is beginning to enrich industrial engineering with new maps, models, and methods that complement the older, machine-centric methods. The new methods have produced dramatic productivity gains in the office -- and on the factory floor. They are inspiring new approaches to designing distributed, client-server computing systems. They are adding a dimension that will enable service work to be both efficient and customer-satisfying.

Measuring Productivity

It is very important to start with an understanding of the sources of poor productivity. Productivity is best understood in the context of the business process. The question is how to design technology to resolve productivity breakdowns.

In late 1995 International Data Corporation reported a study stating that Windows 95 users were able to complete basic computing tasks 19% faster than Mac users and 50% faster than OS/2 users (*Investor's Business Daily*, 11/27/95). The tasks included printing files, managing documents and software programs, creating shortcuts, and customizing the desktop.

This study illustrates how we typically think about work and productivity in the office -- work consists of tasks, tasks process information, the chain of task steps produces the final result, and response time measures productivity. The human looks like a machine that follows a script of information-processing steps. It is very easy, therefore, to describe what has happened with a linear dataflow model.

Linear models appeared to work well in the mass-production factory -- until the Japanese invented a new manufacturing process (Ohno, 1988). The linear model fit the mass production assembly line because much of the work was repetitious and routine; work was not constantly reformulated and customized with each order. But the linear model has never worked well when used to automate modern office work.

There are three main reasons why the linear model has failed. The first reason concerns the value of work to the organization's customers. Treacy and Wiersma (1995) distinguish three basic approaches to generating value for customers: best product, best cost, and best service. Steps that look wasteful for one type of value may be essential for another -- for example, sending clients birthday greeting cards might be an essential ingredient of a family doctor's practice, but it would not work for Federal Express. Assessments of productivity must evaluate each element of the process by its contribution to the satisfaction of customers or by the value generated for them. The delay in completing a task may not be directly related to the value produced by that task for the customer.

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The second reason is that many complaints about dysfunctional, nonproductive work-groups focus on dissatis-fied customers, inability to deliver on time, lack of credibility, distrust, or poor morale. These are very real phenomena that lead to various kinds of waste -- such as missing performers, late deliv-ery, broken promises, useless work flows, complaints, conflicts, lack of records of commitments, and lack of motivation. These kinds of waste are not observable in the linear model. No work model will be successful unless it can deal with them.

The third reason is that much of what goes on in the work place is the negotiation and fulfillment of commitments among people. This is as true for internal customers (co-workers) as it is for external customers. As they fulfill their commitments, workers move objects, process information, and manipulate materials -- the actions observed and measured by the linear models. The linear models do not see negotiations and satisfaction of commitments, they see only the consequences observable in the material and digital worlds. No work model will be successful unless it can deal with the reality that service workers perform complex tasks in nonlinear webs of interaction and coordination.

Thus we can see that the common complaint "it takes 8 hours to accom-plish 15 minutes of actual work" tells little about productivity. This statement might characterize a successful dry-cleaner who promises your clothes back in the evening after morning drop-off; or it might characterize a failing copy shop. Similarly, the common sugges-tion to enter all information once into a shared data system, making it instantly available to anyone who needs it, may reduce transit time between work sta-tions but may not improve productivity.

A Better Map

In 1988, Konosuke Matsushita, chairman of the Matsushita Electric Company in Japan, was asked by an American journalist whether he thought Japan could beat the US. He replied: "We will win and you will lose. You cannot do anything about it because your failure is an internal disease. Your companies are based on Taylor's principles. Worse, your heads are Taylorized too. You firmly believe that sound management means executives on the one side and workers on the other, on the one side men who think and on the other side men who can only work. For you, management is the art of smoothly transferring the executive's idea to the worker's hands." Matsushita believed that the production model of Frederic Taylor was so deeply ingrained in the American mind that American managers were incapable of seeing why

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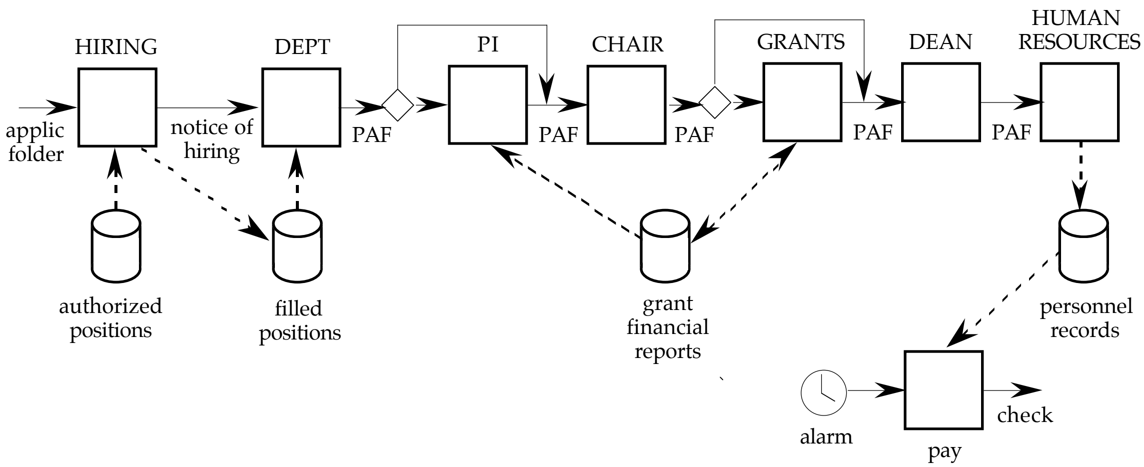

Figure 1. Flow network of a university personnel process shows processing nodes (boxes) transmitting data objects (forms) and storing or retrieving records from databases (cylinders). The state of a personnel action is specified by the station at which the personnel action form (PAF) is present. From this picture is appears that the supporting technologies include: (a) databases of forms and records, (b) client-server architectures to bring relevant portions of data to local work-groups, and (c) software to assist in the task at each station.

the Japanese production system was outperformed theirs. He was saying that all our efforts to make work more productive will be frustrated as long as we cling to the Taylor model as our mental map of work.

Let us illustrate with an example. The personnel action process at George Mason University has a dataflow diagram like that of Figure 1. Three dozen schools, departments, and institutes use this process to employ 850 faculty and 600 graduate students each year. All the personnel action forms (PAFs), which authorize appointments and salaries, are due on September 1. The Human Resources staff are faced with an impossible job in early September: updating over 1450 records by manually copying information from the PAFs into the database system. In fact, their work is not done until October or later. Some faculty or staff become outraged if they are not paid on time or are denied access campus facilities. To find the status of their cases, these individuals must phone each station on the approval chain and ask someone to check in the local PAF pile for their forms. In effect, no single performer was responsible for the individual to be paid; thus there was no sure way that the individual could be a satisfied customer of the personnel action process. The Human Resources staff reckoned that they spent half their time calming the angry, handling complaints, finding status, or entering data. They felt that most of this time was wasted because a proper data system would give status instantly and would not require data reentry. But whenever they tried to agree on the specifications for such a system, they got overwhelmed with its apparent complexity.

Our workflow group met with the HR staff for two three-hour sessions to help

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them construct a formal map of the overall process using the methods to be described shortly. We depicted all roles, performers, customers, commitments, and conditions of satisfaction. The group quickly made three discoveries: (1) no one on the HR staff had knowledge of the full process; (2) a number of transaction-loops had no performer either because PAFs went into an in-box over which no one had taken formal responsibility or because no manager had recognized that the transaction-loop existed at all; and (3) a number of transaction-loops were never being completed, usually because of lack of follow-up with the loop's customer. The first discovery showed them why they were having trouble reaching agreement on changes -- no two of them had the same mental picture of the process. The second and third discoveries enabled them to make immediate changes to remove certain persistent breakdowns. After they all agreed on the common view of the process, they were able to agree on the specifications for a prototype of a new client-server data system. This example illustrates dramatically how a formal business process map can help a group come to agreement on changes they want for their process.

So we have two tasks. One is to produce a map of how people organize their processes of work. The other is to design new tools and instruments, based on the new cartography, that will enable people to see work processes, support them with efficient information technology, track events, and (most importantly) measure the value they are delivering to their customers. What we seek in the end are new technologies that are useful for both office work and factory work. We want diagrams that show us all relevant aspects of the process, tell us what to measure, and lead us to accurate predictions. Then we can reengineer our processes and know that we will get the results we seek.

What is work?

It would seem that the varieties of work are as great at the variety of companies and workers. Consider construction office, doctor's office, bicycle shop, print shop, post office, bank, law firm, department store, auto assembly line, manufacturing line, university, multinational corporation.

Is there an order in the chaos? A deep structure, a simple set of basic patterns that characterize how people everywhere organize their work? Around 1900, Frederic Taylor gave an answer to this question with his theory and practice of "scientific management": the task of each factory worker is described by a precise procedure that can be optimized for minimum time or cost, and the set of all tasks on the line is planned and coordinated by managers. Taylor's methods were perfected by Henry Ford and eventually produced an age of enormous productivity gains for factory workers and enabled the US to win WWII (Drucker, 1993).

In the 1950s, computers were coming to be seen as business machines: engines powering international corporations. Herb Simon, and then Jay Forrester, extended Taylor's basic idea -- workers processing materials -- by suggesting that workers and managers process information. The job of a worker is to perform a well-defined function, the job of the manager is to decide on the series of best functions, and the job of an organization is to interconnect all the worker functions by information-transfer paths. An organization can thus be described and analyzed by a flow network of interconnected functions. If we interpret "function" to include either a material-processing task or an

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information-processing task, the flow network appears general enough to include factory work and knowledge work. For forty years, the flow-network model has appeared to be a reasonable view of the deep structure of work.

An impressive body of information-automating technologies has evolved around this view of work's structure: inventory systems, bar codes, assembly line monitoring, automated assembly lines, process dataflow maps, scheduling and planning systems, management information systems, decision-support systems, forms-management and tracking systems, image-scanning and display, file and document servers, database systems, desktop publishing, spreadsheets, client-server architectures. Sophisticated models have been developed for specifying projects by rules and functions, for general planning of projects, and for predicting plant response to external demands and for planning plant capacity; these include IDEF0, queueing networks, PERT and Gantt charts, and systems-dynamics networks. Until recently, virtually all the information technologies used in organizations are of these kinds.

But these technologies have made hardly a dent in the service-sector productivity problem. Matsushita would say that we followed the Taylor mentality when setting up office procedures and automating them with computers. The dynamics of the workplace call for a different model.

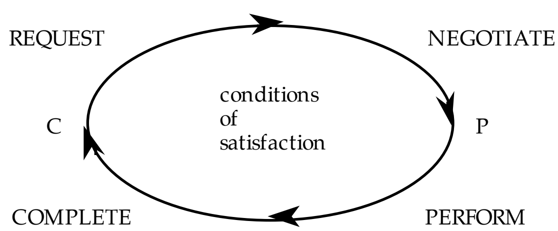

Figure 2. Basic one-on-one transaction is depicted as a loop connecting C (Customer = the person making a request) and P (Performer = person doing the task). The four segments denote time intervals culminating in an event marked by a speech act (arrow head). The loop's mutually agreed on conditions of satisfaction are fulfilled when C declares satisfaction with the performer's work.

The Key is Speech Acts

We can observe a simple, nonlinear form if we look at the temporal structure of human actions surrounding the performance of a function. We observe someone requesting the function to be performed and someone agreeing to perform the function. The requester and performer are usually different people. We also observe the performer notifying the requester when the function is done and the requester signifying his agreement that the request has been satisfied. These six patterns -- taking role as requester, taking role as performer, making a request, negotiating the terms, performing the function, and signing off on completion -- are always present. They make up the basic cycle of the one-on-one transaction, which underlies all work. The

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diagram of this cycle is called a workflow loop. It is shown in Figure 2.

The key is that each pattern is associated with a speech act -- a statement that performs the action it denotes. For the two-person loop, the acts are:

> Manager: "P is performer of role"
> Manager: "C is a customer of role"
> C: "I request"
> P: "I agree"
> P: "I am done"
> C: "I am satisfied"

Speech acts mark state transitions in the workflow. The exact language for each act will depend on the context -- for example, handing over an order form constitutes a purchase request, accepting the form is the agreement, handing over the item is the performer's completion, and the final "thank you" is the customer's completion.

The importance of speech acts is that they are observable. The observer can always tell when a work pattern is beginning or ending by listening for the definitive speech acts by the participants. The observer does not need to be human: it can be speech-recognizer or software that detects when a menu item is selected. Thus it is possible to build technologies for tracking and measuring the essentials of work at the level of human coordination.

The basic loop is just the beginning of the story. The person performing a loop may turn to another person for help, becoming that person's customer for a subtask. That third person may turn to a fourth, and so on, thus creating a web of loops encompassing all the people who work together to fulfill the original customer's request. If the web of loops is recurrent -- the participants do it over and over again -- it is called a business process. A business process depicts all the coordinations among the people who work to fulfill an organizational promise to an outside customer, while leaving open the possibility that each loop may have slightly different conditions of satisfaction depending on the customer's and performer's circumstances. The personnel process is mapped in Figure 3.

In addition to the patterns of the basic loop and of making a subsidiary request, other recurrent patterns appear in human organizations and can be identified by speech acts: making or accepting an offer; negotiating; canceling or revoking; recording a commitment for later enactment; reading a record; choosing among alternatives depending on a previous outcome; declaring roles, functions, and loops; using a machine or

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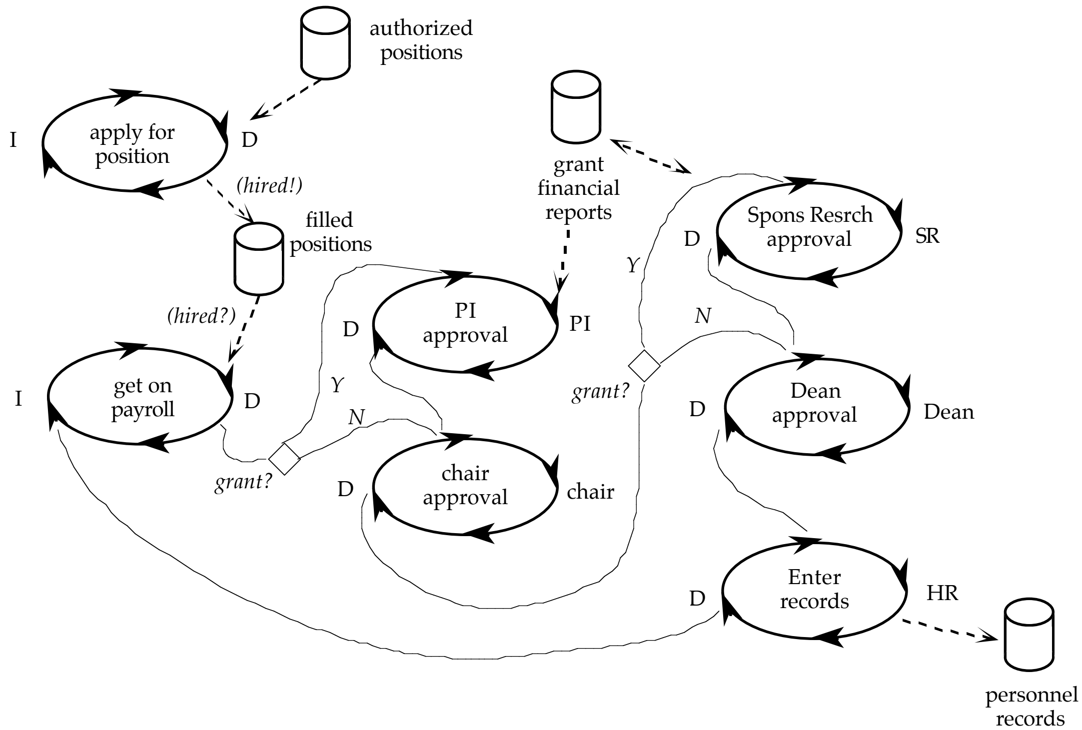

Figure 3. Personnel process is a web of commitments among the various roles in the organization such as the individual (I), the department (D), and a principal investigator (PI). Lines connecting loops represent requests for secondary tasks. Comparison with Figure 1 reveals that the function boxes, with their accesses to the databases, are embedded in the performance phases of the loops. The workflow process shows how tasks are negotiated and under what condition each customer (internal or external) is satisfied.

tool to perform a function; activating a machine; setting a trigger to activate a machine automatically. About three dozen patterns have been identified in actual work processes.

At first it might seem counterintuitive that a few dozen patterns would be sufficient to describe work processes in organizations as small as a corner store and as large as a multinational IBM. But the fact is that work is defined, in its essentials, by a few dozen patterns, all concerned with negotiating and satisfying mutual agreements. The same patterns can be combined in millions and millions of ways: the variety of organizations comes from the combinations, not from the patterns themselves. This phenomenon is like the periodic table: ninety-two elements and a few simple rules of combination generate the immense variety of materials we encounter every day. A similar phenomenon has been studied by architect Christopher Alexander (1979), who inventoried a total of 253 patterns that completely generate every known building, city, or region.

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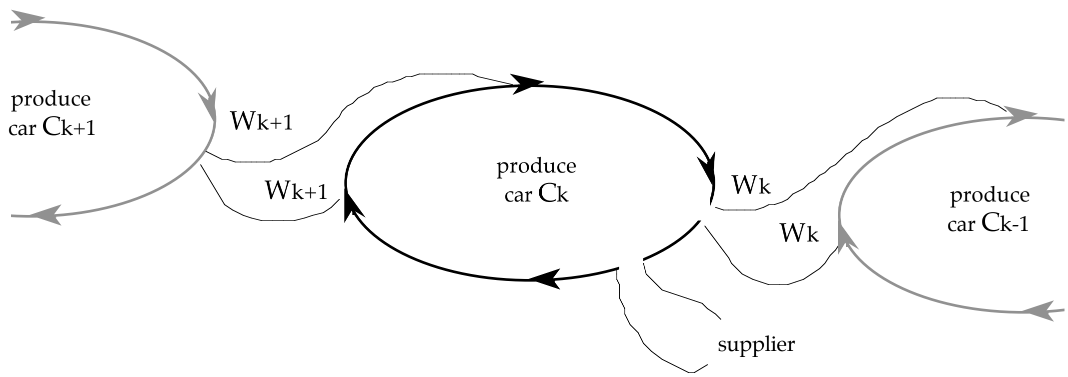

Figure 4. A workflow loop at stage k in a Toyota production line is designed to produce a car C_k that is "stage k complete". The worker W_k who performs this workflow accepts a request from worker W_{k+1}. Worker W_k then requests a car C_{k-1} from worker W_{k-1} and appropriate parts from suppliers; after installing the parts, worker W_k delivers the car to worker W_{k+1}, who accepts it only if it meets all specifications. The overall process is started when a customer requests a complete car. If the loop times are known, suppliers can deliver the parts just-in-time and there are few inventories on the factory floor.

The two insights -- that work is coordination to negotiate and satisfy mutual agreements and that speech acts can be used to observe state-changing events -- were first made by Fernando Flores in 1979. Winograd and Flores elaborated them for the design of an electronic mail system, The Coordinator, that would group messages into conversations and track each one for movement through the four states of the basic loop (1987).

The workflow loop explains the "secret" of the famed Japanese production system, first used by Toyota car company (Ohno, 1988). As shown in Figure 4, each stage of the line consists of a loop in which a worker negotiates with neighbors for parts and for partially completed cars. This has three powerful advantages: (a) Because the external customer's request is propagated up the line and forms the conditions of satisfaction at each stage, each car can be slightly different. (b) A worker who spots a defect can refuse to accept the car at his stage, stopping the line until the defect is corrected; this significantly improves quality and eliminates much of the waste of after-the-fact inspections and subsequent disassembly to correct defects. (c) Every worker sees himself as part of a single process that delivers quality cars to external customers: any miscoordination caused by that worker propagates up the line, adversely affect-ing all other workers and the external customer. The improvements of quality and customer satisfaction, and the reduc-tion in waste, from designing the process in this way enabled the Japanese auto manufacturers to outperform US auto makers significantly for many years.

Ohno did not design his production system with workflow loops in mind. The workflow loops are our interpretation that allows us to see to the heart of the

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Toyota system; they enable us to extract the patterns of coordination and appropriate them into many other organizations in other countries with different cultures.

In today's business terminology, we would say that organizations embody three kinds of processes -- material, information, and coordination -- corresponding respectively to the theories of Taylor, Simon-Forrester, and Flores-Winograd. The traditional methods of industrial engineering were first formulated for material processes and later extended for information processes. Coordination processes are a new model; they are a higher level of abstraction because actions in the coordination process drive the information and material processes. The Toyota production system shows us that the new level of abstraction gives a qualitative improvement in productivity by reducing miscoordination.

The coordination process model satisfies the three criteria for a nonlinear model of work: (1) the types of value being generated are stated explicitly in the conditions of satisfaction associated with each loop and with the entire process; (2) the breakdowns in coordination that pro-duce mistrust, poor reputation, and low morale are explicit and can be acted on; and (3) process maps explicitly show the dynamics of negotiation, and complex tasks can be elaborated into subprocesses at whatever level of detail is needed.

The Power of Process Maps

Groups that have tried workflow mapping have achieved dramatic improvements in productivity. Here are more examples:

(1) The George Mason University human resources staff implemented process changes to eliminate incomplete loops and provide missing performers. Within a few months they reduced the level of complaints without introducing new technology.

(2) The San Francisco office of Young & Rubicam, an advertising agency, was losing business because of customer complaints about late or lost work and budget overruns. They mapped their process of project traffic control and then configured the Action Workflow Manager for Lotus Notes to help them track and measure their process. Within three months, they reduced total overtime by 50 percent and re-do's arising from miscoordination by 64%. They increased jobs completed on time by 63% and jobs completed within budget by 19%. Their customers and employees reported much higher levels of satisfaction.

(3) The IBM Personal Computer Company in Austin, Texas, addressed complaints about sluggish engineering changes by mapping and then improving their engineering-change process. They reduced cycle times to about one-third of their old values -- e.g., from 25 days to 7 days.

(4) Bankers Trust was unable to respond rapidly to inquiries from large investors about possible errors in their portfolios. To find out why, they mapped the process for handling inquiries from those customers. When they used the Action Workflow System with Lotus Notes to manage that process, they reduced cycle time from an average of five days to an average of one, with a reduction of staff by one-third.

(5) Tandy Electronics in Dallas, Texas, was tired of missing project deadlines and failing to satisfy customers. They had

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about 70 new projects each year, each involving up to 300 action items. Within three months after they mapped their process and installed a workflow management system in Lotus Notes, they improved the process productivity by 10%, and they recovered the costs of the workflow project within a few months.

(6) The Business Licenses Department of Clark Country, Nevada, manages 72,000 applications and renewals in 360 categories of licenses each year in the Las Vegas area. Motivated by a large number of complaints about excessive delays to issue licenses, they mapped their process and they discovered (and eliminated) 400 bottlenecks. They reduced the issuing time for a general license from 90-120 days to 45 days.

(7) The Continental Rehabilitation Hospital in San Diego, California, evaluates patients with up to 15 tests involving up to 30 doctors. Being concerned about deteriorating relationships with patients, who thought that the average evaluation time of three months was excessive, they mapped their process and, after building a workflow manager in Lotus Notes, they reduced the average processing time to three weeks.

(8) Babson College in Wellesley, Massachusetts, undertook one of the most ambitious reengineering projects to date that has used workflow mapping as the starting point. They aspire to treat their students as customers who come to obtain the most advanced business education in the nation. To accomplish this without raising tuition, they needed to reduce administrative costs by 40% and transfer the savings (over $2M annually) into curriculum and student advising. They began their reengineering effort with detailed workflow maps of every administrative process in the college, including new processes they needed to create. They used the maps to specify a client-server computing system to coordinate and manage the new processes. They expect to complete the project with all goals attained by mid 1996. They claim that without the workflow maps they would not have been able to deal with the complexities of all the processes and would not have been able to get all the coordinations right. They say that they will be able to reconfigure any processes quickly since all the process specifications are stored in an SQL database. (Kesner 1995)

The common thread in all these cases is that each organization, motivated by a customer satisfaction problem, mapped their business processes and then used a workflow manager system to coordinate the clients and servers that managed and tracked the processes in action, In all cases, they saw dramatic improvements in productivity -- 10% to 60% -- within a few months. Compare this with the 0-1.5% improvements seen per year by installing existing information technologies in service organizations.

These examples also suggest that the group exercise of drawing the map can serve as a bottom-up (grassroots) approach to process reengineering. Coworkers want to do the best job possible; the map shows them how to go about it. The top-down, command-and-control approach advocated by Hammer and Champy (1993) is not the only way.

From Maps to Methods

The success stories of the groups who have begun their reengineering effort with a workflow map demonstrate the power of the method and make the construction of tools to support the method an attractive investment. Five

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kinds of tools exist and are the subjects of ongoing research and development:

(1) Mapping tools allow one to draw pictures of work processes. They directly support the "syntax" of the workflow processes and can report errors in the loops or their interconnections. The maps can be used to reveal breakdowns in an existing work process (and thus remove them), to define a new work process and the responsibilities of people participating in it, and to facilitate group agreements on process changes.

(2) Tracking tools record events corresponding to speech acts (state-changes) in work processes. They can be used to determine the status of a particular case or order in the system, to report on the state of the whole system, and to locate delayed loops. They can also be used to record copies of forms and other documents used in the work process -- i.e., they connect to information-automation systems.

(3) Measuring tools define metrics relative to workflows, collect data, and make reports. Measures include loop cycle time, process cycle time, loop congestion, rate of satisfactory completions, and total expenditure (added value) to complete a customer request.

(4) Modeling tools make formal models of the work process and use them to predict performance measures in future systems. They enable analysts to forecast how much improvement will be obtained from a process change.

(5) Application tools assist performers in carrying out specific tasks such as e-mail, accounting, or scheduling; these tools must be "workflow-enabled", meaning that they recognize relevant speech acts and notify the tracker system that a state-change in a workflow has occurred.

In the current state of the art of client-server systems, the problem of selecting and integrating these tools can be daunting. How many databases are needed? How do they cross-couple? How do they maintain consistency? What functions will various performers want to perform on digital objects they work with? What e-mail system should be used? What are the best application packages? What processes are being supported and how do they coordinate? Workflow mapping is proving to be a useful starting point for the implementer faced with such questions. Sheth (1995) believes that workflow in fact may be a new paradigm for distributed computing, a "glue" for "legacy" systems and a framework for supporting migration of data to new systems.

Beginning the middle 1960s, a series of experimental studies showed that queueing networks were good models for throughput and response time of computer systems. Designers and analysts began to draw diagrams of computer systems in the notation, helping them to discover the bottlenecks, instrument their systems, and determine server capacities required for the stated performance objectives. Beginning in 1971, analysts introduced a line of simple, fast algorithms for calculating the throughput and response time of queueing models. Today those models are standard tools used by engineers designing distributed, client-server systems that meet stated performance objectives.

The same process of evolution is underway now with respect to workflow technologies. We have a notation -- the workflow map -- that is the analog of the queueing network diagram. Service breakdowns are analogous to queueing bottlenecks; productivity is analogous to

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response-time performance. The notation is helping its users see service breakdowns and measure productivity. Soon there will be reliable analytic models that permit forecasting the performance of organizational processes after changes are made in them. Within a decade, these tools may be as standard in the design of client-server systems as today's queueing network tools.

Many of these tools and systems already exist in their first generation forms -- for example, Lotus Notes, Microsoft Exchange, the Windows 95 client, Novell's GroupWise, Action Technologies' ActionWorkflow systems for Lotus Notes and SQL databases, and Action Technologies' Metro system for the World-Wide Web. Microsoft believes it is essential to include workgroup support in future operating systems (Vaskevitch, 1994). Workflow support is likely to migrate into the design of all operating systems by the end of the decade, representing a major paradigm shift (Denning, 1994).

The Coming Generation of Tools

The tools outlined above are only the beginning of what the workflow revolution is likely to bring. Workflow technologies do more than allow people to observe the speech acts marking important state-changes in their work processes. They make the customer (a human being) central to the work process. For this reason they will unleash the creative abilities of workers, who take delight in inventing ways to satisfy the wants and needs of their coworkers and external customers. These technologies, moreover, remind us that work, including manufacturing, is ultimately about people.

Total Quality Management (TQM) and Business Process Reengineering (BPR), which are also concerned with coordination, have inconsistent success because they have not identified the essential patterns making up all coordination, and thus they cannot systematically avoid miscoordination. In the past decade, there has been a shift in the common sense of organizations: customer satisfaction is the metric for quality rather than zero-defect products. Customer satisfaction is directly linked to making commitments and delivering on them. Noting that Hammer and Champy (1993) report that 70% of BPR efforts fail, Redenbaugh (1994) says that TQM and BPR are not likely to attain high success levels until they include rigorous methods of addressing all patterns of successful coordination and customer satisfaction.

Workflow technologies are most likely to succeed in organizations that already have, or are willing to cultivate, a culture of honoring commitments to customers. Simply installing workflow technologies is not enough. Managers and executives will have to foster a culture of effective coordination -- then the workflow tools will show up as aids to a new, more satisfying and effective way to do business.

A new era of productivity is about to dawn, aided by technologies inspired by a new interpretation of work in which language acts generate action. This is the key to making human interactions measurable. Workflow technologies focus on effective coordination among humans, and between humans and machines, rather than on information or material automation. They directly measure satisfactorily completed commitments. They enable the detection and elimination of the waste that impedes service-sector productivity. They are founded in a new common sense that sees organizations as people engaged in nonlinear networks of

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commitments leading to customer satisfaction.

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