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ABSTRACT

International Business Machines Corporation's (IBM) efforts to develop a corporate culture are associated with its founder, Thomas J. Watson, Sr. From the start of his association with the company in 1914, the importance of education was stressed. The expansion of the education and training organization paralleled IBM's 75-year growth. In January 1988, IBM created a corporate office of education with a director of education who has worldwide responsibility. IBM's education strategy has the following structure: key jobs are identified; training is aligned with jobs; a common course catalog and curricular roadmaps provide guidance for individual development and skills planning; quality processes and measurements are identified; and career paths provide for professional growth and continuity of educational staff. Benefits from the application of technology to training help explain the two major motives for using it--to raise quality and contain costs. IBM has researched and developed individualized and group or classroom-based learning systems. IBM's external relationships include IBM staff development programs at universities, seed grants to universities for new curricula, and partnerships with public education. IBM has developments underway that will strengthen and support strategic shifts IBM has already taken. IBM is attempting to meet the mandate for these economic times--to have a highly trained and flexible work force able to compete in a global economy. (YLB)

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TRAINING IN THE WORKPLACE:
A N IBM CASE STUDY

Contract Report

Submitted to the Office of Technology Assessment by

Dr. Ralph E. Grubb
Academy for Educational Development
February 1990

This contract report was prepared to be used as background material for the assessment on Worker Training.

The assessment entitled, "Worker Training: Competing in the New International Economy," was released in September 1990.

All opinions in this report are those of the authors and do not represent the views of the Office of Technology Assessment, U.S. Congress

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The Shaping of IBM and a Corporate Culture

It is 1989 and the 75th anniversary of what is now the International Business Machines Corporation (IBM). How did IBM's predecessor, the Computing-Tabulating-Recording Company (C-T-R), a holding company for three manufacturers of tabulating equipment, scales and time clocks, grow into the world's most profitable ($5.49 billion) corporation? Years later, Thomas J. Watson's son, Tom Jr., would answer that question by stating ". . . the real difference between success and failure in a corporation can very often be traced to . . . how well the organization brings out the energies and great talents of its people. What does it do to help these people find common cause with each other? How does it keep them pointed in the right direction despite the many rivalries and differences which may exist among them?" IBM's efforts to develop this common cause or *corporate culture* is associated with its founder, Thomas J. Watson, Sr., who more than anyone else, shaped the company's early history.

Watson Sr. started his career at National Cash Register (NCR) which manufactured and marketed cash registers. In the late 1800's, NCR's goods were marketed by travelling *drummers*, salesmen who sold their goods off horse-drawn wagons. Apparently, none of the drummers was successful except one salesman who consistently succeeded where the others failed. NCR's founder, John Patterson, began travelling with this successful salesman, taking notes and analyzing the winning sales "pitch." He then set up a sales school and required each drummer to memorize the pitch and kept statistics on their performance.

This program became the cornerstone of Watson's education program at NCR. Eventually, Watson and Patterson had an argument over sales policy, and Watson was fired.

The Emergence of IBM

When Watson joined C-T-R in 1914, the company was debt ridden and Watson himself under a cloud of suspicion as the result of a bitter antitrust case against NCR.[1] It is not surprising that early sales conventions stressed the need for ethical business conduct in all aspects of the business.

Watson also stressed the importance of education. His first major education lecture later became known as "The Man Proposition," delivered by C-T-R's new president to an audience of 235 field and factory employees. Mr. Watson presented the proposition in simple terms. With a piece of chalk he wrote in large words, like rungs on a ladder, the following terms:

The manufacturers
General manager
Sales Manager
Sales man
Service man
Factory manager
Factory man
Office manager
Office man

He then drew a line through all but three letters in each line. These three letters spelled *man*.

[1]On March 13 1915, the Appeals Court set aside the District Court verdict and the case was never retried. On March 15th, C-T-R's Board of Directors elected Mr. Watson President and General Manager.

This is the formula for success, he explained. Everyone works toward a common goal, the development of the *man*, and the company, in turn, grows. *And this development can be achieved only by education*, he concluded.

So education became a key word in Watson's new business environment. The memorized sales pitches from the Patterson era were put aside. Growth was charted in terms of the individual and his job. As early as 1916, a Manager of Education was named.

In February of that year, a one-month study session for salesmen in the Tabulating Machine Division was initiated. Sixteen men were enrolled in what was called the *first school*. Weeks later another group of 14 students was launching a study course in time recording machines. The subsequently abandoned Scale Division also joined the education movement with a school for junior salesmen.

Two years later, a group of executives convened in New York for a one-week training session, and in 1920 this management training program was installed on a permanent basis. " At the center of IBM management practice," Watson went on to say, "is the idea that the manager is primarily a teacher. He must first be an 'assistant' to the members of his department. The manager as 'policeman-supervisor' is subordinated to the manager as 'teacher and assistant' to his people."

Next, Mr. Watson saw the need to train the people on the firing line of manufacturing--the factory supervisors and foremen. These men were more than supervisors, said the president, they were executives--the manufacturers.

In 1924 Watson changed the bulky hyphenated company name to *International Business Machines*, partly to reflect the international scope of the business as well as its trimmer product line. More substantive educational changes were in the wind as well. For example, the first real initiative into customer operator training was accomplished. While customer education would not take hold fully until 1934-5, when General Electric asked to enroll 50 of its people in machine sales school, this would subsequently become one of IBM's newest educational services.

In 1927, a formal program of sales and service instruction was created at Endicott, which was attended by 140 students. The following year a major area of job training was born--a 16-week course in Customer Engineering. This growing commitment to education was underscored in Watson's remarks to the Princeton School of Engineering in 1928, "There is no saturation point in education if you follow sound principles, and you must apply this motto to business."

Just as the Depression was looming, Watson was expanding. By borrowing money, he kept his workforce fully employed and producing products that went into inventory. While this was a potentially dangerous move, the risk paid off handsomely and positioned the Company to land its largest contract. In 1935, Congress passed the Social Security Act, and IBM was awarded the biggest recordkeeping operation of the time. This lucrative contract turned the financial tide and vindicated two of Watson's boldest policies--that one could develop people through the most severe financial times and keep them fully employed. These traditions, still practiced a half century later, set IBM apart from many other companies.

During the same period (1931), IBM named its first Director of Education, Professor T. H. Brown, of Harvard University. He provided the guidance for course development, adopted enriched teaching methods, such as case studies, and employed a number of aptitude tests and personality inventories to aid in personnel selection.

Two years later, IBM built its first school at Endicott, New York. At the dedication ceremony, Watson stated, "Progress in business today depends on education." Since the school was erected at the same time as the site laboratory, he went on to remark, "These two buildings go hand in hand. They are *both* educational institutions. They represent the heart of our business."

Apprentice programs were also initiated for tool makers. Upon successful completion of the 3 year program, graduates received certificates both from Associated Industries and IBM. During those 3 years, students rotated between departments and also attended a local high school one afternoon a week for further study in mathematics and drafting. Another phase of the program included stocking the sales offices and factories with suitable reference library books, trade journals and other publications.

Watson advocated the then revolutionary program of "job enlargement," which reversed the general industrial trend toward narrower and more repetitive work assignments. He personally endorsed a program where operators would expand their jobs to include responsibility for machine set-up and work quality.

During the remainder of the 1930's, a number of improvements were made in IBM's educational programs. An association with Dr. Ben Wood of Columbia University, however, was unique. Wood requested help in analyzing the mountains of data involved in predicting student achievement; Watson donated truckloads of sorters, tabulating equipment, card punchers and counters to streamline the task. This relationship was fruitful beyond expectations and lasted for more than 20 years. As a result, dramatic improvements were made in machine design and speed, mechanized test scoring was developed, and pioneering work in instructional systems with young children was initiated. Parallel work at Columbia University with Watson's equipment resulted in greatly improved nautical almanacs that were invaluable to the Allies as they sought to reclaim the North Atlantic sea lanes during World War II. This work was formalized as the Watson Scientific Computing Laboratory at Columbia University and became an early model for later university/business partnerships.

The New Environment

Watson's development work with Professor Howard Aiken on the *Automatic Sequence Controlled Calculator (ASCC)* at Harvard provided IBM in 1944 with the prototype of its first computer. The first model, *Mark I*, weighed in at several tons, measured 51 feet by 8 feet and operated at the blinding speed of 3 calculations per second.

Meanwhile, Professors J. Prosper Eckert and John Mauchly at the University of Pennsylvania were busy working on their own computer, *Electronic Numerical Integrator and Calculator (ENIAC)* with support from the U. S. Army. They used vacuum tube technology instead of mechanical relays, as in the *Mark I*. When they left the University and commercialized the product as *UNIVAC*, the more advanced product started replacing the old mechanical IBM machines in the Census Department. Until then, Watson admitted, he had not seen much potential in the *Mark I*; but now he was face to face with competition. This forced the Company to reevaluate its business strategy and send the workforce back to school to make the transition from electro-mechanical to electronic technology.

An equally important transformation was taking place in American business. Rapid expansion following World War II caused many companies to decentralize, following the model of General Motors. Under Thomas J. Watson, Jr., who became the new CEO at IBM in 1956 near the time of his father's death, the Company was divided into divisions. Multiple plants were created, each with a mission for a major component in the product line. Operationally, a computer system would not physically come together until it reached the customer's office. Clearly, both education and manufacturing processes would have to reflect this change. While technical education could be mapped into this new environment, management education remained centralized for consistency in policies and procedures across the Corporation.

In order to expand the customer education program, 21 branch offices were selected to become education centers. Residential customer executive education centers were also created in Poughkeepsie, New York and San Jose, California. Outcompany education programs were expanded in 1959 with the creation of a resident graduate study program for doctoral students and the tuition refund program for all employees.

The single largest product announcement in IBM's history was made in 1964--*System/360*, an integrated family of computers but incompatible with other IBM models. This resulted in one of the most massive education programs in IBM history, both for customers and employees. To add to the difficulty, universities did not yet have computer science programs necessary to build a trained user base. In anticipation of this training shortfall, IBM created in 1961 the Systems Research Institute in New York City. This was a residential 13-week program designed to develop employees with the skills to be Systems Engineers. Later, the program would be certified by the State University of New York at Binghamton and one-half of a master's degree would be awarded to qualified IBM graduates. The Institute would also expand to include strategic programs in manufacturing technology, software engineering, and quality. The 1960's were also a time for the emergence of instructional technology in IBM. That story will be told separately in Chapter #4.

This was a period of very rapid growth for IBM. In the years between 1957, IBM's first billion-dollar year, and 1961, the Corporation's sales grew to $2 billion. In 1964, sales exceeded $3 billion. Two years later, the total rose to $4.25 billion. In 1968 the figure approached $7 billion. Thus, in little more than a decade, IBM sales were 8.5 times greater than the sales volume in its first 42 years.

During this era, the international arm of IBM, the World Trade Corporation, grew under the direction of Arthur K. Watson. By 1971 it accounted for almost one-half the revenues to the Company. In 1975, World Trade also built IBM's largest and most modern education center at La Hulpe, Belgium.

In commenting on this corporate growth, Tom Jr. stated that one of the major lessons that IBM learned from its years in business was the importance of fundamental beliefs. He went on to state these beliefs as: respect for the individual; best possible customer service; and pursuit of excellence. These beliefs have served IBM well--both in business and education. Essentially, they have institutionalized the philosophy and actions of IBM's founder and hero and preserved them in a way that both provides continuity with the past but yet serves as the basis for fresh interpretation for the needs of the future. Perhaps the real secret lies in building a corporate culture that pays close attention to its employees--their growth and development--as the ultimate strategic resource. Thomas J. Watson, Sr. once remarked, "You can take my factories . . . you can burn my buildings to the ground . . . but give me my people, and I'll start this business right back up again."

The Education and Training Organization

The expansion of the education and training organization paralleled the Company's spectacular 75-year growth. By the late 1980's, the education function was creating 5 million student days of instruction a year--approximately 4 million consisting of employee education while the other 1 million was made up of customer education. This meant that in an organization made up of more than 390,000 employees scattered among 134 countries, 18,000 IBMers were in training every day. In the aggregate, this was roughly equivalent to running a medium-sized state university, but with the added problem of being distributed world-wide. An education resource of 7,000 employees and an inventory of more than 100 education centers was needed to carry out the program.

During this period, the Company was continuing to decentralize. Most lab and plant sites had a resident vice-president to make timely business decisions. Consequently, each division and operating unit was responsible for its own education programs. This resulted in 15 different directors of education, each reporting to local management. The Corporate Director of Education's position had been eliminated, with the only central focus remaining with new manager, executive and upper-level management education. This program was under the control of the Director of Management Development, who was staff to the Vice-President of Personnel. Simultaneously, some of the divisions were also utilizing alternative delivery systems, such as computer-assisted instruction (CAI) and satellite-based television. The decentralized environment made the technology transfer and economies of scale needed with these systems very difficult to achieve.

In 1983, things began to change. On the public education scene, Terrell Bell, United States Secretary of Education, released the *Nation at Risk* report. While the Report addressed the ills of public education, Frank Cary, a former IBM CEO, was a member of one of the study commissions. He, in turn, began asking questions of IBM executives regarding the quality and effectiveness of its education programs.

This was also the period in which Japanese manufacturing prowess became apparent to most everyone and posed a whole set of questions about the fitness of the American management system and its workforce in the new internationally competitive environment.

With IBM's education programs so decentralized, how could it mobilize a strategic company response to these dual challenges? A special study was initiated which resulted in 4 key recommendations:

1. Establish a central focus on education to track and review this area.
2. Establish guidelines for efficient methods so that best-of-practice and cost-effective programs could be identified and transferred.
3. Establish measurements so that education could begin to move from quantitative measurements, i.e. student days, to more effective measures.
4. Establish standards for delivery systems since rapidly growing, and often incompatible, delivery systems were being implemented.

The Corporate Director of Education position was reestablished and a small staff began assembling guidelines and best-of-practice work in 9 areas:

1. Curriculum planning and development
2. Course development
3. Delivery systems
4. Measurement and evaluation
5. Transition (retraining) programs

6. Administration planning and support
7. Planning education facilities
8. Instructor training and development
9. Management of education resources.

While there was much common ground across the Corporation in these areas, there was also wide variation in course content, which did not always match business priorities. There were more than 12,000 "cafeteria style" course offerings; many were "nice to know", but not necessarily "need to know." There were duplicate efforts, and worse still, there were complete voids in some necessary course offerings. For example, instruction for microcode engineers fell between the cracks of engineering and programming education programs, so there was almost no instruction available for this target population.

In 1985, a Senior Vice-President of the Corporate Staff who was currently on an education task force for Committee for Economic Development, raised questions regarding the cost of IBM education worldwide. Initial estimates were put at $600 millon. This figure included expenses associated with instructors, course developers, managers, outside consultants, administrative support, materials of instruction, overhead, etc. It excluded student's salaries and customer education. Since education was still decentralized with no central accounting function, a cost study was launched to confirm this estimate. The 3-month study established two important findings:

1. The cost of education was $900 million (approximately 50% charged to the U.S);
2. The cost of education by delivery system could now be determined.

The average cost of instructional delivery in learning centers was $75.00 per student day. This figure included overhead, materials of instruction, administrative support, etc. Similarly, satellite-based television instruction averaged $125.00 per day while the cost of local on-site instruction, a plant-site classroom, for example, cost $150.00 per student day. Typical cost at a central or corporate education center was $350.00 per day. The central education cost included all of the costs cited above in addition to travel and living. As mentioned previously, no student salary costs are in these figures, but in reality, should be a major consideration in the selection of cost-effective delivery systems. This hidden training cost can more than double the reported cost of training to an organization. For example, the salaries of the IBM employees in training last year were estimated to be $1.2 billion. Viewed in this way, the true cost of education could be estimated to be approximately $2 billion.

The overall cost study results were presented to upper management when the Company was in the midst of flat earnings statements. While there was initial shock at the $900 million figure, which incidently, *was 4.7% of IBM total compensation* (benefits included), the management committee asked four basic questions:

1. Is all that education necessary?
2. How good is the education?
3. What would happen if we reduce by 20%? by 40%?
4. Are there any breakthroughs in cost and quality?

Since questions #1 and #3 are interrelated, a follow-up study was conducted to find answers. The directors of education were asked to inventory all of their courses and rate them with the following legend:

1. Required for entry and redeployment training-level jobs
2. Required for job upgrading and promotion
3. Training programs required for new product introduction
4. Marketing courses and customer executive education courses to create demand
5. Advanced development courses for management and professionals
6. Nice-to-do.

This effort revealed a number of redundant course offerings and numerous #6 ratings. As a result of consolidation and cutting, the education catalog shrank by several thousand course listings over the next several years.

This exercise also led to a reaffirmation of the role of education and why the Company needed so much; it was necessary for growth, change and productivity. Further, it was indispensable to a tradition of full employment, since employees would need to be retrained numerous times over a 20, 30 or 40-year career. One example involves the redeployment of IBMers when sites are remissioned, such as Lexington, KY, or closed, as in the case of Greencastle, IN. It is estimated that over the last three years, IBM has transferred and/or retrained more than 60,000 employees worldwide. In 1987, a peak year for IBM retraining efforts, this cost was estimated to be in excess of $80 million.

Has retraining been worthwhile for IBM? In economic terms, retraining costs are generally buried in the $900 million, and therefore impossible to arrive at a corporate ROI analysis. In terms of the Company's corporate culture and tradition of full employment, retraining will continue to be the centerpiece in strategically preparing employees for their new jobs. Fortunately, not all this retraining needs to be conducted in classroom environments. More will be said of this in sections on alternative delivery systems and the vision of the future environment known as the "learning organization."

Concerning question #4, "Are there any breakthroughs in cost and quality?", it was concluded that there had been major breakthroughs in raising quality and containing costs. For example, it is well known that courses that are designed, developed and implemented by a systematic approach to instruction are, *on average*, superior to courses developed by intuitive methods. These systematic approaches to instruction are not unlike quality improvement programs in business in which the manufacturing process is "front loaded" with the design process, rather than attempting to "inspect" quality in at the end of the product cycle. This will be discussed further in Chapter #3 concerning the education strategy.

Closely related to quality is cost. Integral to a systems view of instruction are sub-systems that deal with the selection of cost-effective delivery systems. A long tradition of education at IBM had lulled instructors into choosing expensive classroom instruction as *the* method of choice, when in fact, they had available a wide range of cost-effective alternatives.

Since the systems approach and its evaluation procedures were not yet installed at IBM, there was no clear answer to the painful question, "How good is the education?" There were many indices of student acceptance of the instruction, but what was the long-term impact on the job performance? On the "bottom line?"

If the Corporation was to adopt these new instructional systems methods and procedures, the decentralized education organization would not facilitate these changes. Clearly, more structure would be needed, even if it meant breaking step with the prevailing decentralized business environment.

In 1986, the Vice-President for Organization commissioned a task force to recommend the best way to proceed. Participants were selected from all parts of the existing education organization and the other functional areas. The committee recommended that education become a full corporate staff function similar to finance, personnel, communications, legal services and manufacturing. This new central approach would facilitate the adoption of a systematic approach to instruction and cost containment as well as enable management to do "trade-off" planning to mobilize scarce resources to develop alternative delivery systems.

The task force also recommended a new reporting structure. Education directors of the major functions would become IBM Directors of Education and report to a newly created office--Corporate Vice President of Education.

By the end of the year, top management approved the organizational change and appointed Lew Gray as the first Vice President of Education (see Table I). He organized education into three major areas: Management Development; Job Training and Development; and Employee Development. Management Development was broken down into "executive", "middle" and "first-line" management, while the Job Training and Development area was divided into marketing and customer education, service, technical, information systems and operating systems, and finance and planning. The Job Training and Development area was also cross sectioned into: "entry level"; "experienced"; and "expert" levels (see Table II). This resulted in a 3 X 5 array that would later be important for the strategic job

Table I. Education Organization
IBM U.S., 1986

- **IBM U. S. Education** — *Vice-President*
  - **Education Staff** — *IBM Director*
    - Instructional Systems
    - Finance & Planning
    - Education Delivery
    - Personnel Manager
  - **Marketing & Customer** — *IBM Director*
    - Marketing Education
    - IBM Product Education
    - Customer Education
    - Administration Ed.
  - **Technical Education** — *IBM Director*
    - Engineering & Manuf.
    - Systems and Software
  - **Service Education** — *IBM Director*
    - Requirements
    - Course Developmnet
    - Education Center
  - **Business & Quality Ed** — *IBM Director*
    - Quality Education
    - Finance & Planning
    - F&P Course Develop.

Table II. Major Areas of IBM Education

Management Development	Executive Development				
	Middle Management				
	First Line Management				
Job Training and Development *Expert* *Experienced* *Entry*	Marketing and Customer Education	Service	Technical	Info. Systems and Operating Systems	Finance and Planning

Employee Development

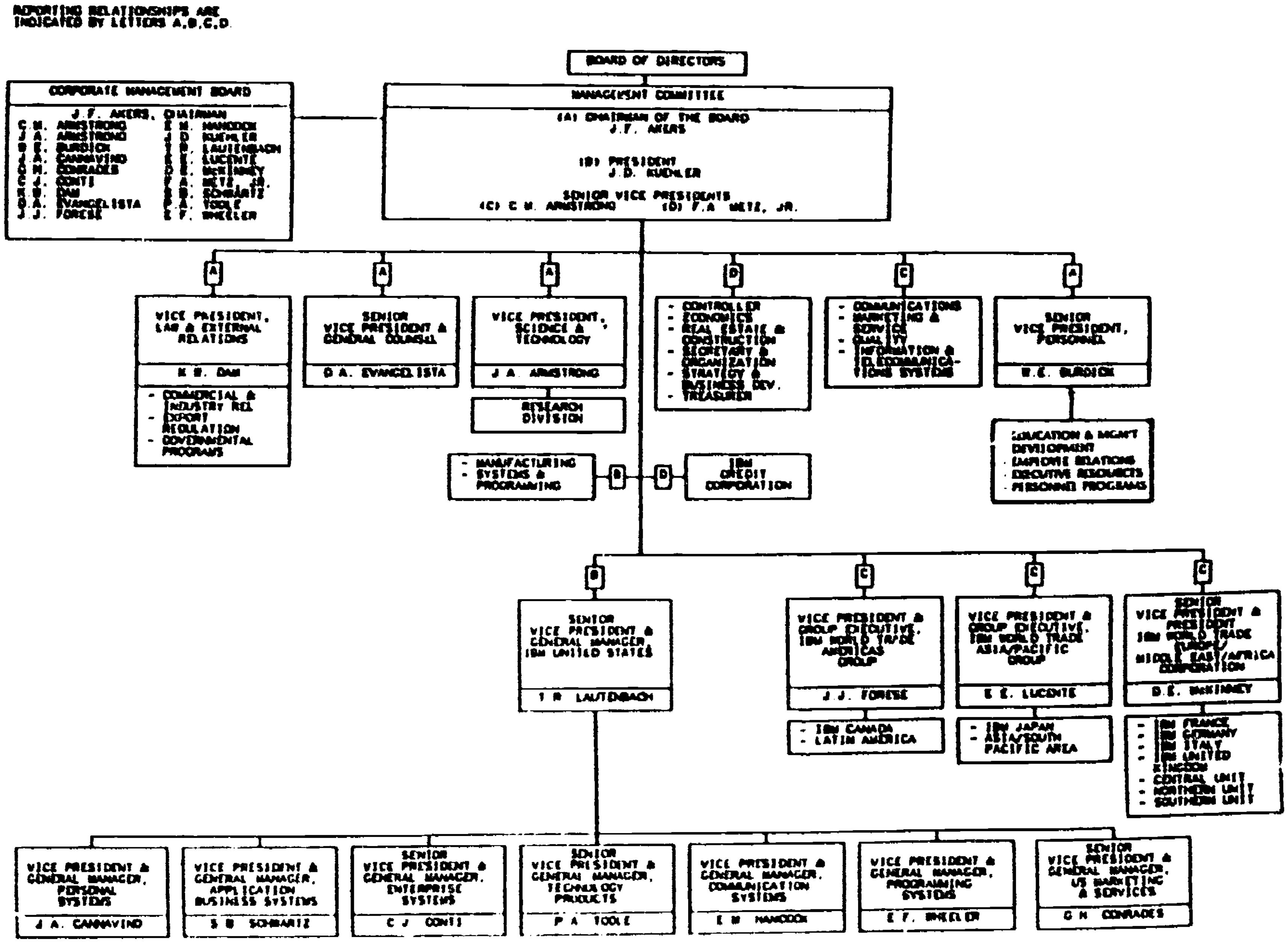
knowledge profiles and education roadmaps.

Both Marketing and Customer Education and Service Education were physically housed in Atlanta, Technical Education was headquartered in Thornwood, New York, Information Systems and Operating Systems in Dallas and the Finance and Planning function on the campus of Pace University, Briarcliff Manor, New York. Management Development was headquartered in the Management Development Center at Armonk, New York.

The new Vice President of Education reported to Kenneth Dam, Vice-President, Legal and External Relations. The Directors of Education in the World Trade units reported to their headquarters but had dotted line responsibility to Lew Gray.

In January, 1988, IBM announced a major reorganization. It created 6 new independent business units responsible for world-wide product development, market planning and U. S. manufacturing. Each was to be headed by a Vice President and General Manager. Later, a seventh, Programming Systems was added. Because of these changes, the fledgling education organization needed to be modified. The corporate office of education was created and Ursula Fairbairn became the newly appointed IBM Director of Education. She has world-wide responsibility for the health of IBM education, including educational strategies, key measurements, and the annual review process with top management. In addition, the line management positions for education in the four operating units, Canada/Latin America, Asia/Pacific, Europe/Middle East/Africa, the United States, have dotted line responsibility to the IBM Director of Education. In 1989, Mrs. Fairbairn's title and responsibility were expanded to IBM Director of Education and Management Development. She presently reports to Walter Burdick, IBM Senior Vice-President, Personnel (see Table III for IBM Corporate Organization).

Table III. IBM Corporate Organization



Creating an Education Strategy

By 1987 the new education organization was in place and turned its attention to identifying what it wanted to accomplish. What strategic plans could be formulated to ensure the competitiveness of the IBM workforce in this new international environment? How could quality be improved while containing costs? How could industry leadership be reinforced and maintained?

The education organization began to answer these questions by looking at how education might help IBM achieve its business goals. In the competitive and cost-sensitive environment of the late 1980's, any new education program that did not contribute directly to business objectives would be merely a distinction without a difference--and not valid in terms of the rigorous standards of program evaluation which were emerging. IBM's 5 business goals at the time were to:

1. Enhance customer partnerships
2. Be the leader in products and services--excelling in quality and innovation
3. Grow with the industry
4. Be the most efficient in everything IBM does
5. Sustain profitability, which funds growth.

Education goals were then derived from the 5 business goals and emerged as follows:

1. Provide a process of shared interactive relationships designed to address the customer's present and future education requirements
2. Deliver consistently high quality and measurable education to employees and customers
3. Train employees for their current jobs and prepare them for future responsibilities
4. Provide training, tools and education in a timely cost-effective manner to support business requirements
5. Provide high quality, cost-effective training which will result in: (a) profit

producing education programs; (b) enhanced employee performance to support profitability.

The next step was to identify the strategic programs that would meet these goals over the next 5 years. For example, in the case of business goal #2, *to be the leader in products and services--excelling in quality and innovation*, and its educational transform, *deliver consistently high quality and measurable education to employees and customers*, the question was, what programs would raise the quality of IBM education and produce measurable results? As cited earlier, research suggests that courses designed, developed and implemented with a *systematic approach* to instruction are, on average, superior to courses developed by intuitive methods. The answer would involve a company-wide commitment to an Instructional Systems Design (ISD) methodology. While there had been successful divisional applications of this approach, these "islands of success" would now become the standard throughout the Company. Three ISD competency centers (Thornwood, Atlanta and Dallas) were created so that specialized instructional design teams could provide the consulting support necessary for implementing the new direction. Additionally, selected courses would be developed and/or brokered by these central groups. Later, the creation of detailed reference manuals, computerized tool kits, job aids and staff development programs would help the diffusion of the ISD process through IBM.

Since measurement and evaluation is an integral part of an ISD model, the issues of quality and measurable education results were both addressed with one strategic program. It was not as though education wasn't being measured. The problem was that the measurements were quantitative, i.e. student days, etc., rather than qualitative. In order to make the shift to qualitative measurements, four levels of education/training outcomes were identified:

1. Student reactions
2. Knowledge/skill
3. Application
4. Business results

Level 1 or *student reaction* measurements, is similar to the ubiquitous question, Did you like the course? the instructor? the materials?--the "happiness" sheets which have been in use for years. The recommendation was made to include an additional question which asked for the student's perception of his ability to apply the course knowledge to the job.

Level 2, *knowledge/skill*, is typically measured with pre- and post-tests to check for learning gains. While the majority of the post-test measurements had been performed with paper and pencil, an increasing number of performance tests, such as laboratory projects, simulated sales calls, and fault finding in malfunctioning equipment, were to be used.

In level 3, *application*, measurements take place out of the classroom to check for transfer back on the job. The basic question here was, "Has instruction produced a better performer on the job?" Data collection usually consisted of interviews with the employee's peers at the job, his/her manager, and direct observation.

In level 4, *business results*, outcomes are quite different from the previous ones. Questions now take the form, "Are better trained practitioners contributing to the profitability of the company?" Specific questions which follow include: "Are trained marketing reps generating more revenue more quickly? Has the quality of our customer service increased because of training? Are trained software engineers producing more lines of error-free code with less resource?" These data are difficult and time consuming to collect, which helps explain why they are almost wholly absent from corporate education programs. *They are, nevertheless, the final arbiter of education's contribution to the business and its "bottom line".*

A dramatic example of level 4 outcomes or "bottom line" results was demonstrated at IBM's Austin, Texas plant. The plant had introduced Continuous Flow Manufacturing (CFM) in an attempt to improve its competitive position. However, there was a problem with lengthy cycle times in manufacturing some of the products. Three CFM education courses were created: overview (2 days); fundamentals for engineers and technical managers (2 days); and core team implementation (4 days). All of the 1500 employees and managers were trained within a period of 29 days. As a result of the instruction, the plant reduced cycle time, in units of days, on product A from 8.5 to 5.1; product B from 9.8 to 3.6; and product C from 16.2 to 3.6. Said differently, the plant doubled manufacturing capacity with the same resource. Consequently, this reduced inventory by $16.5 million and avoided the necessity of adding an expensive third shift. The total cost of the training program was approximately $200,000.

The task force also recommended that targets be established for these educational outcomes so that the education organization would be responsive in carrying out a complete measurement program as opposed to partial implementation. For example, 100% of all courses should receive Level 1 and Level 2 evaluation. While no targets are set at this time for Levels 3 and 4, the motive is to perform as many measurements as possible and collect exemplars for distribution to the educational organization. Guidelines and sample instruments were also prepared to structure this evaluation process and aid in education staff development.

Another strategic move involved the development of a career structure to attract and retain outstanding people for key jobs in education, since a trained educational staff would be necessary to the success of these programs. This issue also relates to education goal #3, which states, *train employees for their current jobs and prepare them for future responsibilities*. Before educational restructuring, many of the Company's employees considered most in need of training were not getting it. The employee's education was mostly left to individual initiative. This can be a risky practice if an average engineer has been out of college for 15 years (some consider the half-life of an engineer at 4 years or less) and the Company has a tradition of full employment. Related to this problem was the "old world" procedure for determining what would be taught. In the past, informal educational questionnaires were circulated to plant-site managers and sporadic responses would dictate the course offerings. Frequently, these did not meet real needs nor did they reflect strategic business directions. A more rigorous approach was needed to initiate education rather than depending solely on informal surveys or individual demand. An earlier success with curricula targeted for specific jobs provided an important first clue. Also, research on defining "job knowledge profiles" for IBM logic and circuit designers indicated that aligning education with key jobs could be a workable and efficient way to proceed.

There are other reasons to plan education by jobs. For example, the voids in the education offerings for microcode engineers, cited in Chapter #2, was the result of such an analysis. Additionally, executives who have functional responsibility for such areas as engineering or programming in the business find it easier to understand the relationship and the importance of education to their mission, and therefore, easier to justify resources.

The U.S. education directors identified the key jobs in their target population which resulted in a total of 83 key jobs in the IBM Corporation (see Table IV). This list accounts for roughly 98% of the employee population. Educational "ownership" for these key jobs was assigned to the six education directors who were also charged with the responsibility of creating and maintaining the curricula and educational "roadmaps" that employees could use as an aid to select courses and chart their progress through the system (see Table V).

Three of the 83 key jobs are in education--*course developer*, *instructor* and *education manager*. This was an important step for the education organization since it confirmed its position in the mainstream of the business and brought a

Table IV. List of Key Jobs by Functional Area

Management Key Jobs
- First Level Manager
- Middle Manager
- Executive Manager

Finance and Planning Key Jobs
- Accounting
- Financial Planning
- Pricing
- Internal Audit
- Business Controls
- Business Planners
- IBM Treasurer Employees
- Cost Estimating

Office Systems Key Jobs
- Office Systems Secretary
- Office Systems Administration Manager
- Office Systems Administration

Information Systems Key Jobs
- Telecommunications Developer/Programmers
- Telecommunications Managers
- Systems Support Programmers
- Computer Support/Operations
- I/S Managers
- Systems/Application Analysts
- Applications Programmers

Information Development
- Information Developers

Software/Microcode Development
- Software/Microcode Developers

Engineers--Product Development
- Process Development Engineering
- Semiconductor Circuit Design Engineering
- Packaging Design Engineering
- Hardware Design Engineering (see roadmap, Table IV)
- Electronic Design Engineering

Table IV. List of Key Jobs by Functional Area (con't.)

Unit Design Engineering
Power System Engineering
Reliability Engineering
Product Assurance Engineering
Product Analysis Engineering

Engineering--Manufacturing
Technology Process Manufacturing Engineering
Manufacturing Systems Engineering
Component Parts Manufacturing Engineering
Box/Systems Manufacturing Engineering
Test Manufacturing Engineering
Industrial Engineering
Quality Engineering/Analysis
Facilities and Engineering

Manufacturing and Development Support *(exempt)*
Product Planning (H/W & S/W)
Production Control/Distribution
Procurement

Manufacturing and Development Support *(non-exempt)*
Direct Manufacturing
Technician
Quality Support
Materials Support
Service Support

Manufacturing and Development--Technical Managers
Technical Manager--Manufacturing
Technical Manager--Development
Technical Manager--Software

Field Administration Key Jobs
Asset Administration
Administrative Secretarial/Services
Administration Management
Accounts Receivable
National Service Division Administration
HQ Site Administration

Marketing & Systems Engineering Key jobs
Marketing/Systems Engineering Trainees

Table IV. List of Key Jobs by Functional Area (con't.)

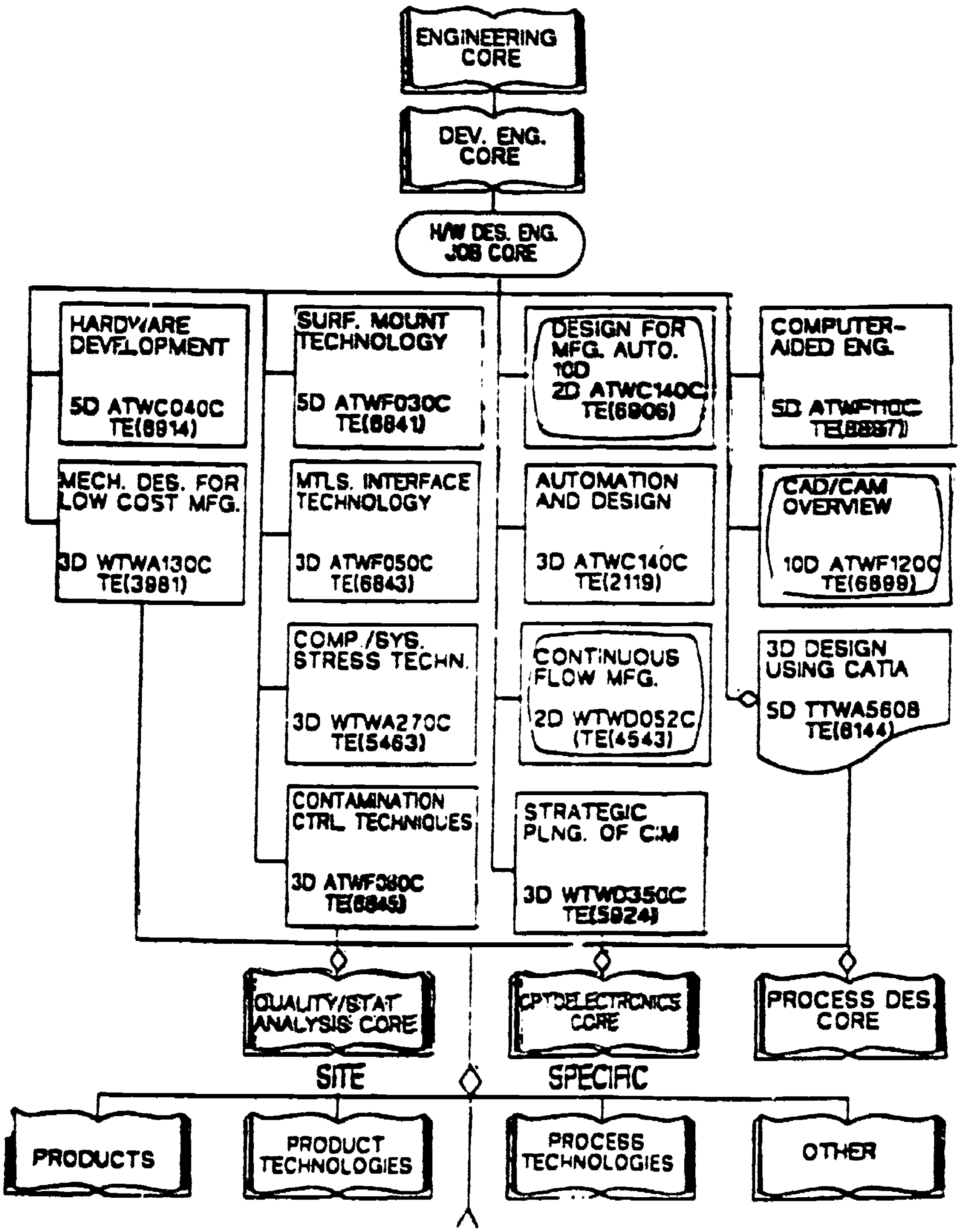
Marketing Representatives
Systems Engineers
Industry Specialists
Systems Specialists
Marketing Managers
Systems Engineering Managers

Customer Engineering & Programming Support Key Jobs
Customer Engineer
Programming Support
Installation Planners

Education Key Jobs
Instructors
Course Developers
Education Managers

Personnel Key Jobs
Compensation Specialists
Benefits Analysts
Other personnel staff
Employment/Recruitment
Equal opportunity/Affirmative Action
Medical/Safety
Employee Relations
Resources/Placement
Personnel Research
Personnel Managers

Table V. Educational Roadmap--Hardware Design Engineering



new level of professionalism to staff positions that were largely viewed as stopovers in otherwise different careers. This has been a particularly knotty problem for American business in general, since education has frequently been viewed as an overhead function and unrelated to the business mainstream. As a result, education staffs have been held to a minimum and reflected the cycles of the business, growing in prosperous years and shrinking or being disbanded in economically troubled times. Consequently, people chosen for education assignments could quickly be recycled when the next downturn occurred. In this new IBM strategic environment, education was viewed as an *investment*. Investments yield returns and should be viewed long-term. The new evaluation and measurements function was central to this strategic view since education could now give evidence of a "return on investment" rather than taken as an article of faith. Another reason for the new importance attached to the corporate education professional was the growing reliance on complex and expensive delivery systems. The skills required in satellite television and interactive video, in addition to ISD, would call for a new breed of training professionals as opposed to a department full of people on short-term assignments.

A strategic program closely related to key jobs and education roadmaps was the creation of a common course catalog. Using a common numbering system, a computerized catalog and data base was created so that employees and managers could query the system for what education is needed, when available and how delivered. Since education directors were responsible for deleting needless redundancy from their appropriate areas of the catalog, approximately 12,000 course entries in the catalog dropped to 8,000.

The initial curricular work on the education roadmaps for each job family proceeded by combining segments of existing courses. While this produced short-term results, more systematic procedures, such as job and task analysis, are being phased in to create precise job profiles. These "skill specific" profiles are necessary so that abstract course titles can be brought down to levels that employees know and understand. This also ensures compatibility with other components of the ISD model. Further, it will be necessary for future work environments, where narrow job boundaries are expected to drop away and remain fluid over time. More will be said of this in Chapter #6.

The fourth and final educational goal to be discussed here is *provide training, tools and education in a timely, cost-effective manner to support business requirements*. Since the cost of education by delivery system was known (see Chapter #2), it was clear that a strategic direction would be to move more instruction out of expensive classroom environments and closer to the workplace. Not only would the outcome be affected by the direct costs of instruction but through productivity increases that would be associated with making instruction available on a timely "need-to-know" basis and the avoidance of travel to a distant education center. Business cases could now be established for each course since its contribution to curricula, the size of the target population and its delivery costs were known (see Chapter #4 for an inventory of instructional delivery systems and cost-benefit results).

With the key jobs and curriculum roadmaps in place by 1988, one major component was still missing--a management information system to systematically plan skill requirements for each employee. This system is presently under development with a prototype expected in 1990. Students will ultimately be able to use the system to assess themselves against a skills profile, and as a result, receive from the system an individualized education plan. The education organization will be able to summarize the individual education plans and more carefully plan education offerings. Line management will be able to build a skills inventory and relate skills planning with business needs.

Ultimately, much of the instruction and information services will be delivered directly to the employee's workplace, which in turn establishes the need for another strategic requirement--*the effective and efficient utilization of facilities*. To deliver these integrated services to the workplace means that the Company needs a new standard for buildings--a smart building with full-function workstations and an electronic "nervous system" that can switch voice, data and video from any place to any place, including to and from telecommunications.

These strategic plans have provided the structure for major changes in IBM education: key jobs are identified; training is aligned with jobs; a common course catalog and curricular roadmaps provide guidance for individual development and skills planning; quality processes and measurements are identified; alternative delivery systems provide the means to move more instruction out of classrooms and closer to the workplace; and career paths provide for professional growth and continuity of educational staff.

Is the new education strategy working? Thus far, IBM is half-way into the five year strategic plan with promising results. The vital signs indicate that the program and organization is in excellent health and moving in the right direction. It will take another two or three years for all programs to take hold with the intended results, but of course, that is the nature of strategic planning.

The Growth and Use of Training Technologies

Technology has been defined as the systematic application of organized scientific knowledge to practical tasks. The practical task under discussion here is education and training--*and it is big business.* Estimates of American business and industry's annual expenditures for this task range from $40 billion to $200 billion. This report has chronicled a history of IBM that puts education and training as its centerpiece during its unprecedented 75-year success, irrespective of cost; and Thomas J. Watson, Sr.'s 1933 quote, "progress in business today depends on education," is as true today as it was then. It follows, therefore, that considerable attention should be directed to the improvement of tools and techniques for the education process. One of these efforts has been the application of technology to training.

The major benefits from this technology application fall into three categories: structural; content; and process. *Structural* benefits are derived from technology changing the contextual elements of learning--making the instruction place and time independent. For example, self-study makes it possible to learn independent of a classroom, instructor or most other expensive resources. Satellite instructional television delivers education at convenient local sites and avoids costly and time consuming travel to a central education center. Self-study and video tape also shift time to suit the learner's needs.

Content benefits are achieved when the technology makes possible learning outcomes that might otherwise be impossible or impractical to achieve. For example, integrating all the works of an author and a literature course through a computerized multi-media data base, structurally changes the course. Complex data manipulation with a computer and the associated graphic output is another example of helping learners achieve levels of understanding beyond the capabilities of even the best teachers.

Process benefits derive from technology applications when it changes the nature of the instructional interaction. A computer can in real-time, for example, collect the student responses from keypads and present the statistical output to the class. This has been shown to fundamentally change the nature of the classroom teaching/learning process. Not only do the data make it explicit whether the students have mastered a concept but they also become a point of departure for the students to discuss why they responded the way they did.

In sum, these benefits help explain the two major motives for using technology in education and training--to raise quality and contain costs. Quality improvements mostly flow from *content* and *process* innovations while cost benefits are mainly found in the *structural* changes brought about by technology applications. While these are illustrations of "hard" technology applications to instruction, the definition of *technology* is not limited to hardware. Methodology, such as that found in ISD, authoring languages, artificial intelligence algorithms, toolkits for instructional developers, and other practices also meet the definition of *technology*. This "soft" side of technology is currently undergoing rapid development and will be discussed later.

The Beginnings

The hardware side of technology in IBM can be traced back to joint development work in the 1930's with Professor Ben Wood at Columbia University. Wood's development work with IBM typewriters as a learning system to teach reading to pre-schoolers was a direct forerunner to the current *Writing to Read* system. Another important breakthrough in development occurred when a Michigan school teacher, Reynold Johnson, was experimenting with the electrical resistance of pencil marks on paper. Wood met Johnson, and the popular IBM test scoring machine came into being.

By the early 1950's a psychologist at IBM Poughkeepsie, Robert Miller, developed task analysis as a methodology and the "soft" side of modern instructional technology was born. Task analysis is a methodology for breaking down tasks into their component parts, and then reassembling them as learning hierarchies for instructional programs. This proved to be the necessary step for the development of Programed Instruction (PI); subsequently, the first IBM programed text was written, *Introduction to Data Processing.* The subsequent developments of instructional technology are, for convenience, divided into individualized and group or classroom- based learning systems. In practice, this division is not always so clear nor practical. For example, as early as 1964, research was being conducted on small groups of learners at computer-assisted instruction terminals, traditionally thought to be an individual tutoring system.

Individual Learning Systems

By 1959, Drs. Gus Rath and Nancy Anderson at IBM simulated for R&D purposes a teaching machine on an IBM 650 computer, and the first instructional link to a computer was forged. But it was in 1962 that Drs. William Uttal, Werner Koppitz and Ralph Grubb founded IBM's computer-assisted instruction (CAI) movement as it is known today. Working at the Thomas J. Watson Research Center, they turned an IBM 650 computer into a multi-processed, time-shared system that could teach three courses simultaneously to many students. Additionally, this pioneering system had remote computing and a conversational authoring system for course development. Two years later the system was upgraded and teleprocessing added. This enabled universities and geographically scattered departments in IBM to use this unique resource as a shared facility. The first IBM division to apply CAI was the then-named Field Engineering Division (FE) who used the new technology to teach its people how to service computers.

That same year IBM entered into courseware development through the acquisition of Science Research Associates (SRA). A rash of mergers between computer companies and publishers followed, but the expected synergy never seemed to materialize. IBM also created an interdivisional department for the new technology and its first product was the IBM 1500 System--a specially built R&D system for the purposes of understanding the CAI requirements and transferring the technology to universities. The system consisted of 32 video display terminals, light pens and audio-visual devices, and this technology advance prompted entirely new instructional approaches that are currently considered normal practice. For example, a student in a statistics course could use menus, and with a light pen, organize his own pathway through the course, making selections that fit his needs. He could also utilize simulation games and have the computer generate real data to be applied to the statistical concepts that the same computer was teaching. Before the advent of this technology, instructional strategies and techniques such as these were impossible to achieve.

The first CAI user group, as such, was formed when IBM made the 1500 System available to universities, and ultimately to the training command of the military. This proved invaluable to the growth of CAI since user group members readily shared instructional programs, techniques and research results. Many of these enhancements found their way into CAI applications on System/360 and subsequently, System/370. This meant that CAI had become an application on already cost-justified equipment, squarely in the mainstream of computing and available to anyone. In less than 12 years, CAI had moved from a laboratory curiosity to a business training tool.

Two critical problems remained unsolved in this era of rapid CAI growth, both inside and outside of IBM, and partially account for this movement never reaching its full potential. The first problem was lack of high quality instructional programs. The vast majority of programs resembled mechanical page turners, a habit carried over by many former teaching machine practitioners. No wonder then, that many research studies found no significant difference between CAI and programed texts and other instructional delivery systems. Related to the quality issue, was the lack of courseware maintenance. Courses that were previously of high quality were allowed to grow out of date, and subsequently fell into disuse. Perhaps the single largest cause for these problems was that the educational groups charged with program development almost never reached the critical mass necessary to develop the requisite variety of instructional design skills and provide the continuity necessary for course maintenance.

One notable exception was Field Engineering's (FE) successful CAI project--the Field Instruction System (FIS). FE management astutely assembled author centers, staffed these with instructional design teams and the necessary support people, and adapted an instructional systems design methodology from the military, who pioneered the wide-scale application of ISD to training problems. Authors worked alongside engineers at plant sites during product development so that instructional programs and materials would be available for training at product announcement time.

FE's first CAI efforts in 1967 were directed to pre-requisite training. This meant that a customer engineer had to give evidence through testing at a terminal that he was academically prepared to go to an education center. But as the program grew more successful, increasing amounts of classroom instruction were displaced. For the last decade, approximately half of FE's education program was mediated through FIS. At the peak of its education offerings, FE administered 300,000 student days a year, which meant that 150,000 were being conducted through FIS. Two major research studies conducted during this time period showed that there was no significant difference in learning and job performance between FIS and classroom trained customer engineers. There was a 25% savings in time to learn, however, in favor of the CAI group. Due to the combination of off-loading classroom instruction, time savings and the development of more reliable computers, FE was able to reduce its 15 education centers to one within a 20-year period.

In 1983, the personal computer business was growing; and IBM saw the need for expanded function in its PC if it were to become a general purpose instructional tool. Early models of computer controlled video disc units were already on the market and showing promise, but they would impose *more* requirements on the training development function, not fewer. Consequently, IBM management launched an interactive video disc development project (InfoWindow) and created a new education organization in Atlanta to amass the critical skills needed and the necessary economy of scale. By 1986, InfoWindow was announced as a product and now is in wide use in settings ranging from marketing to military training.

The system components consist of a PC, as many as two laser video disc playback units for high quality video and stereo sound, a touch sensitive display capable of showing *both* data and video, a mouse, and software support packages, including an authoring system. This technology advance permits the instructional designer to break the tyranny of text-only systems by making all the audio/video resource material for a course directly accessible by the student. As will be seen in Chapter #5 with an example from Brown University's Hypermedia project, the nature of the student interaction with the course materials changes, and ultimately, the quality of the student performance.

One interesting application at the IBM Management Development Center at Armonk, New York, is the use of simulated interviews with employees exhibiting performance problems. The learner has a chance to "talk" to the problem employee via InfoWindow, chose a method of action and play out the consequences. Later, external modifications were made to InfoWindow so that an accessory VCR and miniature TV camera could record the student's reactions to the critical incidents in the episodes, and on command, play back the two as one integrated scene. In a related development, the marketing training department is using the same technology for sales trainees to make simulated sales calls. Video "customers" present every objection possible. Trainees go through the scenarios as many times as they like and when satisfied with their performance, show their visual record to the instructor for critique. Contrast this sales training program with the memorized "pitches" of the *drummers* in Chapter #1. Needless to say, the requisite variety of skills needed to develop these materials is considerably greater than the first generation of CAI systems and materials. As a consequence, authoring teams and centers are now becoming the norm rather than the exception. They also provide a secondary benefit--helping to ensure that the materials will be maintained during their life expectancy.

By 1987, IBM was teaching 800,000 student days a year on a world-wide basis (both employee and customer training) with individual learning systems. This translates into, for IBM U.S., an annual cost avoidance of 1,000 education staff headcount and $150 million. These cost avoidance numbers are achieved by a 25% instructional time savings, eliminating the need for most travel and living, and reducing the number of education centers and their instructors, including support personnel. Another way to state these results is that the education function will be able to accommodate increasing educational demands with a level resource.

Group or Classroom-based Learning Systems

Instructional television (ITV) is the major alternative delivery system for group learning in heavy use today. IBM's first experience with ITV occurred in the 1960's with a microwave link between an IBM programming group at the Time/Life Building in New York City and the programming development group in Poughkeepsie. This activity enabled remote programmers to upgrade skills and receive timely advice and counsel as needed.

In 1969, the first TV link was established between the IBM plant at San Jose, California and Stanford University's School of Engineering for the purpose of offering continuing education to engineers. A number of business and university partnerships followed and are discussed in Chapter #5.

IBM's present use of ITV has its roots in a project initiated late in the 1970's at its customer education center in New York City. In that prototype, an instructor-controlled TV studio was used to teach customers in small classrooms scattered throughout the building. The motive was to teach more students while simultaneously giving students the impression that they were in smaller classes. Productivity was also achieved by having the instructor produce the program as well as teach. This was accomplished by having the instructor sit at a special console and face a wall that houses TV cameras and monitors. Document cameras were to the right and left of the instructor for displaying graphics or other materials. The instructor could with a switcher, select and distribute dual TV signals to the 2 monitors that were in the front of each specially-built classroom. Typically, one picture was of the instructor while the second image was a graphic. Later, keypads and microphones were added to the classrooms so that the students could talk to the instructor over an audio link as well as respond to multiple choice questions posed through the system. This program proved so successful, both in student acceptance and academic performance, that a satellite link was tried between New York and Chicago, with the same results. In 1983, IBM launched the satellite network and called it Interactive Satellite Education Network (ISEN). Today, ISEN broadcasts more than 70 product and technical education courses from studios in New York, Chicago, Washington, D.C. and Los Angeles.

Also in 1983, The Systems Research Institute (SRI) was planning its move from New York City to its state-of-the-art residential campus in Thornwood, New York. This was the opportunity to design and test ITV under a new set of conditions, as well as deliver it to a new target population--technical professionals in the IBM plant and lab sites. SRI faculty expressed doubts about teaching in a studio environment and wanted to preserve elements of the classroom. The decision was made to combine the best qualities of the studio and the classroom into one entity--the television classroom.

The system works like this. A trained operator sits in a windowed control room adjacent to the TV classroom, and with joy sticks, is able to remotely pan, tilt, zoom and focus all 4 television cameras mounted in the classroom. Two of the cameras primarily pick up instructor activities, a third largely covers student reactions, while a fourth, embedded in the ceiling, serves as a document camera. Additional inputs come from video tape, computer, film, slides and other live TV signals emanating from within the building and/or satellite feed. The use of special effects, such as "windowing" and chroma key, a technique for combining several video signals and commonly used by TV weather forecasters, serve to enhance the instruction and result in quality production values that viewers have come to associate with commercial television. The separation of instruction and production roles in this project allows for a wider range of techniques, requires only one TV channel of information rather than two, and enables subject matter experts, who are otherwise naive about television, to teach with a minimum of training.

From 1985 to 1989, the network expanded to include all IBM's major plant and lab sites in the U.S. The keypads and talkback system from ISEN were added to the candid classroom network so that students anywhere in the network could speak to the instructor and/or respond to multiple-choice questions. Computers poll the keypads and send statistical data in real time for display on the instructor's touch sensitive screen. The instructor can see the data summarized for the entire network or by individual locations. Electronic mail and computer conferencing also enable instructors and students to communicate with each other asynchronously. The Thornwood campus is wired for voice, data and video; the same ITV signal can be simultaneously distributed to student bedrooms, faculty offices, overflow classrooms, conference rooms, auditorium, labs, etc. This development brings all the benefits of distance learning to a residential campus, making each "people space" within the Center a virtual classroom, as well as providing the obvious advantages from satellite delivery to the plant and lab sites. This dual benefit can be seen in examples ranging from a lab demonstration shown "live" to a conference audience on the auditorium's theater-sized screen, to the productivity increase gained from the number of students that instructors reach. For example, instructors in the Manufacturing Technology program routinely have class sizes of 100 students who are distributed geographically on the ITV network. This contrasts sharply with previous residential classes that averaged 15 students.

In 1988, the two satellite networks, ISEN for customer education and the internal technical education network for employees, were merged and are managed as one corporate education network--CENET. The integrated system now has a total of 14 transmitting studios and/or candid classrooms and almost 200 receiving classrooms. With these combined facilities, 75% of IBM's customers, 65% of its field force and 85% of its manufacturing and development personnel are within commuting distance of a satellite classroom.

What courses are being taught with this system? The answer is as broad as the course catalog. Essentially, any course that has been taught in a classroom is a candidate for instructional television. These courses typically range from topics in software engineering to quality control to manufacturing engineering. What is new, however, is the increasing use of this system for laboratory environments. For example, operating systems education in Dallas is using a laboratory setting in its satellite education classes so that students can see from a distance the effect that operations have on a central system. "Expert systems" are also used for remote student lab support to help the student through problem sets in class exercises. These two modes of operation are found to greatly facilitate the student's preparation prior to attending class.

Three major research studies on employee education conducted during this period indicate that ITV was equal to or slightly superior to traditional classroom instruction in terms of student performance results. Students reported that they were able to concentrate better in the small groups at the remote classrooms and generally preferred the smaller time units of instruction as opposed to massed instruction that necessarily occurs at a central education center. The system was extremely effective from a financial viewpoint. By 1992, the number of student days delivered on this system is expected to grow to from a 1987 base of 150,000 student days to 250,000. In 1992, IBM projects annual savings of $40 million a year (see Figure 1). This results in a return on investment (ROI) of 36%, and when expansion plans are complete, this ROI figure will nearly double.

Financial Results: Satellite Classroom

Student days ('87-'92): 100K to 250K

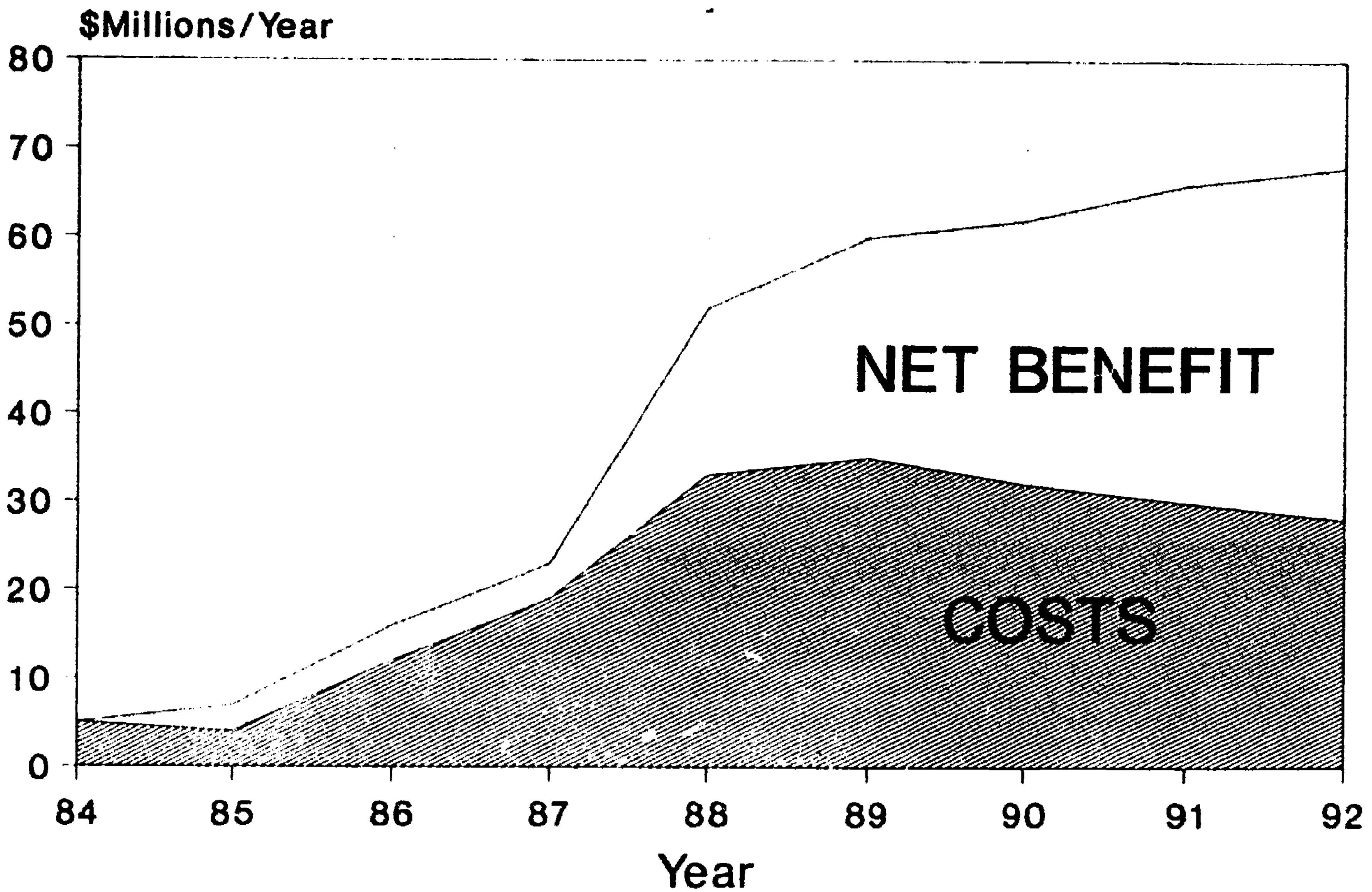


Fig. 1. Financial Results: Satellite Classroom.

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IBM has been applying some of the techniques developed in alternative delivery systems to classroom teaching. This is the focus of the development of the Advanced Technology Classroom (ATC) at the Management Development Center (MDC) in Armonk, New York. In this project, a personal computer serves both as a controller for all the AV devices in the classroom as well as student keypads of a type similar to those in the ITV project. When an instructor poses a question in the ATC setting, the computer readies the keypads, and collects and summarizes the student data in real time for large screen display. Since the same computer has stored the student response data from previous classes on the same questions, the instructor can choose to display these historical results next to the current data. This frequently provokes classroom discussion as to why a particular class responded the way it did. This student response feature also helps to keep each student vigilant and actively involved in the classroom instruction. In contrast to traditional classrooms, the ATC provides greater interaction and involvement with immediate results.

An additional feature of the ATC is the interface controller to other AV devices, such as video tape, video disc, film, slides, etc. This means, that on command, the same PC can dim the lights, show a short video sequence of a case study, stop the sequence, activate the keypads, elicit a group response, summarize and display the data, and restore the lighting level for classroom discussion, with no breaks in transition. This capability is particularly important in those classes where there is as much emphasis on group process as there is on content mastery.

A comparison of the ATC with traditional class instruction at the MDC involving more than 3,000 students indicates that student performance and acceptance were significantly improved with this system, and learning time reduced by 25%. As is true with most instructional technology systems, the first major benefit derived was the discipline that the system imposed on the instructor--learning objectives clearly stated and evaluated, cycles of revision based on student performance, etc.

Other instructional delivery systems and techniques used in IBM include video tape applications with small groups, specially constructed texts, job aids, etc. Some of these will be discussed in Chapter #6.

In summary, instructional technology has been a major force in IBM's strategic effort to improve quality and contain costs. But technological innovation without people is mere application of hardware. The ultimate goal of training and education is to produce competent and well-trained practitioners--employees who are willing to learn, flexible enough to change, and committed to life-long learning and growth over the course of their careers. Instructional technology becomes an important means for achieving this end.

IBM Education and External Relationships

A major reason for IBM's 75-year growth has been its emphasis on customer service. It is not surprising that IBM's first of five business goals is to, "enhance our customer partnerships." These external relationships help define customer requirements for new products and leverage the Company's resources in important ways.

Examples of this synergy can be found in IBM's relationships with higher education. One important function that colleges and universities serves is the development of human capital. A steady stream of graduates from the higher education pipeline enters IBM every year as new hires, and is a major part of the business and education strategy by helping to maintain a technically current and competitive workforce. An excellent article in the September 19, 1988 issue of *Business Week* illustrates the importance of human capital:

> The evidence is overwhelming that people, not machines, are the driving force behind economic growth. In the period of 1948 to 1982, the nation's gross national product increased at an annual rate of 3.2%. Edward Dennison, an expert in growth economics, finds that one-third of that gain was caused by the increase in the education level of the U.S. workforce and about one-half of the growth was the result of technological innovation and increased know-how, which also depend on education. But just 15% of the total increase was the result of more capital equipment.

IBM relies on the colleges and universities for assistance in another area of human capital, the continuing development of its employees. In spite of IBM offering more than four million annual student days of training to its own employees, last year more than 11,000 IBMers were on campuses furthering their education under such programs as tuition refund, resident graduate study, and graduate/work study programs, at a cost of more than $10 million. There are also out-company executive development programs at major universities that range in length from one week to nine months.

Another example of this synergy is found in IBM's relationship with the National Technological University (NTU), a consortium of several dozen American universities delivering graduate level engineering programs by satellite directly to business and industry. NTU offers five different master's degree programs in engineering and computing subjects, as well as timely, non-credit seminars ranging from topics in leadership skills to supercomputing. In other resident campus programs, course credits are lost if an IBM engineer is transferred to another work location. This delivery system is consistent with IBM's ITV strategy and complements the already cost-effective internal network. Other major American business partners in the NTU network include AT&T, Digital Equipment Corporation, Eastman Kodak, Hewlett-Packard, Honeywell, NCR and Xerox. This program is currently under development in Europe under the name *Euro-PACE*. IBM was one of the founding partners of that network as well.

Closely related to the universities' role in developing human capital is the question of curriculum. Are the right courses in place that will lead to a trained and flexible workforce? In 1983 IBM surveyed graduate programs in manufacturing technology and discovered only one master's degree program existed in the United States--the University of Massachusetts. This single program could hardly be considered sufficient in the face of the Japanese manufacturing revolution. As a result, IBM University Relations offered a series of competitive grant programs to universities to seed new curricula that were of vital importance to itself and the national agenda--manufacturing systems engineering, CAD/CAM (engineering design), management of information systems, and materials and processing sciences. IBM awarded a total of $50 million in equipment, people and money to 22 universities to initiate the first two programs. Federal funding agencies and Congressional staff were informed of this strategic program and in many cases, parallel support was provided by the government to accelerate progress. Today, there are more than 50 master's degree programs preparing students, and ultimately the American workforce, for advanced work in manufacturing technology.

Subsequent rounds of competitive grant proposals resulted in programs to strengthen instruction and research in Management of Information Systems ($25 million) and Materials and Processing Sciences ($27 million), areas critically important to the U. S. computer and electronics industries. Thirty universities participated in these two programs.

Sometimes college curriculum is designed for a specific plant-site's mission. In the case of IBM in Mid-Hudson Valley, NY, a pr duction employee training program was designed in collaboration with Dutchess Community College. In this case, employees proceed through a work-study program consisting of courses at the College, classes on-site, self-study and home study. There are site support systems to coordinate and reinforce these experiences which include labs, learning exercises, tutors, student groups, and management counseling. The community college also provides the basic skills and knowledge upgrade in mathematics to meet the requirements of a new and more demanding work environment. This rhythm of work and study provides a meaningful blend of the two and telegraphs an important trend that is occurring--the integration of work and learning to prepare a more trained and flexible workforce. More will be said of this in Chapter #6.

Another area targeted for development was the application of technology to education. Since instructional technology was already being used so successfully in IBM (see Chapter #4), how could this technology be transferred to colleges and universities and to what effect? In 1985, IBM's Academic Computing and Information Systems (ACIS) announced a series of three-year partnerships with 19 universities designed to investigate the application of innovative workstations and networks to instruction. A total of $100 million was awarded to the schools which, in turn, administered the funds through project offices to faculties under a competitive proposal process. More than 3500 instructional projects resulted from this program, leading to many innovative instructional techniques and hardware/software developments. One example was Brown University's Hypermedia project. This project's objective was to build a *multimedia* data base for two introductory courses so that students could with computer terminals browse through the materials and experience a holistic approach to instruction. This is in sharp contrast to traditional approaches to instruction in which students proceed through textbook assignments in a linear path and then recall information for a final examination. In Brown's English Literature course, for example, students studying Tennyson could call up conceptual maps at a computer terminal, browse through developments in science and technology of Tennyson's time, read his biography, see pictures of Tennyson and important art works of the times. Additionally, students could select other conceptual maps such as the cultural context of the Victorian era and similarly, browse through examples of architecture, images of Victorian life, and the lives and works of other writers of the period. The results from the Brown study showed that students using this instructional methodology were better prepared for classroom discussion, and wrote final examination papers that were broader in scope and had more depth of content.

In another example from this instructional technology project, educational researchers at the University of Minnesota have been experimenting with interactive simulation as a teaching technique. In this case, students managed a 20-acre strawberry farm and were forced to make decisions about mulch, fertilizer, irrigation, etc. Every decision had cost-benefits involved and a running score on crop yield was displayed to the student. Different weather and soil conditions added to the realism and the complexity of the decisions. Value judgments were also called for. For example, some fertilizers negatively affected the environment but produced a higher crop yield. The student progressed through an entire growing season, harvesting and selling the crop through the wholesale, retail or pick-your-own market. Depending on crop yield, hiring and advertising decisions, a gross and net income was calculated and the student's decisions were reviewed by both peer group and faculty advisors. Simulation has been found to be a dynamic and effective mode of teaching and is being investigated for possible use in a variety of subjects ranging from chemistry lab experiments to computer operations.

Communications networks have been another subject of investigation in IBM partnerships with universities. Communications is what integrates the many functions and people on campus. Further, it enables students, faculty and administrators to link up with other functions and people scattered world-wide, including those located in IBM.

In one well publicized example, IBM entered into a joint study with Carnegie-Mellon (CMU) to wire the campus for voice and data. The effort resulted in a high-speed network that tied together more than 7,000 workstations and file servers scattered over 50 buildings. This communications system is being used in every facet of instruction, particularly undergraduate. Students conduct literature searches, upload assignments to faculty, compose papers, link up to a supercomputer located elsewhere, send electronic mail and engage in computer conferencing with their peers and faculty. This network is being emulated by other universities, and signals an important trend regarding the tools, information technology and an electronic infrastructure necessary for effective and efficient learning.

Project Athena is another university partnership and involves MIT, Digital Equipment Corporation, and IBM. The goal is to accomplish the same objective in the CMU project, but additionally, do it in a multi-vendor environment. By using agreed upon standards in software protocols, the incompatible workstations normally present on campus become integrated into one functional system.

Paralleling these joint projects was IBM's effort to seed the development of other general purpose university networks. In 1981, IBM assisted with the data communication costs between City University of New York and Yale University, and BITNET was born. Subsequently, partner networks have grown up in Europe (EARN) and Canada (NETNORTH), interconnecting more than 900 computers and 300 university campuses world-wide. This facility set a new standard for international research and scholarly cooperation. Shortly thereafter, a gateway was formed to IBM's proprietary world-wide network, VNET, enabling members of the academic community to interact and cooperate on projects with IBMers.

Another function that American universities serve so well is the production of new knowledge. Basic research at the university supports the resources of IBM and enables partnerships to form that naturally complement each other. One example of this partnership is the relationship between the Cornell National Supercomputer Center and IBM. The Center is one of five national centers sponsored by the National Science Foundation (NSF) to maintain American competitiveness in computing. IBM has loaned the university both advanced computing systems and people support and established close cooperation with IBM laboratories through networks of computers similar to the configuration at Cornell.

IBM is also working closely with the University of Michigan and MCI to provide a "National Data Highway" that will link together all of the five supercomputer centers. This capability will make state-of-the-art computing technology availabie to university and business researchers nationwide.

Another significant way that IBM helps research is through the contribution of funds for new ventures. Under a Faculty Development Award program, the Company selects promising untenured faculty in areas of critical importance, such as science and engineering, and grants them $30,000 per year for two years to become established in their research fields. A related program grants unrestricted seed funds to university departments for up to three years to support risky start-up scientific programs. University research also plays an important role for IBM through research contracts. These collaborative research activities are targeted to specific problems of a common interest. Examples of this contracted research for IBM education are: assessment of interactivity in distance learning systems; design of advanced courseware authoring systems; development of graphical data bases for instruction; and effectiveness of instructional strategies.

Communications exchange and faculty seminars provide another form for partnerships that support a strategic position. For example, IBM Education hosted a seminar for 19 professors of instructional design to critique its educational strategic plans and study examples of new techniques with alternative delivery systems. Programs in faculty sabbaticals, summer employment and consulting also serve to enhance this information exchange.

Customer education outside the university has also been a fruitful area for methodology development and technology transfer. IBM's extensive use of ITV for employee education was launched with its customer education application in New York City. In another case, the build-up of learning centers at the plant-sites can be traced to the Company's success with its Guided Learning Centers for customer education. The learning center concept becomes an important intermediate step in the Company's plan to off-load increasing amounts of instruction from the classroom and move it closer to the workplace. With technology advance, one would predict that much of that instruction will ultimately be delivered to the desktop.

Sometimes this methodology transfer works in the other direction. For example, the Company's internal success with job knowledge profiling for its key jobs is currently being tried with a customer's information systems staff. If successful, IBM will be able to offer the customer an educational development program as strategic as the one being formed for its own employees.

Another area of IBM Education relationships is in public education. More than 300 major task force studies published since the 1983 *Nation at Risk* report have served notice that deep and far reaching changes are needed to correct the ills of public education. On international tests of math and science skills, for example, American public school students have typically scored at or near the bottom of the list of major industrialized nations. Since public education serves as a feeder system for both higher education and the economy, it is impossible to think of a trained and flexible workforce without a strong foundation in the basics.

IBM supports partnerships with public education through a broad spectrum of programs. These range from increasing public awareness of education needs to focusing support in curriculum areas where there is a strategic match with the company's products and the skills of its individual employees. For example, IBM employees have established mentoring programs to provide positive role models for students and strengthen skills in mathematics and the sciences. More than 750 local partnership programs involving 10,000 IBM employees are active in all 50 states.

In 1989 IBM announced a five-year, $25 million grant program to help improve U.S. elementary and secondary education through more effective use of technology. The money will be used to support two separate but complementary cash and equipment programs. The first is designed to improve teacher preparation with respect to computers, and the second to stimulate innovative uses of computer technology in the classroom through partnerships with colleges of education. The program also will develop classroom laboratories which can serve as "showcase sites" for application elsewhere.

While other examples of external relationships and their benefits could be cited, the list is sufficient to conclude that IBM's strategic plan for a flexible and competitive workforce does not only focus on itself. IBM's business success is largely attributed to the attention it gives its customers, employees, and the various "publics" it serves. Ultimately, the nation's long-term economic health will depend on the efforts of companies like IBM who are moving toward a vision of strategic interdependency among the widest possible representation of institutions--partners as it were, in the continuing challenge to maintain our very way of life in the face of stiff and unrelenting international competition.

IBM Education and the Future

A view of the future and a strategic plan are two sides of the same coin. What is a strategy but a perception of the environment five years in the future and a set of actions to get there? Implicit in the strategic action programs detailed in Chapter #3 is a future that requires a flexible and trained workforce in order to be competitive in a global economy. IBM has already taken the following educational strategic actions: identified key jobs; aligned education and training with these key jobs; designed a common course catalog and curriculum roadmaps for instructional guidance; adopted quality instructional design processes and measurements; launched an integrated management information system; and employed alternative delivery systems to make information and instruction available in a timely, cost-effective way.

IBM has other important developments underway which will strengthen and support these strategic shifts. In instructional technology, for example, there is already some progress with embedding training in two of its newest systems products. This means that when an end-user logs on these machines, the first thing to appear will be a series of menus offering the training necessary for their operation. As the base of end-users grows and contains more first-time users, this self-teaching feature becomes vitally important to the effective and efficient use of information systems.

Advances with interactive video should make future versions of this device more cost-effective. The video disc, which has traditionally been the "pinch point" in this technology, will probably be displaced with digital video. The major implication in this shift is that video can be created, stored, and edited as easily as data. Further, digital video can be transmitted over less expensive communications lines and also reduces the need for the scarce and expensive skills necessary for videodisc production. While this digital video will require tremendous amounts of computer speed and storage, history has shown that dramatic technology improvements have occurred in these areas, which make this realistic and cost-effective. IBM and Intel have already entered into a joint agreement to study advanced video compression techniques to speed up this transition.

The proliferation of networks and their added capacity will make it possible in the future to deliver more instruction to the workplace, and ultimately to the desktop. This would also suggest a new role in education for the computer mainframe, which has consistently given way to stand-alone PCs. With the growing commitment to ISD, more instructional development teams and competency centers are being formed to amass the required range of skills necessary for quality programs. These ISD teams and centers typically require larger systems to support their development and store the necessary curricula for which they are responsible. Downloading the training materials from one of these mainframes on user demand will also ensure that the learner has the most up-to-date version of the instructional materials. This "Just-in-Time" (JIT) mode of training will complement the JIT delivery procedures already in wide use with manufacturing.

The growth of ITV in operational units outside the U.S. is moving IBM closer to a world-wide commitment to this medium. Differences in usage are also extending its traditional role. IBM Japan, for example, has been using two-way video, as opposed to traditional one-way video and two-way audio, for several years. This project will be useful in assessing the instructional value of this added capability in corporate training. IBM UK has been experimenting with fiber optic networks in its use of ITV, which has implications for systems integration, costs and security. IBM Australia has initiated a satellite ITV system that has a footprint that reaches to Singapore. The experiences gained from teaching such culturally diverse groups will be extremely important for corporate training functions in multinational environments.

On the "soft" side of technology, IBM has developments underway to support and extend its commitment to the ISD process. ISD, like instruction, is labor intensive and needs to experience more productivity gains and less reliance on highly trained practitioners if it is to make the broad advances necessary across the Company. Programs underway with the development of computer toolkits for the instructional designer offer some hope in this endeavor. Ultimately, the ISD fraternity hopes for a promising application of artificial intelligence (AI) to capture the rules and logic of the interview process in which instructional designers perform a task analysis. Emulating this process by means of a computer-mediated dialogue, similar to successes in the area of medical diagnostics, would offer a breakthrough as IBM starts the momentous move from key job profiles that are course-based to ones that are skills-based.

A major development underway in support of the education strategic plan is the development of the administrative information system. What currently exists are a series of separate application programs that each address a piece of the education process, i.e. student registration at a central education center; education records; common course catalog; etc. An effort is underway to combine these disjoint applications, but more extensive work is required to make this an integrated system. For example, the ideal system would provide self-assessment for learners and generate individualized educational development plans; aggregate them for educational planners; register students in courses; maintain all the student records and charge-backs; and assist site management in skills planning. This system would also help management monitor more closely the effects of training programs on the business, control costs, and aid in its search for better measures of functional excellence.

Another example of an information system that supports the strategic plan is the IBM Technical Information Retrieval Center (ITIRC). ITIRC is a computerized information retrieval system that provides access to published information in the areas of engineering, electronics, programming, materials science, physics, business and computer science. To help employees stay informed in rapidly changing fields, the ITIRC system tracks thousands of journals, reports and conference proceedings. The system has 25 different databases internally and provides access to hundreds more externally. ITIRC's primary function is to help IBM professionals sift through huge volumes of current information and locate documents that correspond to their individual needs. Basically, ITIRC handles this task in two ways: automatic notification and online searching.

Automatic notification is accomplished by having each subscriber enter a key word profile that best describes his/her interests. Then, on a regular basi ., usually once a month, recent entries to the data base are screened against the us .r profiles and "matches" are sent electronically to the employee's work station. In contrast, online searching can occur at any time and is handled in the conventional manner.

As these information and education services coalesce at the employee's desktop or the work station on the factory floor, one glimpses a strategic plan taking hold. Even though IBM is only half-way into its five year plan, instruction of higher quality and effectiveness is being created daily. Steady progress is being made to extend the use of cost-effective alternative delivery systems. ISD competency centers have been established and staffed with highly qualified people. Staff development programs have raised the general level of awareness and skill level for structured education procedures throughout IBM. Further, the Company expects increased growth after a period of relatively flat earnings.

Additional Perspectives

How do these strategic plans and accomplishments square with the larger issue of workforce trends and America's economic future? Perhaps there is no better place to begin than to review the mandate for these economic times--to have a highly trained and flexible workforce which is able to compete in a global economy. The *sine qua non* of the competitive workforce is job performance.

Education and training programs attempt to address this issue by analyzing jobs, designing and implementing instruction and evaluating the effectiveness of this instruction. In terms of IBM's education mandate, the Company seems well on its way toward accomplishing this.

But many factors influence job performance, of which training is but one component. Frequently, training isn't needed to correct a given job deficiency, but rather some other action(s) may be required, such as the redesign of the work environment, new policies, job feedback, better control of consequences, or simply, creation of job aids. What has emerged is a discipline known as Performance Technology that attempts to systematize this domain and prescribe possible actions. A schema for analyzing performance problems and matching appropriate action, both training and non-training, was proposed by Romiszowski (1981) and is shown in Figure 2.

In general, training departments in business and industry have traditionally operated solely in Quadrant #1, producing instruction to solve training problems. They were either oblivious to issues in other quadrants or assumed that other functions would address them. Competitive environments today are not tolerant of these inefficiencies and suggest that a more integrated and effective approach to job performance needs to be taken. Department boundaries, of course, mitigate against this, resulting in piecemeal approaches to job performance problems. A total approach to addressing job performance problems would benefit from a team of people possessing backgrounds in such areas as: industrial engineering;

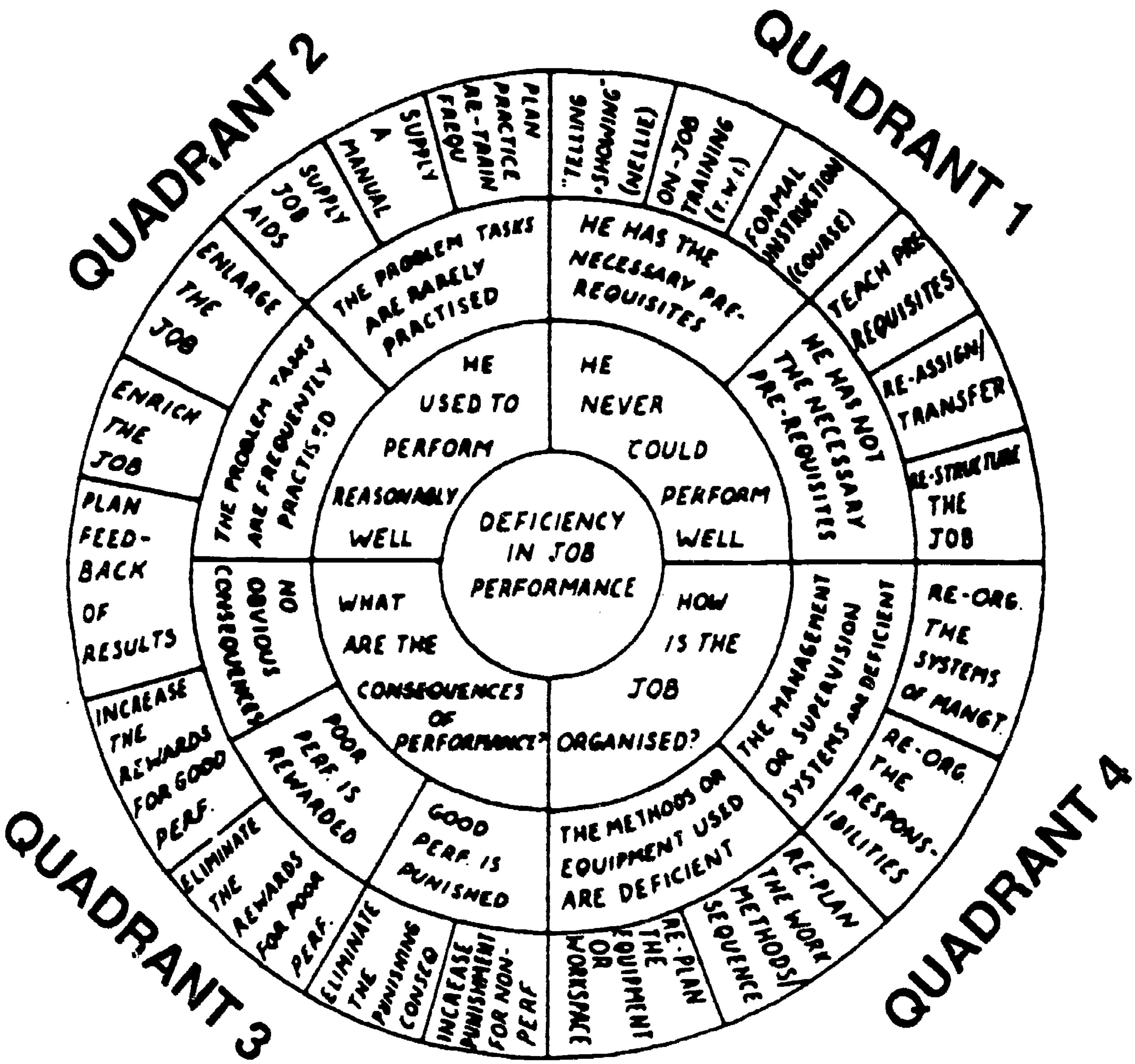

Fig. 2. Schema for Analyzing Performance Problems.

programming systems; human factors; service; finance; industrial psychology; management; personnel; instructional systems design; and alternative delivery systems. A new interdepartmental organizational structure could be created that would in effect have a loose-tight coupling with these people and their diverse skills. The organizational structure that comes closest to this proposal exists in academia as an "institute"--an organization with a mission that cuts across departmental and subject matter boundaries but is staffed with people whose appointments reside in the various subject matter departments. The institute structure permits the college to mobilize these diverse and specialized skills to address problems beyond the domain of a single department. While business and industry have competency centers, they are generally staffed with consulting experts on a narrow subject and lack the diversity required for the comprehensive approach to job performance proposed here. On the rarest of occasions, business approximates this structure in the form of a well constructed task force. But task forces have no continuity beyond the immediate problem which caused their creation, and therefore have limited effectiveness in this context.

If and when training is the recommended course of action, it needs to have a closer fit with work than it now has. Alternative delivery systems have already shown their cost-effectiveness in bringing learning closer to work. External relationships, as cited in Chapter #5, can also be very effective when designed as work study programs and create a synergy between these two areas. It will be the integration of work and learning, however, that will provide the basis of the future organization, or what some are calling the "learning organization." In this organization, learning is continuous with work and performance is supported by everything from apprenticeships to coffee break areas to electronic support systems to formal classrooms.

The second facet of this discussion centers on the term *flexible workforce*. This has generally been interpreted to mean that employees need basic skills to grow past the current stage of technology and its requirements. Employees need basic skills in literacy in order to comprehend complex instructions and manuals. Math skills are required to plot and interpret basic statistical quality control measures associated with their performance. Half of all young American workers, however, do not attend college. Studies reveal that few of this "forgotten half" possess these reading-writing-math workplace basics or receive training on the job to correct them. Analysts predict that the economy is going to depend as much on these less schooled workers as it will on the highly trained engineers and programmers. An insidious double threat is posed since the increasing application of technology to jobs is raising job knowledge requirements at the same time basic skills are falling in entry level workers. This "skills gap" is widening at a rapid pace in the face of accelerated international competition. This current condition is in sharp contrast to the widely-held view of the 1970's that automation would "de-skill" jobs, thereby compensating for the effects of an underprepared workforce. The fact is that technology has displaced only selected low-level jobs into the service industry, and simultaneously raised requirements for the other workers.

Piore and Sobel (1984) argue that another important shift has occurred in manufacturing. Mass production is coming to an end and competition is forcing shorter run cycles, faster turnarounds, and greater diversity in products. Several other social scientists, Bell (1973) and Stanback *et al.* (1981) support this thesis and believe that customized or flexible production is replacing mass production. Berryman (1988) observes that the key to this customized production is the functional flexibility inherent in computer software that is being applied to the manufacturing process. These symbol-rich application systems have essentially reversed the trend of specific skills and specialized machines to general purpose tools and machines, raised the knowledge requirements and called for generic skills, and changed the way work is organized. This call for generic skills squares with the seven skill groups outlined by Carnevale *et al.* (1988) which range from "learning to learn" to "creative thinking" to "leadership skills."

Dertouzos *et al.* (1989) forecast a significant shift in the organizational structure for the new competitive environment. They foresee a flatter organization, which means that many of the service functions as well as layers of middle managers will have to be redeployed for other tasks. With these services absent, the future employee will of necessity face an enlarged job responsibility. For example, not only would this new worker function as a member of a team, performing a variety of tasks, he would also order from his workstation all the raw materials for the manufacturing process. Embedded training in the same terminal would be available on a need-to-know basis to lead the employee through these varied tasks. If these trends hold, companies who aspire to be leaders in high-volume, low-cost, production of goods will want to proceed with caution.

In sum, the economic outlook forecasts more and stiffer competition. The global nature of the economy indicates that this competition will not only come from the Asia/Pacific Rim, but from the "new" Europe as well. In this hotly contested environment, all the signs point to the "knowledge worker" as the basic ingredient of the competitive workforce. To serve as a reminder as to how basic this ingredient is, recall from Chapter #1 Tom Watson, Sr.'s "man philosophy." At the heart of the matter was the individual, and as the company developed the individual, the company, in turn, grew. Complementing this view was Watson's management philosophy that cast the manager as teacher, rather than supervisor or policeman. When Tom Sr. dedicated the Endicott Education Center in 1933, and turned to the site laboratory which was being erected at the same time, he remarked, "These two buildings go hand in hand. They are *both* educational institutions. They represent the heart of our business." This learning organization may not guarantee future economic success, but it would be impossible to imagine success without it.

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