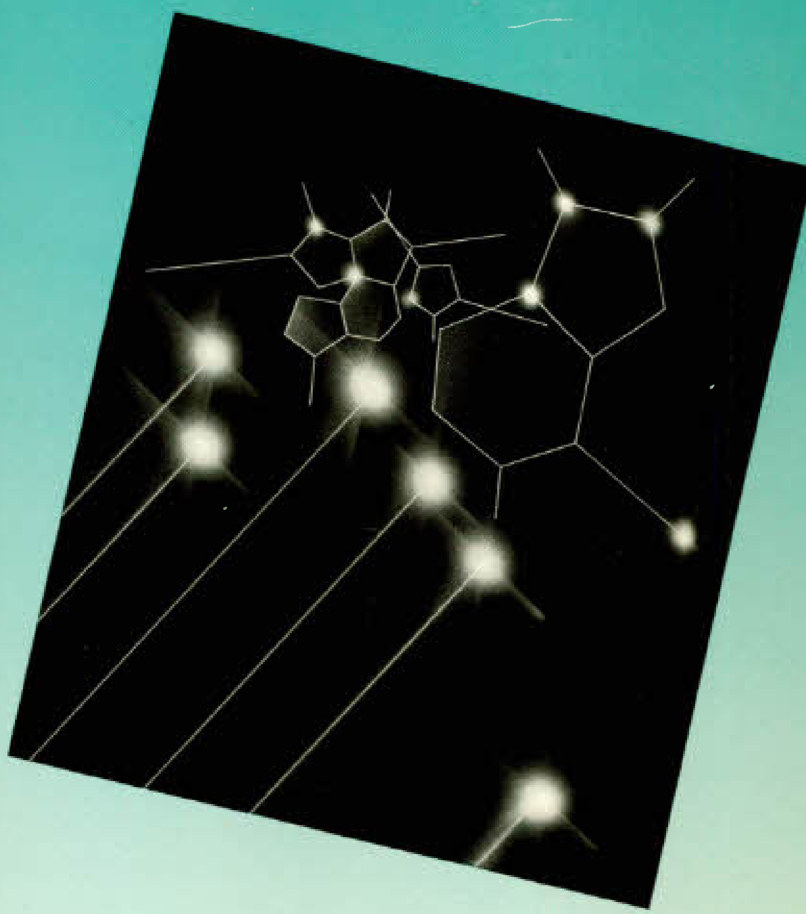
Two Steps Forward

Human-Resource Management in a High-Tech World



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Foreword

This case book is about innovation in Canadian organizations. As such, it covers a variety of technologies in a number of industries. Most importantly, however, it focuses attention on the human side of the innovation process. From its studies on the labour-market impacts of new technologies, the Council concluded that:

> Canadians must innovate on two fronts. Success depends as much on innovations in organization and the development of human resources as it does on technical expertise.

This conviction is reflected in the titles of some of our publications – *Innovation and Jobs in Canada*, *Making Technology Work*, *Working with Technology*, *Workable Futures*, *Workplace Innovation in Canada*, for example – where technology and human-resource concerns appear side by side.

It is important, therefore, that Canadian organizations rapidly adopt not only the best technologies, but also the best practices with respect to the development of human resources. The Council's survey of 1,000 private-sector establishments in Canada showed that the vast majority of technologically innovative firms had also introduced some form of organizational change. Now, through case studies, we attempt to enrich our understanding of the human element in the change process with concrete illustrations from actual Canadian experience. This is not a scholarly tract and is not based on formal economic analysis. It is meant to complement the more traditional statistical analysis and survey work undertaken for the Council's Labour Markets Impacts of Technological Change project. As such, it attempts to capture actual experience with the process of innovation through visits to plants and offices, and through interviews and discussions with employees, managers, and union representatives. We hope that its message will prove interesting and useful to students, practitioners, and policymakers concerned with the process of innovation and change, in general, and with human-resource development, in particular.

Judith Maxwell
Chairman

1 Overview

Two simple tenets are the motivation for this book. The first is that our economic future depends critically upon our capacity to innovate. The second is that innovation must be defined broadly enough to encompass more than just the kind of technological advance that is embodied in new machinery and equipment. Most importantly, it must encompass developments in the enhancement of skills and know-how and in the organization and remuneration of work. Innovation in this broader sense is the essence of "working smarter" in the knowledge-based economies of the information age.

Already employers, workers and their representatives, and (somewhat more slowly!) governments are beginning to pay more attention to innovations in human-resource development. What has come to be called the "new human-resource management" (NHRM) is not just simply a reactive strategy to offset some of the costs of progress – though such strategies are a necessary component of equitable and efficient adjustment. Rather, it explicitly embraces a range of policies and practices designed to enhance the skills and adaptability, the motivation and the performance of people in the workplace. By equipping people to cope with adjustment to change, this approach minimizes both personal and organizational costs and, in addition, ensures the fullest exploitation of the potential of new technologies. Indeed, many contend that there is a powerful synergy between a well-prepared work force and the best possible technology.

Furthermore, the pursuit of this "innovation synergy" will prove to be even more important in the coming years because of demographic developments. With a more slowly growing labour force and a declining proportion of young people – on whom we traditionally rely for fresh ideas based on up-to-date training – we must, more than ever, seek innovative ways to realize the potential of our human capital.

Clearly, questions of reward and performance, the design of work, and workplace relations are timeless. Some may argue that current developments are simply an outgrowth of a long tradition of concern for human beings in the workplace that stretches back to the so-called "Hawthorne" experiments at Western Electric in the 1920s.

Others will recall with skepticism the humanistic approaches to workplace relations of the "quality of working life" (QWL) movement in the 1960s and 1970s. Still others dismissed the recent flirtation with quality circles as simply another manifestation of North American fascination with all things Japanese. Clearly, there is a good deal of skepticism about human-resource management (HRM). Weaned on concepts of hierarchy and control, the denizens of many traditional organizations won their spurs in the countless skirmishes and occasional head-on confrontations of adversarial collective bargaining. Fads come and go, they say; so what is new?

What is new is that global economic and technological realities have changed. Pure technological advantage is a fleeting, transitory phenomenon. Knowledge of, and access to innovations are quickly acquired; and the sheer pace of advance is such that superiority, once gained, may quickly vanish. In such competitive circumstances, technology is a vitally necessary, but not sufficient, condition of high achievement. There is growing evidence that without more flexible, collaborative organizational designs supported by innovative reward structures, even the most technologically sophisticated processes and products may not prosper.

What, then, is the Canadian experience? The case studies in this book are real-life illustrations of technological and organizational adaptation.

For the most part, the field work for these studies was carried out between 1985 and 1987. In some of these cases, there have been significant developments since that time. Some of these, such as the start-up of the Pratt and Whitney Canada (PWC) Halifax plant, were expected. Others – most notably, the sales of Synerlogic and Camco/Fedders – were not. Developments of lesser magnitude have taken place in all of the other cases as well. Change is simply an intrinsic part of history and stories such as the ones that follow will not "stay still." While recent developments have been incorporated to the extent possible, the cases, nevertheless, should be read as the efforts of individual organizations to deal with technological and workplace change at one point in time.

The stories told in this book describe situations where the computer revolution is very much a reality. While the contexts vary enormously, two essential conclusions emerge from each. First, technological change brings with it the potential for profound social and economic impacts. And, second, people can play a critical role in influencing what these impacts will be.

The following chapters describe organizations that have had interesting approaches to new technology and, particularly, its human side. Our objective has been to demonstrate the strong and important link between the human and technological aspects of change through the experiences of a number of different organizations.

Throughout this case book, we try to highlight the keys to successful innovation, and thus to set out directions that Canadian employers and workers might consider in order to make technology work for them. But readers will find no ready-made blueprints or instant answers. Indeed, though many of the cases must be considered success stories, success does not always come easy. We found, for example, that it is not just the firms classified as "failed cases" (discussed in Chapter 8) that had problems: none of the other organizations we studied was exemplary in itself. The field work unearthed practices that were far from ideal or even desirable. These included situations where innovation design was purely technical with no attention paid to implications for job content, where workers found out about technological change only when new equipment arrived at the plant door, where joint decision making really involved management telling workers what it was going to do, where fundamental disagreements between the parties could not be resolved, and where union-free operations were part of planning for high-tech production.

These are not the sorts of practices that will lead to successful change. Taken together, in fact, they would almost certainly lead to disaster; indeed, they are among the observations made in our stories of innovation failures. While we certainly found problems such as those listed above, we did find a number of very promising approaches to social and technical innovations. As these are recounted in the following chapters, it is important to keep in mind the challenges faced by the organizations and their workers in doing some of the following things right:

- featuring advance planning of both the technical and social aspects of change;

- developing job designs that incorporate human discretion, responsibility, and skill;

- retraining so that existing employees will be part of the future;

- adapting technologies to expand opportunities for the disabled;

- sharing the added prosperity brought about by technological change; and

- committing themselves to the concept of "involvement" in which all stakeholders have the opportunity to influence the innovation process.

In many respects, approaches such as these run against the traditional ways of doing things in Canadian industry. Yet, they must become a fundamental part of the hardware and software in the high-technology economy.

The Cases in Brief

"Old Hands, New Skills" tells the story of a New Brunswick company that embarked on an extremely ambitious venture which involved the start-up of a state-of-the-art papermaking plant and, concurrently, the modernization and integration of two pulp mills. To make this work, Miramichi Pulp and Paper had to implement technological change on a massive scale. It also had to completely retool a work force that had no experience with the new production methods. Using a train-the-trainer approach in which designated workers learn to impart skills to their fellow employees, the company was able to carry out a tremendous amount of training in a relatively short time. When the new integrated three-mill operation was ready to go, so were the people to make it work.

Government incentives helped bring the Ford Motor Company's Essex Engine plant to Windsor in the early 1980s. When the plant opened, it had the advantage of an experienced work force of auto workers who had been laid off from other auto plants during the recession. With this advantage came the challenge of preparing these workers to work in a technologically more-advanced plant, to increase productivity and meet the Japanese competition. The story of "People Make Quality 'Job No. 1'" shows how the company trained its experienced auto workers, and how the union and management developed a more cooperative working relationship based on mutually beneficial goals and ongoing consultation. In the uncertain environment of the automotive industry, the plant's productivity may be the key to its survival. That productivity, in turn, benefits from a union-management relationship that works.

The labour-management relationship is a critical ingredient in any innovation situation. If the workers in an organization do not have access to information nor the opportunity to provide input into the innovation process, there are bound to be problems when new technologies are implemented. "Techspeak" is about a Continental Can office in Toronto, where the first wave of office automation was introduced without any sharing of information, let alone joint involvement in decision making; the result was haphazard innovation, which raised a number of serious concerns for the employees. In response, the Steelworkers' local representing the office workers developed a set of principles to guide the introduction of new technologies, which eventually were codified in the collective agreement. With a systematic approach to innovation, which emphasizes joint problem solving, office automation has proceeded in a mutually satisfactory fashion.

Putting people first can be the difference between success and failure when planning for new technologies in manufacturing. Change cannot usually be done from the ground up, but as we describe in "Systems and People," Pratt and Whitney Canada was able to use the opportunity of a new plant to ensure that its "people system" and technical systems would work together smoothly. The company applied the "socio-technical" approach to organizational design to plan a work environment that would get the best out of new, integrated computer systems and a new work force. As this case shows, the keys were planning and consultation. The bottom line can be improved by ensuring that everyone in the organization is reaching for the same goals, both for the company and for its people.

"The 'Plus' Is Employee Involvement" tells how, when faced with tough competition from Japanese firms in the early 1980s, the Orangeville, Ontario, plant of Camco Incorporated introduced a gain-sharing plan to help boost its productivity. When combined with a commitment to employee involvement, good working relationships, and competitive compensation packages, gain sharing can provide tangible benefits to both employees and employers. And a good plan can endure the trauma of change companies may face. With technological changes and increased employee involvement, the Camco plant improved its overall productivity, but eventually succumbed to the overseas competition on a major product line. Then, after years of informal labour-management relations, the plant's workers joined a union. In late 1988, the plant was sold to Fedders Inc. Through all the changes, the gain-sharing plan, called "Orange Plus," has endured and continued to have the support of workers and management.

While the popular image of the high-tech sector may be a collage of 21st-century equipment, the reality is that this industry runs on its people. Human skills – creativity and knowledge – are behind all of the frontier hardware and software so high-tech firms face a powerful human-resource imperative. To make this more challenging, the sector is intrinsically an unstable one. Products have a very short lifecycle, firms come and go, and risk taking never stops. "Change Is the Constant" describes the growth of Synerlogic, an Ottawa-based computer consulting company that has seen it all in its brief 15 years of existence. Throughout the changes that never seem to stop, the company has tried to maintain and apply human-resource strategies that recognize and enhance the creativity and skills of its people.

Even the best technologies can fail when they are improperly introduced and implemented in manufacturing firms. In the case study, "Not in Our Best Interest," six companies' experiences show how *not* to introduce technological change. It is in a firm's best interest to consult the work force before purchasing new technical systems, to do the homework in finding out what innovations are available, and which of these best meets the company's needs. Once the system is brought in, and even before it is in the plant, workers must be trained to work with the system. The implementation of new technologies must be continually overseen by management, with one manager designated to solve the inevitable problems. To work in our best interest, technological change cannot just be bought, it must be managed.

Women in clerical jobs have frequently been cited as the group most adversely affected by new technologies. Certainly, office automation has been rapid and widespread in Canada, and women make up the vast majority of the office work force. "Impact on Women Workers" describes two cases of automation in the federal public service, in office settings staffed predominantly by women. As in many cases in this book, the issues of skills, motivation, job security, and training emerge clearly as crucial factors in the change process. In addition, the Statistics Canada experience illustrates how technological change may be accompanied by organizational innovation such as autonomous work groups. Finally, both government departments' approaches raise certain questions about the impact of new technologies on the fundamental tasks that constitute the content of a job and therefore, by extension, on its evaluation and classification.

While new technologies are sometimes feared as a cause of lost jobs and reduced skills, they can and do work in the opposite way. Such is the case with the design and application of technologies for the disabled. "Breaking Down the Barriers" describes the development of a number of technologies that permit even severely disabled people to perform a variety of tasks that would formerly have been beyond them. Computers, robots, and an array of other devices open up to the disabled not only increasing independence from institutional care but, in addition, the prospect of greater financial independence through rehabilitation to the workplace. A specific illustration of this prospect is the "Computer Comfort" Program of the Vancouver-based Neil Squire Foundation (NSF). With government support and a unique team approach involving scientists, engineers, students, and health-care professionals, this program uses technological devices to accommodate the special needs of thousands of disabled individuals in accessing the personal computer.

Two Steps Forward

Our experience in developing the cases for this volume gives us cause for both optimism and concern. It is clear, from these and many other situations with which we have become familiar, that Canadians *can* exercise the foresight, judgment, and good will that permit the exploitation of new technologies in innovative work settings by a well-motivated and highly skilled work force. This is an important conclusion because of our conviction that only by taking two steps forward – not just technological change, but innovations in organizational design and human-resource development, too – can we smooth our transition to the knowledge-based "information economy."

At the same time, it is equally apparent that the processes of technological and organizational innovation, and human-resource development constitute a complex and continuing challenge. Change is uneven, disruptive, costly, but nonetheless, unceasing. People and organizations, no less than machinery and equipment, need constant care and upgrading.

People and organizations are unique. They do not come with a detailed set of instructions for installation and servicing. With the human dimension of the innovation process, there is rarely a predetermined blueprint for success, but only a few key ingredients and guiding principles. It is regrettable, therefore, that in too many enterprises there is still relatively greater emphasis on the husbanding of financial and physical – as opposed to human and institutional – capital.

Furthermore, although our studies reveal that there are many fine examples of Canadian successes with an integrated approach to the management of workplace innovation – and some are included in this book – it is apparent that too many organizations, while paying lip service to the notion that "people are our most important asset," continue to see human-resource management as an irksome cost rather than a good investment.

We believe that these observations are important not merely to the viability of the individual enterprise, but increasingly vital to national goals of productivity and competitiveness. Many observers regard technological superiority as the key to success in the global information economy. Such superiority depends critically upon highly flexible and innovative organization structures and work forces that can identify and quickly exploit new opportunities.

While public policies can play an important role, ultimately the successful diffusion and implementation of technological change must depend on the commitment of employers and workers, and their representatives.

The conclusions flowing from our case studies demonstrate, in environments as varied as a papermaking operation and a high-technology service company, that people hold the key to effective uses of the latest and greatest technical advancements. With open communication between workers, their unions, and management, and among all levels of an organization, technological pitfalls can be avoided and enhanced productivity and job enrichment can result.

The cases also show that virtually all workers can be trained and retrained in the new skills demanded by technological change. High-tech jobs can be made to be more challenging and interesting for employees, and can sometimes result in better-paying, higher-status positions. Where job content is not improved by technology, new work arrangements, including greater autonomy for workers, can increase job satisfaction.

The cases highlight the critical role of communication in implementing technological and organizational changes in the workplace. A strong union and strong management team can both benefit if common goals are agreed upon and problems are dealt with openly. Even where "fighting, stumbling, and arguing" are necessary to get past the roadblock of intransigence, positive results can ensue. In the end, there is a significant degree of complementarity between workers' needs and management goals. All can win.

Furthermore, employee participation is important in designing work systems that "fit," and in increasing workers' accountability and independence in their jobs. Without adequate planning and involvement of both managers and line workers in its implementation, technological change can wreak havoc on a company's performance.

We have also seen that truly "user friendly" technology can enhance the quality of life and work for people with disabilities. Slowly, but increasingly, the potential of the disabled work force is being recognized. The imaginative application of technology to the needs of the disabled is an important dimension of human-resource development.

In the end, Canadian industry faces a choice about how it will operate in the emerging high-technology world. One option is to pursue the traditional logic of automation – essentially, the mechanistic substitution of technology for people, without considering organizational or social implications. Alternatively, it can view the adoption of new technology more broadly than as a simple enhancement of production techniques; the cases described here demonstrate how the nature of work and organizations can be reshaped along with the technology to better respond to the goals of employers and workers. The choice is ours.

2 Old Hands, New Skills: Training the Trainers at Miramichi

In the summer of 1986, one of the most advanced coated-paper mills in the world started up in the Miramichi Valley in northeastern New Brunswick. Technologically, the Miramichi Pulp and Paper plant at Newcastle is unique in terms of the scale and complexity of its equipment and processes. This state-of-the-art technology – along with the concurrent modernization and integration of two existing pulp mills – has understandably received a lot of attention within the industry.

The Miramichi story, however, does not end with the ultra-sophisticated pulp and paper machines and computerized control systems that dominate the new operations. It also features a unique "people" approach that has emphasized a company commitment to include its existing workers – many of them older and poorly educated – in the new era. In carrying out this commitment, Miramichi has undertaken a massive retraining effort that has included virtually all of its employees, many of whom have had to learn skills very different from those they previously possessed.

Bringing a high-technology three-plant pulp and paper operation on stream and staffing it with a completely "retooled" work force has been a great challenge for Miramichi and its parent company, Repap Enterprises (Repap). This challenge and the promise of meeting it were neatly summed up by the Repap executive vice-president shortly after the paper plant opened:

> We took two relatively older pulp mills, upgraded them and married them to an ultra-modern paper machine. Now look at this facility, it's world-class. The pulp mill has a future, the area has a future, and there's a lot of people learning new technology and they're doing it well.

The Coated-Paper Solution

No one had seen a coated-paper mill in the region's future but, in retrospect, Repap's decision in 1983 to build the new paper plant in the Miramichi Valley made a lot of sense. The long-term prospects for coated paper were good and, with very little domestic competition in lightweight grades, opportunity existed for a producer who could serve the Canadian as well as the eastern U.S. market. And coated paper is something Repap knows how to make and sell. The corporation was already established in the industry through a subsidiary, Midtec Sales, which manufactures high-quality lightweight coated paper in its Kimberly, Wisconsin, mill and markets it through an expanding North American network.

In addition to the apparent product demand and this established "know-how," a Repap coated-paper plant in the Miramichi Valley represented a creative solution to a number of issues facing the corporation. To appreciate this requires a bit of history. In 1962, a groundwood pulp mill was opened in the Newcastle area by Italian interests, primarily to provide pulp for newsprint in Italy. The plant, known as the Acadia mill, was sold in the mid-1960s to Jannock Industries and then again in 1974 to Repap. At that time, the groundwood mill's pulp was used for newsprint, tissue, and multi-ply boards. In the late 1970s, the plant began producing a higher quality pulp for papermaking, particularly coated paper. While the Acadia mill had potential – including a wood supply well-suited for papermaking – it was an old, outdated plant with productivity levels that were too low for the increasingly competitive groundwood pulp market.

By the early 1980s, something clearly had to be done with the Acadia mill. At that time, with the Midtec coated-paper plant in Kimberly, Repap had an interest in completing a "backwards" integration into raw materials. Pulp, of course, is the main input in papermaking. Two kinds are required: mechanical and chemical. Repap was already making the former in the groundwood mill. Across the river in Newcastle, Boise-Cascade was producing chemical pulp in a bleached-kraft plant. When this mill became available, Repap management decided to buy it and add on a coated-paper plant, thereby developing a fully integrated pulp and paper operation in the Miramichi.

It all fitted together for Repap to make coated paper in the Miramichi. Papermaking was a business the company knew, the market seemed favourable, and the plan offered the benefits of vertical integration. An important part of the strategy was the marginality of the pulp mills by themselves. The paper mill guaranteed a demand that was critical, particularly for the groundwood pulp operation. In the final analysis, it must be understood that the coated-paper plant – with a high value-added product and requiring the two types of pulp – was the key to the Miramichi solution.

Modernization and New Technologies

New technologies were introduced at Miramichi Pulp and Paper on a massive scale. To begin, there was the start-up of one of the most technically advanced coated-paper plants in the world. Then add to that the wholesale modernization of a groundwood mill that was at least two decades behind times and, finally, more moderate innovations to the kraft mill. The challenge associated with all of this technological change was heightened by Miramichi's tight schedule. Ground breaking for the paper plant took place in May 1985, and the plant began producing 14 months later in July 1986. The modernization of the groundwood mill started in September 1985, and the first phase was completed less than a year later.

The technology in the coated-paper plant represented the "state of the art" that was available when the mill was being planned. Repap management stressed, however, that at the time the company did not see itself as technology "pioneers." (Interestingly, the company has very recently committed itself to a new paper plant at Newcastle that will use a pioneering papermaking process.) According to the general manager of the Miramichi complex, the coated-paper plant was designed with "up to date *proven* technology." Nevertheless, putting all of this highly advanced technology into a single, integrated, large-scale system in a new setting represented a tremendous challenge.

The technical uniqueness of the coated-paper mill essentially resides in two areas – first, *production* equipment and processes and, second, *control* of the manufacturing processes.

The production of coated paper essentially involves four stages: papermaking, coating, smoothing, and rolling and wrapping. At each stage, the technology installed at Miramichi was the most advanced that was available at the time.

- The paper machine was among the widest and fastest in the world. It involved a forming concept that produces a sheet which, for printing purposes, is almost identical on both sides. The press section has an extra press that increases drying and also improves the even-sidedness.

- The coating process was to be carried out with the largest, fastest machine in the world.

- Smoothing and glazing involved two huge supercalenders that add to the even-sidedness of the sheet.

- The winder was designed to wind large-diameter, wide-width rolls that are compatible with the emerging technology in printing presses. The roll-wrapping system included label printing and shipping documents.

Computerized control of all stages of the manufacturing process was highly advanced. The system installed at Miramichi gave the company extensive ability to control quality and costs. Distributed process control covered everything from stock preparation (the blending of pulps and other raw materials) on. A management information system provided detailed data on raw material inputs, machine efficiencies, and costs. Before the mill started up, the significance of this control capability was explained by Repap's executive vice-president:

> In essence, we will be able to track a specific product through every single step in the process. We will know exactly what our raw material costs will be at each stage. It's a management tool we never had before.

At the same time that all of this high technology was being installed in the new paper plant, Miramichi was modernizing aspects of its pulp operations. It was critical that the groundwood and kraft mills, as the pulp suppliers for the coated-paper plant, be technically efficient and competitive operations in their own right.

Of the two, the kraft mill needed less attention. Built in the late 1940s, it underwent extensive modernization in the early 1970s and again after 1977 when Boise-Cascade took it over. Since Repap bought the mill in 1985, technological innovation has centred on the installation of the same advanced computerized process control system used in the paper plant. Other technical modifications have been made to certain stages of the kraft pulp operation in order to establish a smooth technical integration with the paper plant.

In the groundwood plant, modernization was much more extensive. According to the plant manager, by the mid-1980s, this mill was 20 to 25 years behind times in terms of technology. The price tag for this lag was poor productivity. The groundwood mill manager noted that a new thermal mechanical plant was producing 525 tons of pulp per day with only 71 employees. His mill, on the other hand, was getting out only 380 tons per day in 1983 with nearly 300 workers. After modernization was completed, the plant was to produce roughly the same tonnage (although the product mix changed) with about 150 fewer people.

Technological change has affected most stages of production in the groundwood mill. New systems have been introduced to receive, sort, and grind wood, and the pulp machines have been replaced as well. A high-technology control system has also been installed. In the words of the mill manager, modernization has taken the groundwood mill from "no-instrumentation operations to full computer control."

The Training Challenge

The start-up of the coated-paper mill along with the modernization of the pulp operations was much more than simply a technical feat. A great deal of the action took place on the human-resources side. While high-technology systems were being designed and installed in the Miramichi plants, the company carried out a massive training program to develop the skilled work force necessary to make the whole thing run.

The scale of the retraining effort grew a great deal because of the approach taken to staff the integrated operations. Early on, Miramichi made a public commitment to give priority to its existing workers in filling the jobs for the new paper plant. This had significant training implications since many of the workers, particularly in the groundwood mill, were older and poorly educated, some with literacy problems. Workers such as these tend not to be included in the plans of companies undergoing wholesale innovation. At Miramichi, special efforts were made to ensure they could make the adjustment. Basic literacy efforts were required in some cases. As well, the trainers were selected very carefully. A point was made to show the workers other older workers who had already made the transition to high-technology production. And, symbols, rather than printed words alone, were used on control panels.

With this principle of a commitment to the existing work force, a staffing policy was negotiated by the company and the two Canadian Paperworkers' Union locals that represented the pulp mills.

That employment strategy gave everyone in these two mills and in the woodlands operations an opportunity to apply for the jobs in the coated-paper plant. Since job classifications and wages were going to be high in the new mill, the prospect of transferring was generally attractive. Accordingly, about 400 employees – a majority of the existing work force – applied for just over 100 papermaking jobs.

The necessity for training did not stop with the new paperworkers. The company-union agreement stipulated that the pulp mill positions previously held by those selected for the papermaking operations were to be filled by an internal posting procedure. And the jobs previously held by the successful bidders for these positions were, themselves, filled in similar fashion. Even where the jobholder did not change, some reskilling was usually dictated by the modernization that was taking place. In the end, the holder of virtually every job in the revamped three-mill operations required retraining.

When the retraining effort got under way in the summer of 1985, the company and workers certainly had their work cut out. Most obvious was the sheer magnitude of the effort that was called for. Also, there was not much time. The paper plant was scheduled to start up in July 1986 and completion of the first stage of the groundwood mill modernization was expected at around the same time. Furthermore, pulp production had to be maintained throughout. To add to the challenge, existing employees had no papermaking experience and some, particularly in the groundwood mill, had only worked in relatively low technology operations.

Finally, back in the summer of 1985, it was not entirely clear what the exact content of the paper-mill training programs should be nor who should be trained for what. While Repap had decided on the machinery and equipment to be installed, much of the technology was developmental and customized for the Miramichi plant. As we will see later on, this posed difficulties in the design of training programs, since it was often difficult to anticipate what the operators would actually have to learn in order to do their jobs in the new system.

Moreover, the design of the individual jobs and who was going to occupy each created additional problems. The actual job structure was under union-management negotiation, and it was not until early 1986 that a classification system delineating specific jobs and identifying worker assignments was finalized.

The Train-the-Trainer Approach

Traditionally, training for a new production system, whether it is a greenfield site or modernized operations, is carried out in a "top-down" fashion. People with specialized knowledge – typically vendor or engineering company representatives and plant supervisors and engineers – train the operators. In this model, the people who will be running the equipment are usually taught only those parts of the production system that they will be operating. The ultimate technical expertise, then, does not reside with the workers on the floor but, rather, with managers and engineers.

In contrast to this traditional model, Miramichi management chose a train-the-trainer method to develop the vocational skills it required for its revamped operations. While there are many variations on this method, the company decided to follow an approach where selected operators were trained to teach the new skills to the rest of the front-line workers. With this format, Miramichi was able to carry out the necessary high volume of training while at the same time developing a substantial core of workers on the shop-floor with superior technical expertise. Perhaps most importantly, the train-the-trainer approach offered a strong force for employee involvement.

The decision to go with this training approach was influenced by a successful "Train-the-Trainer" Program in the bleached-kraft mill around 1980. At the time, the plant was still owned by Boise-Cascade (Boise). Although Boise had invested $50 million in a mill-improvement program in the late 1970s, it was having productivity problems. A survey of the workers had revealed a widespread need for training. In response, Boise management decided to adopt an approach known as "train-the-trainer," which was being used by MacMillan-Bloedel in its Powell River papermaking operations. This method turned out to be a successful one for Boise-Cascade which made it attractive for the Miramichi integration. Generally, workers and managers who had been involved in the Boise exercise had had positive experiences.

To help in the implementation of a new Train-the-Trainer Program, Miramichi managers brought in ARA Consultants. The senior consultant on the project had been involved with a number of train-the-trainer initiatives including the 1980 Boise-Cascade effort. The role of ARA Consultants was to work with management in planning and scheduling the project. Making it function, however – and this is critical – were the employees.

The core principle of the Miramichi approach was employee involvement: front-line operators were to be the trainers even though none had papermaking experience. That expertise was to come from Repap's Kimberly mill and, also, from the new plant's superintendents and supervisors who had been recruited from the paper industry; it should be noted, though, that while these individuals had papermaking backgrounds, most did not have experience with the equipment being introduced.

Miramichi's Train-the-Trainer Program was initially conceived for the paper plant. It was expanded, however, to include training required in the pulp mills. Here, modernization dictated a need for retraining, particularly at the groundwood mill. As well, training was necessary to prepare replacements for those workers going to the paper mill or moving elsewhere through the internal posting procedure. Indeed, a Train-the-Trainer Program was eventually put into place at the Midtec Kimberly plant in order to hone the skills of its experienced paperworkers!

The coated-paper plant was scheduled to begin producing in the summer of 1986, and preparations on the training side began just over a year earlier. An overview of the train-the-trainer process is shown in Figure 2-1. An important aspect of the planning stage was the selection of trainers. Eventually, for the paper plant, there was a core of 16 trainers for the operators and 12 for the maintenance personnel. All of these people were in place by October 1985. While the ensuing description focuses on the experience with these trainers, the Train-the-Trainer Program at Miramichi extended far beyond these 28 people. In total, almost 80 people received trainer-training courses for the pulp and paper operations.

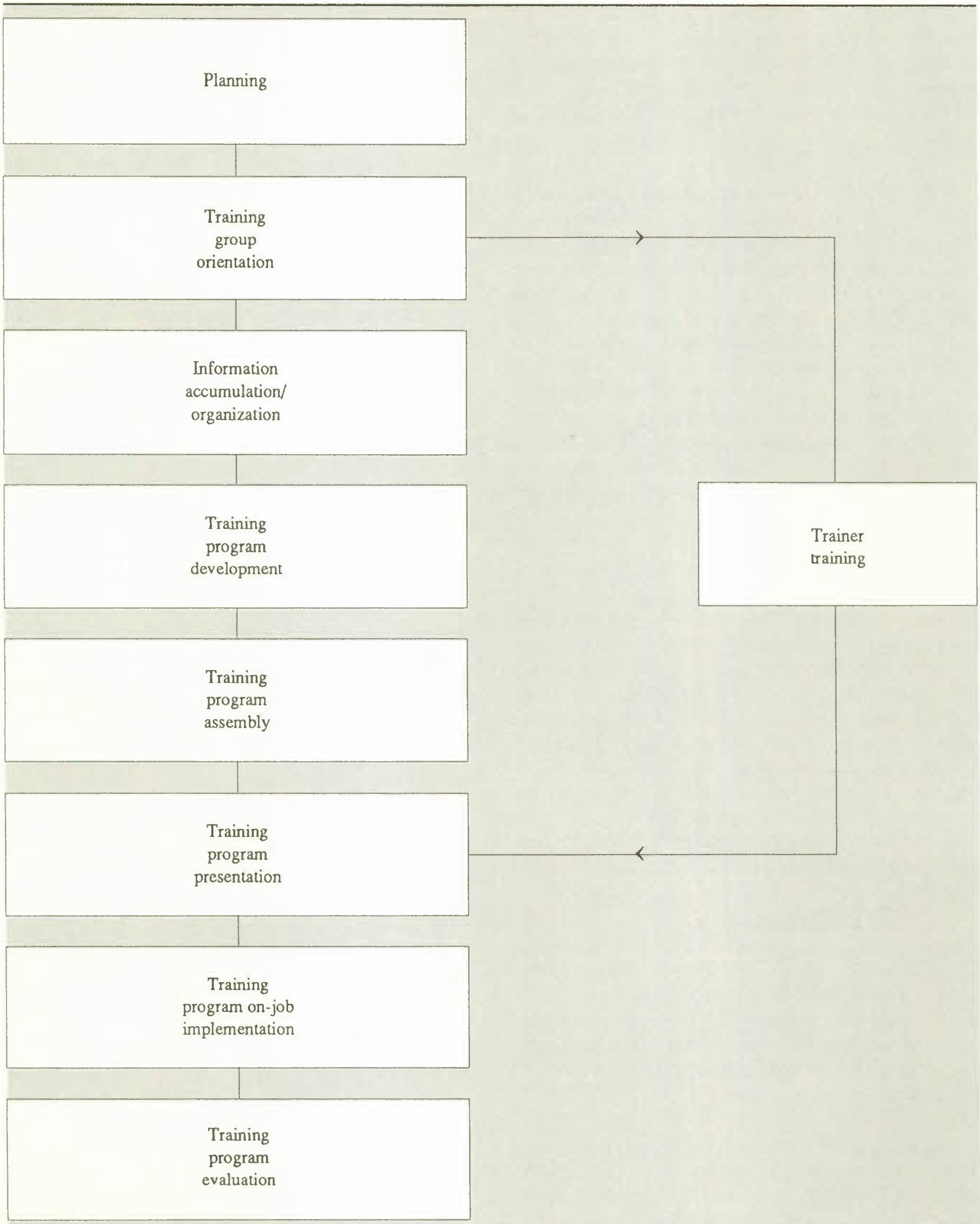
Trainer-training involved a number of activities. These essentially fell under two areas: developing course material and learning how to communicate it. Initial trainer-training for the paper mill focused on course material. While communication and group skills had been important factors in their selection, the trainers generally did not have formal experience in training. Accordingly, orientation sessions were given in teaching techniques and, also, job analysis, blueprint reading, and manual writing.

The bulk of the trainer-training, however, dealt with the preparation of the course material. This began with the accumulation of information by the trainers on the aspect of the mill operations they were scheduled to have responsibility for. Naturally, the specific training assignments required a detailed job design. However, the company and the union had different concerns regarding job design and its classification implications. It turned out that rather lengthy negotiations were necessary to resolve these differences.

The original plan for the operator job-classification system in the coated-paper plant was put together by management in the summer of 1985, as the Train-the-Trainer Program was just getting started. The idea was to have four lines of progression corresponding to the main stages of the production process. The top four jobs on each of these ladders were to be filled by employees who had been selected as trainers. The 16 trainers, then, would have the top-paying jobs, which the company proposed would all be at the same wage rate. In this way, each trainer would have a definite "jurisdiction" of training responsibility, would be rewarded with one of the top-level jobs in that area, and there would be no value placed on one area over another.

Figure 2-1

Overview of Training Process



The company's proposed job design, however, raised difficulties for the union. One concern the union had was that it did not conform to the Canadian Papermakers' wage scale established in other paper mills. The job design for the paper plant went through a number of iterations before the parties came to an agreement in February 1986. The eventual classification scheme had a different wage hierarchy and even somewhat different ladders than the original proposal.

The difficulties in arriving at a job-classification system posed problems for the training program. Without a finalized plan, it was not always possible to establish who should be trained for what. Operators could be trained on one machine, for example, with the possibility that they would have a different assignment once the job hierarchy was finalized. The classification problems particularly affected the trainers who had been given expectations regarding their own job assignment and classification. Trainers were investing considerable time and energy into learning the technical process in their area and, with the classification difficulties, it was not always clear that they were going to wind up employed in that area with one of the top-paying jobs in the mill.

Finalizing the job design was not the only obstacle the trainers faced in preparing for the actual training courses. As well, since they had come from the pulp mills, none of the trainers knew much about papermaking. Certainly, they did not know about papermaking the way paper was going to be made in the state-of-the-art Miramichi plant. While the mill's managers, drawn from the paper industry, as well as people from the Kimberly plant were resources, the trainers had to draw heavily on vendor manuals and engineering and construction material. Much of this information, however, was slow in arriving and not always particularly suitable for operator training. In fact, the manuals for some Brazilian-made equipment arrived in Portuguese!

Gradually, as the necessary production details were pieced together, trainers assembled course manuals. At this stage, the contribution of a training materials production crew became important. This crew included a training consultant, a technical writer, graphic artists, word-processor operators, and video technicians. When courses were eventually finalized, some were videotaped as a supplement to live lessons and for use in retraining.

The development of the training manuals and courses took place over about a six-month period beginning in the fall of 1985 when trainers were selected. In early 1986, advanced trainer-training was given for lesson planning, preparation, scheduling, and presentation. Trainers developed teaching skills by giving lessons to each other. This also permitted cross-training, which was consistent with the company's interest in multiple skilling.

In Miramichi's multiple-skilling approach, employees in the paper plant were to receive training for their own position and for the two jobs immediately above. While this is difficult to do in the on-the-job component of training, multiple skilling was pursued in the classroom. It helped employees understand how the operations actually worked, and it made things easier when it came to promotions and providing relief.

By February 1986, about six months before the anticipated start-up, the actual training for paper-mill operators and maintenance personnel began. This involved short orientation courses, theoretical and practical training at Kimberly, and then a return to the classroom at Newcastle. At the same time, it should be pointed out, training was under way elsewhere in Miramichi's operations. One important function of this activity was replacement training in the pulp mills to free up those employees who had been selected for the paper plant.

As the papermaking equipment began arriving, the training effort started shifting to the mill floor. The installation of the technology included an extensive simulation and testing program; and this was used as an opportunity for operators to begin on-the-job training. As well, modification and updating of training manuals and courses continued. After start-up, in fact, a number of trainers revised manuals based on the operating experience; this proved to be extremely useful subsequently when replacements for the original operators had to be trained.

Conclusion

In July 1986, the production of coated paper began at Miramichi on schedule. The integration and modernization challenge was formidable and continues to be so. The technology involved has deservedly attracted considerable attention. At least as important, though, has been the development of a work force capable of running the leading-edge technology.

Overall, the Miramichi training initiative to prepare the work force for the integrated three-plant operation cost about $6 million and involved about 600 workers. A range of parties – the company, union, consultants, and government – played some part in this effort. What was required in terms of numbers and time was considerable. So, too, were the obstacles facing many of the individuals who had to get retraining.

Many of the workers were older, virtually none had experience with papermaking or with "state-of-the art" technology, and a number had basic literacy deficiencies. The difficulties associated with the negotiation of a job-classification system, for example, created uncertainty, procedural problems and, to some extent, dampened trainer morale.

At a more fundamental level, people's attitudes had to change for the program to work. A train-the-trainer approach poses an inherent threat in that it takes some of the power out of the hands of those who are used to having it. In traditional settings, managers, supervisors, and engineers possess the ultimate technical knowledge required to run the plant. They then transmit this knowledge downward in the doses they view as necessary for the operators to do their job.

In a train-the-trainer setting, such as Miramichi, on the other hand, the hierarchy of expertise is, in a sense, turned on its head. There is no question that this requires considerable adjustment on the part of management. When companies introduce this type of approach, managers must also receive "training" in order to understand and support the new reality. Where this is done, train-the-trainer can be a powerful method not only for meeting skill requirements but, also, for heightening employee involvement in an organization.

3 People Make Quality "Job No. 1"

When the Economic Council first visited Ford Canada's (Ford) Essex Engine plant in 1986, the work climate was one of uncertainty: one of the two shifts was about to be closed down in preparation for the plant's conversion to produce both front- and rear-wheel drive engines; union and management could not agree on which workers should receive training; and Ford's Employee Involvement (EI) Program had been disbanded after a vote among the plant's employees showed that they wanted the initiative discontinued. When the Council prepared to update its case study in 1989, it was with uncertain hopes for the plant's performance. Instead of finding a plant in difficulty, however, the Council discovered that Essex Engine had become the first Ford plant to win the prestigious Q1 Award from its parent company. As the Council learned, the story of the plant's success from 1986 to 1989 was testimony to the importance of a continuing dialogue between union and management representatives, respect for each other's views, and a consensus on mutually beneficial goals.

The Essex Engine Plant

The Essex Engine plant is part of a five-plant Ford complex in Windsor, Ontario. It shares a site with the Essex Aluminum plant, and two other engine plants and a casting plant in Windsor are also grouped together in the complex. There are three plant managers for the five plants – one at the Essex Aluminum plant, one at the Windsor Casting plant, and one who oversees all three engine plants, including Essex Engine. The site is a single local for the Canadian Auto Workers (CAW).

The Essex Engine plant was built in 1981 to produce the 3.8-litre V-6 engine used in the Ford Cougar, Thunderbird, Mercury, and LTD. A conversion begun in 1986 and lasting 14 months enabled the plant to produce both front- and rear-wheel drive engines, and added volume to its production. As of 1989, the plant produced three engine types: front- and rear-wheel drive engines for the Taurus and Sable; Thunderbird, Cougar, and Continental engines; and the supercharged engine for the Thunderbird Super Coupe. Its products put the plant in a good niche: manufacturing fuel-efficient engines for mainstay vehicles that have been in demand.

The plant covers 1.6 million square feet and was considered state-of-the-art by industrial standards at the time it was built, with features including 20-foot wide main aisles, high ceilings, an adequate storage area for parts, and well laid-out production lines. Because it was designed just as the emphasis in automobile production shifted towards the implementation of programmable equipment, the plant's manager described its technology at the time the plant opened as "a modern facility," but not necessarily "high tech."

Ford received $66 million in direct subsidies from the Canadian and Ontario governments for locating the plant in Canada. In addition, $2 million was allocated for the industrial training of the plant's work force from the federal Critical Skills Training Program. Although there was considerable controversy over the government incentives to the company, supporters pointed to the potential for an estimated 2,600 new jobs, generating annual taxable income of $70 million in the community. The forecast of 2,600 jobs has not been met. Except for the plant's conversion period, when only about half the work force was required, the plant has averaged about 1,100 employees since it opened.

Engine-Plant Technology

Engine-making operations have become relatively standardized over the past 20 years. There are automated machining operations that manufacture the cylinder heads, cylinder blocks, and crankshafts. There are additional machining operations that manufacture the camshaft, piston, intake manifold, and connecting rods. These parts, along with the flywheel, oil and water pumps, and other subunits – some of which are purchased from suppliers and subassembled at the plant – are put together in final assembly operations. In the final assembly process, the engine undergoes comprehensive testing.

Technological advances in machinery control systems allow for greater flexibility of operation and less production time lost through set-up and inspection. Sensors monitor tool wear, and precise measurement systems can detect slight changes in part cutting and automatically make adjustments. Computer-driven equipment can produce faster, more accurate cutting machines. The micro-computer can also generate a preventive tool-changing schedule, which may eliminate some costly breakdowns, and offer a scheduling capacity that saves costs in inventory control.

Essex Engine's technology is reliable. For example, its programmable controllers are "up" more than 95 per cent of the time, considered robust for industry.

On the recommendation of the engineering group, Essex Engine management has standardized the choice of suppliers of robots, controllers, gauging systems, and computer numerical control applications. As the available technology changes, Essex Engine adopts the improvements offered by the same supplier from which it had purchased the previous system, instead of shopping around for slight advantages in price or technology. While the plant may pay more for some of its technological improvements, or lose out on the increased flexibility or quality that may have been achieved by other vendors, it gains by being able to capitalize on workers' familiarity with the vendor, the vendor's training staff, and the equipment. The introduction of technological change is thus incremental, rather than revolutionary. The plant's experience with this sole source supply system has been that the suppliers it has selected have provided state-of-the-art products, although sometimes at a slightly higher cost. The firms selected have proven stable, while other suppliers have come and gone from the marketplace.

From 1986 to 1989, the plant managers introduced new technology into the Essex Engine facility and extensively upgraded existing technical systems. The plant uses servomotor robots in machining and assembly areas. Vision systems are used to check the physical location of certain points prior to proceeding to the next operation.

The Essex Engine plant uses statistical methods to control the operations and measure variability in production on significant dimensions. Statistical process control (SPC) has been considered one of the "soft" technologies that surround, support, and manage the entire production process. Statistical data are collected, analysed, and used to evaluate the performance of a particular process or machine. SPC is used in all of the machinery and assembly operations at the Essex Engine plant.

The plant has used its computer technology to gather the data necessary to ensure quality production. For example, data from 50,000 engines were automatically collected from the cold engine test to develop a normal statistical curve of the engines' performance. As engines are produced, they are tested against that standard and any variations are investigated. A deviation from the norm may not indicate a defect, but all such variations are checked out. In one instance, workers identified a deviation from the standard in a shipment of 3,000 engines that had left the plant. Management determined that about a dozen of the engines could be different from the norm. It may not have been a defect, but the workers had noticed the difference, and management's response was "Bring 'em back."

Essex Engine has relied on workers' experience, skills, and knowledge to make the most of the technical systems in place. Because the plant manufactures two-cylinder heads, for example, it developed a one-of-a-kind recognition system to ensure that the proper parts are used for each engine type. "We invented as we went along," in the words of the engineering manager.

The Work Force

The work force in an engine plant is organized around its automated production process. Operators, who feed stock to the machines and who run the entire manufacturing process, and assemblers and testers in the final engine assembly operations represent the majority of the hourly work force at Essex Engine. Skilled tradesmen such as electricians and pipe fitters maintain and repair the equipment in the plant.

The introduction of computer technology in the final assembly and testing areas has an impact on the work force. New computer applications in robotics, machine vision, or new computer-controlled gauges have an impact on the job skills and the number of workers. The application of three robots in the valve insertion operations at Essex Engine eliminated the requirement for three operators, for example.

The emphasis on making the plant's processes more reliable reduces its reliance on after-the-fact inspection. But any inspectors whose jobs have been eliminated as a result of the process improvements have been absorbed across the site. Indeed, since a majority of the machining operations is already automated, there is little direct labour displaced by new technological advances. If anything, they increase the significance of the skilled workers who maintain the equipment.

For the local plant management, there is no question that part of the reason for the implementation of the technology is that there should be a gradual decrease of employment without a loss in quality, thus increasing the plant's overall competitiveness. The continuing high capacity of the plant with a mix of products and slightly declining employment levels would indicate that this has, in fact, been achieved.

Productivity

In October 1985, the Essex Engine plant was producing 2,350 engines daily, which represented 100 per cent of its capacity at that time, with 1,162 hourly and 305 salaried workers. As of April 1988, with the ability to produce both front- and rear-wheel drive engines, the plant had 1,100 hourly workers producing 2,214 engines daily, considered to be total capacity.

Management says that the plant's productivity has improved 85 per cent since it opened, but they believe that Essex Engine must achieve production levels of three engines per person, per day, or better by 1994, in order to remain competitive. They expect progress to be made in small steps through the efforts of everyone in the plant to improve processes, reduce waste, and innovate.

As engine-making costs drop, it may be possible to have engine plants adjacent to assembly operations, as was done for the General Motors Saturn Automobile. If this trend continues, a new generation of smaller engine plants will develop, and facilities such as the Essex Engine plant could be considered less attractive, thus making the need for high productivity at such plants all the more important.

Union-Management Relations

The hourly workers at the Essex Engine plant are represented by the Canadian Auto Workers (CAW) Local 200, which also represents workers in the four other Ford plants in the complex. A contract provision negotiated by the local gave workers, laid off from the other two engine plants during the downturn, transfer rights for the new jobs at the Essex Engine plant before new workers could be hired. Thus, since the plant opened, it has always had an experienced work force. While Ford management publicly stated that the experienced work force was "a plus for us," clearly the human-relations issue has been to introduce technological change in a new plant with an existing labour force.

Just as workers facing layoffs from other Ford facilities in the bargaining unit, who have higher seniority than Essex workers, can "bump" into the plant, workers at Essex with higher seniority can bump into the other plants. Thus, the work force at Essex is altered not only by the change in demand for its engines, but by the demand for the products made at the other two plants.

Employee Involvement

In order to improve productivity in the early 1980s, the Ford Motor Company sought the involvement of workers in regular discussions with lower level management on ways in which this could be accomplished. From the company's perspective, Employee Involvement would ensure a greater concern for quality and provide a forum to discuss the problems with the implementation of the technology.

EI was introduced at the Essex Engine plant when it opened. In 1981, there were 22 EI teams, each consisting of eight or nine people. Each group was considered a problem-solving team, and each participant was given 20 hours of training, including a course in public speaking, communications skills for meetings, and value clarification.

The Canadian Auto Workers, however, unlike their American counterparts, were suspicious of the EI concept, because they believed it could undermine the collective agreement and what they perceived as the "natural" adversarial relationship between management and labour. This view was held by the workers and leadership of CAW Local 200 as well, and the plant's EI program was disbanded after a plant-wide referendum in 1985.

Finding Common Ground

Despite the cancellation of EI, progress was made in working relationships and the ability to resolve problems on the shop floor.

The union representatives and management point to a three-day "Managing Conflict" Program offered in London, Ontario, by Ford's Dearborn Training Department in March of 1988, as a critical point in the development of a positive working relationship at the plant. During the program, which involved role-playing sessions where management took on the union role and vice versa, each came to learn important lessons about the other. As the plant's industrial relations manager points out, they learned that, "It's very easy to be at war – it is difficult to try to understand each other's views and get along."

In 1986, product line changes and the resulting changes in jobs led to workers' complaints about jobs which were "too tight" or "not tight enough." Management's response was typically, "That's the way it is." In 1989, when line changes led to problems in job content or processes, management's response is likely to be, "If it's too tight, we'll change it – for an honest day's work." The union and its members are committed to providing that honest day's work. As Local 200's chairperson says, "You don't make money on layoff." Both the union and management want Essex Engine to be profitable, productive, and known for its quality work. With a common goal, there is a mutual desire to seek solutions to problems.

There have also been changes in personnel, management, and the union since 1986. With a plant manager who has worked in every part of the engine business and who insists on a clear vision of the plant's goals, the emphasis in hiring new managers is on finding people who will fit in to Essex Engine's approaches to union-management relations and quality. Assignments for managers and supervisors are decided on the basis of people skills, not just technical skills. And management continues to work on developing the relationships in the plant.

Historically, there has never been a high number of grievances at Essex Engine. And today, with an increased emphasis on solving problems on the shop floor, the industrial relations manager becomes involved with union complaints only infrequently. The union says that the manager's willingness to listen has made a big difference at Essex Engine, and that the "guys in Windsor give it their best." The manager responds by saying that there is a "very strong work ethic" in Windsor.

Winning the Ford Motor Company's Q1 Award was the result of a collaborative effort between Essex Engine's management and union. As the two sides worked together to maximize productivity and demonstrate to head office their commitment to and success in achieving quality production, they developed a greater openness in their relationship. The union and management started to deal with problems differently; they worked around the intractable, gut issues which cannot be solved easily, and talked openly about rumours which in the past had led to disquiet among workers and stoic silence among managers. With free trade and intense competition from overseas car manufacturers, there are constant rumours of plant closures in the automotive industry. At Essex Engine, managers had always denied the possibility of layoffs or closings, while the union worried for its members' jobs. In the past few years, management has been open with the union about grapevine news or the latest head-office plans. And the union has learned that managers face the same uncertainty and inability to know what the future may hold as do the CAW members. Today, even the most dire rumours are greeted with equanimity. They have been heard before.

The mutual respect of union and management at Essex Engine echoes attitudes towards fellow workers within the CAW itself. While new United Automobile Workers members in U.S. plants are automatically relegated to the evening shift while their colleagues with more seniority hold down the day shift, all Canadian workers rotate between the two shifts. In this way, newer and more senior employees share the benefits of a normal workday, while all are also able to spend days with their families when working the evening shift. Such an approach is not popular in the United States. But in Canada, the equality works.

Training Programs at Essex Engine

Training at the Essex Engine plant starts even before applicants are selected for jobs in the plant. After an initial screening, management invites the best qualified job applicants to attend a week-long training session, for which successful candidates are paid. Eighty per cent of applicants who complete the orientation training are subsequently hired. Workers at the plant tend to have high educational levels – most new hires since 1983 have been high-school graduates – and literacy levels are therefore also high. The union is just as interested in having well-educated, talented workers as is management. The union skilled trades chairperson reviews the papers of all skilled trades personnel hired, because, as he said, "We want quality people." This view is echoed by the leadership of the CAW, which urges its members to make quality products, to keep the North American auto industry operating. The CAW has also endorsed the use of new technology in auto plants, with the appropriate training.

Essex Engine management has worked together with the union to develop an innovative training program within the plant for its electrical trades workers. The in-plant training centre is used to conduct a three-phase program for groups of four workers. Participation in the program is voluntary and promoted by the union. To date, only two workers have declined to take the training, both of whom are expecting to retire in the near future.

The program was developed by the plant's manufacturing systems section supervisor and is taught by a retired Essex Engine employee who had headed the electronic repair shop. Each group of four workers takes four hours of instruction each day for four weeks. Workers are welcome to repeat any part of the course until they are comfortable with the new skills. The program instructs workers on fundamental electronics and digital theories, and how industrial electronic and computer controls work in the plant. It also offers specialized industrial skill training on the computers, control systems, and robots used in the plant.

This last phase of the training program will allow Essex Engine skilled trades people to undertake the repairs of equipment that previously had been done by representatives of the equipment vendors. The Essex engineering group was frustrated at the cost and unavailability of some vendors' repair personnel to service the plant's more sophisticated equipment. They, therefore, asked vendors to supply video programs to train Essex workers in the repair of their systems.

With in-plant expertise, there is the advantage of cost-savings; but, more importantly, there is less downtime on equipment than there was previously. While the in-house capacity for such repairs will save the plant time and money, workers, too, will gain by having a significantly higher level of skills and a broader range of duties.

Management's commitment to the training of skilled trades personnel is equally strong when it comes to retraining people. With workers' ability to bump into jobs outside Essex Engine, and workers in other plants able to bump into jobs at the plant, management trains and retrains workers so that there will always be someone available to repair each type of equipment should it break down. The payoff is great when the training ensures that people with the right skills are always available.

The engineering group is heavily involved in training the skilled tradesmen. With their training and the resultant increased flexibility and knowledge, the skilled trades personnel need to rely less on the engineers; and the engineers and skilled trades complement each other. The machine repair and electrical trades people tend to receive the most training at the plant, while the other trades, where the technology has not changed as much, receive less.

In the mid-1980s, the Essex Engine plant dramatically increased the amount of training given to engineers, because of the demands for knowledge of different machinery and especially of control systems. As Ford attempts to reduce its work force to a size similar to that of Toyota, its major competitor in the production of engines, the engineers at Ford and elsewhere will have to become generalists with a wide and varied engineering background.

First-line supervisors at the plant receive ongoing training in what the plant has defined as core skills and supplementary skills. Management emphasizes finding the right fit for supervisors, based on individuals' background and the best application of their skills.

Most training of operators is task-oriented, on-the-job instruction in machining or statistical process control, or in operating computer numerical control equipment, for example. In addition, workers involved in installing the camshaft visited the company that manufactures the part to see how it is made.

Ford and the CAW

Essex Engine management and CAW Local 200 continue to have their differences, and potentially divisive issues may arise in the next round of contract negotiations. Both watch the trends in consumer preference and volume of sales in the auto industry as weather vanes to indicate what the future may bring. The possibility of layoffs or plant closures is a constant threat, but both sides believe that building quality engines puts Essex Engine at a comparative advantage within the Ford Motor Company and the competitive world of automobile production. In fact, whereas in 1986 the Council researchers heard all about the lessons management had learned from their visit to Japanese auto plants, in 1989 we learned that the Japanese auto makers now visit the Essex Engine plant.

The CAW and Ford are proud of the engines they produce. The plant manager believes that, "The success speaks for itself." He pointed out that Windsor gives the United Way the highest per capita donations by far in Canada and says, "The CAW built this town." And those people, the workers and managers, make "Quality Job No. 1."

4 Techspeak: Contract Language on Technological Change

There has not been much attention paid to the role of industrial relations in technological and organizational change. Yet, there can be no question that effective labour-management relationships are a critical part of the innovation equation.

This is a case study about how a union and an employer dealt with the transition to new office technology. In a situation where there had been no tradition of discussion over technological change, the union took the initiative to get provisions associated with technology into the collective agreement. The parties subsequently negotiated contract language on a number of aspects of innovation that has helped them to understand and address issues associated with the introduction and impacts of technological change.

The particular setting for this case was a Continental Can office in Toronto with about 20 employees represented by a United Steelworkers' local. Its lessons are relevant, most obviously, to the unionized sector where collective agreements offer the structure for negotiations over new technologies. At a more abstract level, though, the Continental Can-Steelworkers experience may be generalized to all labour-management relationships in the sense that it underlines the value of sharing information and working out issues of concern within the context of technological change. When this is done, the introduction of new technologies can, in fact, be a catalyst for the establishment of more open and constructive relations between managers and workers.

Collective Bargaining and Technological Change

In the typical Canadian workplace, management plays the active role in the introduction of technological change. Surveys have shown that workers or their unions are involved in the innovation process in only a relatively few firms. Certainly, production-related matters – including technological change – are usually considered a managerial prerogative. As such, many employers resist the notion of worker participation in technology issues. At the same time, technological change is not always a priority for labour since it is most often implemented incrementally, touching only a minority of workers at any one time, and with impacts that are not always easy to understand.

Even where there is a union present, technology-related issues tend to be negotiated rather infrequently. Clauses pertaining to the introduction of new technology or its impacts are still not commonplace in Canadian contracts. The majority of collective agreements in this country do not include any technology provisions, even the most basic "informational" clause dictating that the workers receive advance notice of technological changes. Given this, it should come as no surprise that more involved clauses that bring workers into the decision-making process or that address their major concerns are far from common.

Unions and management in most situations have agreed on the need to improve productivity, quality, and competitiveness by using new technologies. While not saying "no" to new technology, then, labour is concerned with how its needs will be met as the innovation takes place. As the Continental Can-Steelworkers experience suggests, collective bargaining can be an effective mechanism for addressing these needs and, thereby, providing a stable environment for making the transition to the new technology.

The Company and the Union

Continental Can of Canada is involved in the manufacture and packaging of a wide range of consumer goods, the production and printing of pressure-sensitive products, and the manufacture of containers. It is a major player in these markets with annual sales in excess of $600 million.

The establishment involved in this case is part of the Container Division. During the mid-1980s, the period we are concerned with, this division employed about 2,300 people in 17 facilities from Quebec to British Columbia. About 75 per cent of these were production workers, leaving roughly 500 employees in salaried or office categories. The division was quite heavily organized with all but about 400 salaried workers in bargaining units. While the bulk of union members were in production, there were approximately 100 unionized office employees who formed four locals, including three Steelworkers units.

Continental Can has been a stable employer and many of its employees have been with the company for a long time. In some of the older facilities, people with 25 to 30 years of tenure were quite common. This was not only true for the largely male production workers but, also, for the mainly female office workers. Because of this seniority and, also, because the Steelworkers office locals had been in existence for 30 years, these office workers enjoyed higher-than-average wages for the jobs they did. They also had relatively stable employment: while there was no growth, Continental Can's office employees had not been experiencing major layoffs either.

Collective Bargaining in the Container Industry

Collective bargaining in the container industry has traditionally taken place on two levels: a North American master contract and local agreements. The master contract negotiations usually take place every three years with representatives from each of the major employers and from the Steelworkers. Union representation reflected the composition of its locals with each local sending one delegate to represent it during bargaining discussions.

As so many other manufacturing industries, the container industry has been going through a variety of changes in response to the challenges of the late 1970s and the 1980s. One such change has been the ongoing replacement in the United States of organized office workers with non-union salaried employees. As a result, there were very few white-collar locals under master agreements by the mid-1980s. In the 1986 negotiations, office locals had a small representation in the Steelworkers bargaining discussions: for Canadian office locals, this meant that there would really be no one to speak for them. Knowing that many of their concerns would not be considered in the master bargaining process, executives of these bargaining units focused on the local negotiations to achieve their objectives. For the Toronto office local, an important objective in the 1986 round was to get contract language on technological change.

Technological Change and the New Toronto Operations

The New Toronto Continental Can plant is located in an area that was industrialized in the 1930s and 1940s. Its employees tend to come from the surrounding community and, in many cases, they still live there. Until very recently, these people had a strong sense of security about their jobs and their community. However, in recent years, there have been some disturbing developments: some plants in the surrounding area have been shut down and some others have been affected by modernization.

In the New Toronto plant, new technology was first introduced into the manufacturing operations and, by the mid-1980s, into the office. The technological changes in the office were not "leading-edge"; basically, the system was moving from a manual non-integrated model to the type of integrated computer-based office automation that was becoming so widespread at the time. From watching similar changes going on around them, some employees knew that such innovations could mean significant changes for their work. As well, the local president had developed an awareness of technology issues, having attended a number of union education programs on the subject.

The master collective agreement in existence in 1985 had only very limited language on technological change: notice had to be given within 30 days after ordering new equipment; and the company had to provide "reasonable training" for displaced workers. The local agreement had nothing. In 1985, as office automation picked up, the local began to address the matter of technological change. They had researched a number of issues including concerns about radiation emission, eye and back strain and, also, possibilities for rest breaks, training and retraining, advance notice, and joint labour-management committees to oversee change.

In 1985, one year in advance of the next round of bargaining, the local completed an eight-page document that incorporated their version of model contract language on technological change. Management's reaction was to ignore it. The document was lengthy and restrictive. Also, at this time, the plant management was still quite unaware of issues associated with office automation. Decisions were made by head office about what hardware would be purchased and when it would be installed. As the production control manager stated later, "I knew virtually nothing about this stuff but that was still more than some others."

The union's document stayed in the industrial relations manager's desk drawer for a year. And, during that period, automation of the office continued. In 1986, about one quarter of the work stations had computer terminals. The workers were increasingly dissatisfied with the haphazard way in which the new technologies were being implemented. While there was no contract language to control the situation, the union eventually refused to receive any more new equipment by calling on a provision of the Ontario Health and Safety Act that gave workers the right to refuse unsafe work.

By this time, there had been some turnover among managerial personnel and those now in place were somewhat more sympathetic to the idea that some of the issues the unions were raising did at least need to be dealt with. While management awareness did not extend much beyond recognition of possible radiation threats, they were prepared to entertain the union's proposals.

As the 1986 master contract bargaining got under way, the parties faced deadlines for resolving local issues. The union retabled their technology document which included demands for the creation of a joint-technology committee, advance notice of 120 days, job security through retraining, and a range of health and safety provisions.

Negotiation of these items was not easy. As one manager put it, "we fought, argued, and stumbled our way through it." Management was still reluctant to commit too much in the contract. But the union was determined, as the following quote from the local president demonstrates:

> The company came back with flowery proposals, saying yes we will define such changes, we are all going to work together – things like that which, in no way, shape, or form can ever be enforced and we, the union group, held firm that there had to be language to explain what we were going to work together on and what getting along meant. We ended up changing by saying "okay fine, I will put in your bit about down the yellow brick road and you go along with our bit on how we work on the machines and what has to happen when these machines come in." It is the same old story from management – "yes, we agree with that so it doesn't have to be written down." But we've been here for twenty years and these guys are a dime a dozen, they come and go and the next guy comes along and says "oh, there's nothing in writing here."

With the changing management attitude, the persistence of the local, and compromises from both sides, the parties did come to agree on contractual language regarding technology.

Through the process of "fighting, stumbling, and arguing," both groups developed a better appreciation of the issues involved in moving from manual systems that had been in place for nearly 30 years to integrated computer-based office technology. They had many meetings over the course of their local negotiations. In addition to improving their understanding of what they were up against, the parties also developed a better, more open relationship that carried them into subsequent automation phases.

Outcomes of the Agreement

The agreement has altered work practices in the office in a number of ways. Among the range of issues negotiated were the following:

- decision making and the joint committee;
- health and safety;
- training; and
- notification.

Decision Making and the Joint Committee

Probably the key outcome of the negotiations was the establishment of a joint labour-management technology committee. In this committee the parties can discuss and resolve issues associated with technological innovation. The composition and responsibilities of the committee were explicitly set out in the agreement. Membership is evenly split between management and the union with three representatives from each. The joint committee can be involved in all aspects of implementing technological change in the office. Once it is notified, the committee oversees the plans for the introduction of the technology from the location and layout of work stations to the training and retraining of affected workers.

The approach underlying technological change in the office was made explicit in the preamble to the agreement. The parties agreed to the following principles: Technology would be introduced in a manner that preserves employment security by ensuring access to adequate retraining. In planning for change, the input of all affected employees would be obtained. And if the number of jobs were reduced by technological change, the joint committee would be notified at least six months in advance in order to plan for those affected.

Health and Safety

Health and safety had been the union's initial focus regarding the introduction of new technology. The workers' refusal to work in unsafe conditions had forced the initial negotiations over technological change. Concerns had ranged from wires running in every direction to the effects of exposure to the terminals. As the local president put it, "we were not prepared to count casualties ten or fifteen years down the line . . . our attitude was this is the beginning, so let's do what we can now to prevent problems later."

The union became very well informed about potential health and safety hazards and made this issue a priority.

Management had also learned a fair amount in this area and the parties were able to agree on a number of specific ways to secure a healthier and safer environment. The agreement incorporated various measures including a maximum of four hours per day on VDTs, periodic eye examinations, regular terminal maintenance, and protective equipment or temporary reassignment for pregnant employees.

There was also considerable attention paid to physical aspects of the workplace. The union's health and safety representative had a bad back himself and, accordingly, he was particularly sensitive to ergonomic design principles. By this time, the new management group had also become aware of the need for a major physical overhaul. The office was 1950s vintage and it was certainly not designed to deal with office automation. When computers were first introduced, the company had set up a separate room to house them; however, as more and more terminals were brought in, they spilled over, somewhat chaotically, into individual work stations.

With both labour and management dissatisfied with the physical layout, the joint-technology committee took the lead in addressing problems in this area. Following a presentation to senior management, $100,000 was allocated for the office redesign. Ergonomic work stations, appropriate for the new technology, were put in and careful consideration was given to layout, storage space, furniture, privacy, and lighting.

Training

Training was given an important strategic role in the agreement. The preamble, which included a commitment to employment security through retraining, has already been noted. Where possible, the company was obliged to provide the necessary training for workers to continue to carry out their jobs where new technology was being introduced.

Two other significant clauses providing access to training were also in the agreement. One stipulated that all staff, not just management, could attend company-sponsored courses related to technology. The other guaranteed company funding for union members to attend up to five days per year of external education in the areas of technological change, stress, or health and safety. Through the contract, then, training was assigned two important roles in the innovation scenario: first, as a critical means for providing employment security through the "retooling" of workers and, second, as a mechanism for generally educating all employees in regard to technology and its impacts.

Notification

Advance notification of impending changes in technology is necessary if employees, either alone or jointly with management, are going to have any impact on implementation. Under the 1986 local contract, the company agreed to provide the union with at least 120 days notice prior to the introduction of new equipment into the workplace. Moreover, this notification had to include a detailed plan for the project, including its human-resource implications. Part of the joint committee's mandate was to review these plans. As well, when the number of jobs was going to be reduced by technological change, the contract stipulated that the joint committee be notified at least six months in advance so that an adjustment plan could be prepared for those affected.

Discussion

In the end, the transition to an automated office at Continental Can's New Toronto office was relatively smooth. People were part of the process and, consequently, supported the outcomes. A job reduction that might traditionally have resulted in a layoff was handled, instead, through attrition. Protections against health and safety threats were implemented. The physical changes made as a result of the negotiations and the subsequent committee work were seen as a success in most quarters. According to the production control manager, if management alone had redesigned the office, the changes would have likely been "cosmetic not ergonomic."

While the agreement seems to have been successful in several areas including labour adjustment, health and safety, and physical layout, it should be pointed out that not all issues associated with new technology were resolved. For example, job content in the automated system remained a concern. The new job design essentially replicated the old manual system. There appears to have been little attempt to enrich many clerical jobs beyond mere data-entry functions and, according to the employees, much of the judgment and discretion were removed from their work.

Job design may well be a concern for future negotiations between the union and the company. While this is a more abstract issue, we should not forget that the parties now have the problem-solving experience and institutions in place. And, more generally, bargaining over the technology agreement and resulting discussions regarding implementation improved the atmosphere in the New Toronto office. People started applying problem-solving skills not combat skills and, in the process, resolved a number of old difficulties that had persisted for years. This more general benefit was recognized in the following remark by the plant controller: “management does care about people and about what they think; this whole experience gave us a chance to show that.”

In the final analysis, the Continental Can-Steelworkers case suggests that collective bargaining can be an effective way to make the successful transition to new technology. In organized settings, it is a negotiating mechanism that is already in place. For the union and, in some cases, both parties, there is a great deal of commitment to the concept of collective bargaining. It produces written arrangements which, as this case shows, can act as clear and mutually acceptable ground rules without unreasonably restraining flexibility. And, where labour and management openly and effectively collaborate on something as important as technological change, their ability to work together, in general, is likely to benefit.

5 Systems and People: Managing Socio-Technical Change at Pratt and Whitney Canada

Managing the introduction of computer-integrated systems in an industry as technologically and organizationally complex as the aeroengine industry requires a clear focus on the social dynamics of plants, as well as on their technical features. This case study examines the approach taken by Pratt and Whitney Canada (PWC) in 1985-86, to plan for a new plant with a work environment designed to enhance workers' collaboration and their participation in the overall success of the plant.

While it is not always possible to start from scratch, as did PWC once the decision was made to build a new facility, the process used by the company to define its corporate mission, and the analysis it undertook of how its new computerized systems would interact with the workers are instructive for any company contemplating the use of computer-integrated work processes.

The Aeroengine Industry

The aeroengine business requires people who can engage in long-term strategic planning under the most uncertain conditions. While there are significant entry barriers to this oligopolistic industry, comparative advantages between established competitors are short-lived. Innovation is essential, and the competition for military contracts means that technological advancements are soon imitated, thus narrowing comparative advantages to those of differentiation in service practices and after-market strategies.

The industry is characterized by long product development and product life cycles. The 1980s saw an industry in transition, facing an unprecedented escalation of development costs because of the number of new projects and the longer gestation period required for military projects, underutilization of capacity worldwide, and head-to-head competition for finite markets. In addition, the industry's traditional after-market business was threatened by the use of repaired rather than new parts in overhaul, and by the possibility that these parts could be sold by other than the engine manufacturer.

Pratt and Whitney Canada

Pratt and Whitney Canada, a subsidiary of the United Technologies Corporation, designs, develops, manufactures, and services engines for general aviation and regional transport aircraft, and for helicopters for civil, paramilitary, and off-the-shelf military roles.

In the mid-1980s, PWC was manufacturing three engine families and marketing a total of 50 engine models. The company focused on four market areas, including corporate aircraft, regional transporters, military off-the-shelf engines, and civil helicopters. It now manufactures two additional families of engines and auxiliary power units for large aircraft. More than 90 per cent of its production is exported. The commercial success of its products has given the company a leadership position in the general aviation and regional transport markets around the world, and a select niche in medium-weight helicopters.

Established in 1928, PWC's headquarters and main research and development and manufacturing facilities are located in Longueuil, Quebec. It has facilities for the assembly and testing of engines and for research and development in Mississauga, Ontario, and recently opened a plant in Halifax.

In 1986, PWC employed some 8,000 people, 2,000 of whom were involved in R&D. Employment has expanded to about 10,000 people in the late 1980s, with the number of people involved in research and development activity remaining constant. PWC is the largest Canadian aerospace company and in 1986, ranked second of Canadian corporate investors in R&D, spending more than $200 million per year. The company's investment in R&D has since declined to about $150 million per year in 1989.

Use of Technology

The story of PWC's decision to build a new plant, using the "socio-technical" approach to organizational design, begins with the years 1979-81, boom years for the aeroengine industry. At that time, PWC's manufacturing criteria of quality of first effort, scheduling, responsiveness, and cost were not being met. There was a high volume of work-in-progress, growing inventories, inadequate control and monitoring systems, and too much rework to achieve acceptable quality. Standard time to perform operations and set-up times were too long. With these high costs, the company was becoming less and less competitive while competition was increasing. The trend had to change, and costs had to come down.

PWC had introduced revolutionary changes to its production processes in the 1970s. Computer-aided design and manufacturing (CAD/CAM) gave the company added flexibility and cut down design and product development costs, while reducing uncertainty and improving its long-term planning and manufacturing capabilities.

PWC's market forecasts at the end of that decade showed, however, that its capacity was insufficient to meet market predictions; it was outgrowing its facilities at Longueuil, Quebec. A consultant's report also showed that, although the company had achieved some success with introducing computers and computer-aided equipment in pockets of the organization, many processes, such as materials handling, were still carried out manually. With computer prices down and more mature technology available, PWC could look for greater success with more widespread introduction of new technologies and methods.

In 1981, the market fell apart. Increased capacity was no longer the target. Nevertheless, in studying the consultant's recommendations, the company realized that modernization was still essential to improve productivity and competitiveness. The company, therefore, established a Manufacturing Modernization Program (MMP).

The Manufacturing Modernization Program

Established in 1982, the MMP group was made up of senior people from all major departments in the company: quality, production and plant engineering, information systems, materials, non-product planning, finance and personnel. Its mandate was to "plan and implement leading-edge manufacturing technology at PWC."

In its two years of study, the MMP group came to understand the gaps in the company's use of technology, and the potential benefits of still more advanced and integrated uses. There was some computerization in manufacturing planning and control, CAD was used in product design and CAM, in process planning; but aside from the use of computer numerical control, there were major gaps in the use of new technologies in the factory, and there was no integration of the various technologies. To achieve major gains in flexibility, productivity, and predictability, a flexible manufacturing system was needed that would integrate the process and material handling equipment with the planning and control systems into a single, synergistic system known generically as computer-integrated manufacturing (CIM).

The Computer-Integrated Manufacturing System

A CIM facility uses micro-computers to integrate support functions such as manufacturing planning, scheduling, control, and accounting, into operations. It involves a whole new manufacturing approach and philosophy, not just faster and better tools. At PWC, therefore, CIM was to include strategies for just-in-time inventories, process technology, material handling, human resources, and other systems.

In the early 1980s, there were not many fully operational models of computer-integrated manufacturing systems which Pratt and Whitney Canada could look at. Nevertheless, the company perceived that there was a need for total integration and that previous systems' failures may have been due to a lack of sufficient integration. It was also expected that a CIM installation could help the company understand and improve the role of indirect labour, which comprised the greater portion of PWC's total costs, to generate cost-savings. Finally, CIM was expected to assist with increased product flexibility and responsiveness to change in production schedules.

For Pratt and Whitney Canada, CIM also meant using the concept of flexible manufacturing systems (FMS) in its plants. FMS takes the concept of "families of parts" – group technology – and links machine tools, material handling equipment, measuring equipment, and storage equipment by a transport system, so that all the systems are operated and controlled by a computer. In this way, a variety of parts can be processed at the same time.

The MMP group developed a plan for the gradual, step-by-step transformation of PWC's manufacturing facilities to a computer manufacturing environment over 10 years, and outlined the impact of changes on all the major functions: production engineering, quality control, materials, finance, and information systems.

The introduction of such wholesale changes in the way PWC was to build its engines and link computer data from systems in the plant to support systems such as accounting, inventory control, and payroll seemed to require a new approach to the management of its plants. The company's managers worried about the effects of a large-scale expansion of its Longueuil, Quebec plant. In addition, that plant's unionized work force and hierarchical organization would not be easily changed over to the kind of integrated environment PWC sought for an advanced, computerized facility.

To avoid disruption of production and the strain and inefficiency of introducing massive changes to its existing large plants, the MMP group recommended that a new facility be built to incorporate a pilot FMS project and CIM. In early 1985, it was decided that the new facility would be built in Halifax.

The Socio-Technical Approach to Managing Change

The work of the MMP group had given Pratt and Whitney Canada a good understanding of the technology it should have. Before the modernization program was to be implemented, management wanted to understand and manage the social implications of the new technology.

Having made the decision to build a state-of-the-art manufacturing facility, a PWC manager stated that:

> It was clear to us that we also had to take a new approach from the human point of view. We knew that our mode of operation was not one which allows maximum use of our people's capabilities. We had a vision of what was possible and what we wanted.

PWC managers wished to incorporate the values of more collaboration, better development of individual potential, consensus, and participation into the company as a whole, and especially in the new computer-based plant.

PWC engaged consultants to guide them in designing an organization based on socio-technical principles. The socio-technical approach reasons that the best technology alone, or the best human system alone, will not achieve the objectives of the work system. Only through careful analysis to jointly optimize the system's technological aspects and human implications will the system achieve maximum results.

Planning Conferences

As a first step in designing the social system for the new plant, top PWC management joined the MMP group and selected corporate representatives in a "search conference" organized by the consultants. This was an intensive exploration and planning session designed to develop a clear image of the kind of organization participants wanted to see and their commitment to make it a reality. Although the search conference focused on the organization required for the new Halifax plant, it was clear to participants from the beginning that new systems in Halifax would have an impact on other parts of the organization. In addition, it was hoped that the lessons of the Halifax experience could be applied to other PWC facilities.

During the search conference, participants identified all the major changes in their environment and discussed what was needed to respond to those changes. They enumerated the values that would guide the people and the organization in their responses to the changes in technology and the marketplace.

The participants found that there was not much difference between the values of people in different functions and at different levels. As one participant said, "We began to get a better feel for what we care about and what we need to do to incorporate those values in our work place." Consensus formed on establishing an environment allowing individuals to develop to their full potential, a more participative organization, and the interrelatedness of the changes, as summarized in the following diagram:

		Aspects	Responses
		Techno-logical →→	New manufacturing technology
Change →→	Social →→	Values →→	Impact on organization
		Business envi-ronment →→	Built-in response capabilities

As the diagram shows, changes affecting PWC, like any manufacturer, can come from three areas: technological advancements, such as the introduction of CIM or FMS; social forces, such as workers' needs and management goals; and the business environment, where competitive pressures and market changes demand corporate responses. PWC wished to develop strategies to deal with new technologies, its corporate values, and a changing marketplace. The goal of the search conference was to determine what the forces for change were and would become, what strategies the company should pursue, and what impacts these strategies could have on the organization as a whole, and on the new Halifax plant, in particular.

At the end of the search conference, participants were more comfortable with the task ahead and with management's attitude towards change. To disseminate the spirit of the conference to a larger number of people within PWC, and to encourage more participation, management organized a "change conference" a few months later. Search conferences were also organized at two other PWC facilities, to start change processes there.

In a strategy session, management focused on key change issues for the corporation as a whole. Strategic planning was being linked to organizational design, and change became corporation-wide. Company and corporate management worked on integrated strategies for:

- a manufacturing-improvement strategy;
- a human-resources strategy; and
- a market/business strategy.

The design of the new Halifax plant was only one of the activities undertaken by PWC to achieve its overall objectives. It was important, however, as a proving ground for the company's new orientation.

The Technical System at the Halifax Plant

In PWC's Halifax plant, where the main objective is to turn rough castings into various machined cases, machines are connected by computer and the support functions are integrated into operations through an information system. What is revolutionary about the plant is that the process system, machine tools, and hardware are no longer the dominant features. The information system and the human system have acquired much greater weight, sharing equally with processing. This change in the relative importance of the plant's systems was the essence of the innovation – the Halifax experiment.

PWC's old manufacturing style had been to build to inventory, planning for an ideal scenario that was seldom achieved. This led to shortages, frustration, and a focus on putting out fires. In the Halifax plant, the focus is on reducing inventories and building to order.

Under the new system, quality is crucial. The idea of ongoing quality control, rather than after-the-fact control, is part of the FMS strategy. The FMS acknowledges the reality of the shop floor in its planning approach and has built-in flexibility to deal with problems as they occur.

In the Halifax plant, the computer can search for a casting, select and find tools, retrieve the numerical control program, make the set-up information available, prioritize every machine, move materials, tell technicians and managers how many hours are required of each machine and what the shipping time will be. The computer follows the life of each cutting tool, checking on its use to know when it needs regrinding or rebuilding. The computer also follows each component through the process for quality. All this information is integrated into one system.

The transformation process has been divided into five-unit operations, with the following output:

- received palletized materials;
- prepared castings;
- machined cases;
- cases with non-machining operations completed, such as deburring, anodizing, dichromating, and so on; and
- shipped cases.

Each unit operation at the Halifax plant includes a mix of manual, semi-automatic, and automatic activities. Employees must have both theoretical and practical skills, including at least a basic understanding of the computer system. They must understand the logic of automation, have a knowledge of gas turbine engines, and be proficient in mathematics. They must be able to function as machinists for tool set-ups, to perform basic maintenance, and monitor chemical processes. Some need to find and enter information in the computer system and understand various software applications. This myriad of skill requirements was reflected in the job design and integrated work systems for the Halifax plant.

The Socio-Technical Approach to Organizational Design

Integrated technological systems mean that compartmentalized tasks such as production, maintenance, quality control, finance, and shipping are united under one central information system, giving information which all can then access. When the computer integrates a number of processes, it tends to integrate the functions as well. As the impact of events in one area of the plant is reflected in data transmitted to every other department, workers can readily see that the functions they perform affect the plant's performance in other areas.

When introduced company-wide, computer-integrated systems require far-reaching changes in relationships at all levels. The more complex the system, the more complex the changes. For example, design, manufacturing, and marketing are likely to be more closely linked. Everyone has to develop data-processing skills. Organizational and work system issues such as "territory" and decision making become extremely important, as the existing culture and conventional ways of doing things are put into question. Social values, such as individual development, must also be reflected in the organization of the work and the plant.

The choice is either to design a traditional hierarchical system with highly differentiated tasks and functions, or a participative and integrated system. Under the first option, dull, repetitive and narrow jobs, routine, isolation, and frustration are the order of the day. Analyses of organizational design and efficiency suggest that the second option not only increases job quality but, also, can meet technical imperatives.

Pratt and Whitney Canada was committed to providing a quality work environment that would include responsibility, variety, involvement, and growth. It felt that the socio-technical model would provide a social system that would be as innovative and responsive to its environment as its technology.

Designing the Socio-Technical System for the Halifax Plant

In its purest sense, the socio-technical approach to organizational design requires that the technical systems and the social system of a plant be designed together. For Pratt and Whitney Canada, technological decisions had in fact been made before elements of the social system were addressed. For this reason, the approach taken by the company is more appropriately termed a "social retrofit," rather than a true socio-technical approach. In effect, some of the social systems had to adjust to decisions already taken on technology and plant design. The company created committees to deal with this situation as well as the overall social and technical design of the plant.

Two committees were established to oversee the design of the Halifax plant: a steering committee and a design committee. The first dealt with policy issues and the other, with operations. Both were designed to be as participative as possible, including different functions and different levels.

The Steering Committee

The steering committee, the senior of the two committees, was made up of top functional managers, corporate representatives, and the chairperson of the design committee. Its basic task was to review and support the work of the design committee and to adjust or develop corporate policies as needed. When designing a new concept, whether technical or social, it is important to keep top managers apprised of developments so that there are no surprises at the end. As one committee member stated, "The last thing you want is to go so many miles down the road and then find that the top managers are scared and won't back you up."

The steering committee also wrote the mission and philosophy statements for the Halifax plant and for the company as a whole. The mission statement captures the company's strategic vision and organizational identity in relation to the current environment. The philosophy statement, on the other hand, captures the values and principles that guide the organization in its activities. Both documents are the key to providing a sense of direction as well as some sense of stability. The environment may be changing, but not the values and principles that guide responses to the changes.

The Design Committee

Because the design committee was formed before any employees were hired for the Halifax plant, it was initially composed of two members of the MMP group and representatives from all key departments involved in the design of the Halifax plant. It was chaired by the plant manager and assisted by the socio-technical consultants. As they were hired, plant employee representatives were brought onto the committee. Very soon, they constituted half of the committee. In addition, for the first few months all employees served for one day each week on one of the several subcommittees set up to design different aspects of the plant and social systems such as pay and training. The subcommittees, which continue to operate, were and are assisted by consultants and corporate representatives from the Longueuil headquarters of PWC and from the United Technologies Corporation.

The design committee went through a team-building period in order to focus all members on the same goal. A special organizational design course helped them map out the steps and issues in the design process. Then the team had to reach consensus on a general philosophy of operating principles for the Halifax plant, based on the philosophies developed by the steering committee.

Job Content

Since one of the objectives of a socio-technical work system is employee participation, the employees themselves should be involved in the design of the jobs they are to perform. The design committee, therefore, followed the rule of "minimal critical specifications," defining tasks and job content as little as possible, in order to include plant employees as much as possible as they started working in the plant. This was especially important for the Halifax plant, as the design had to get under way before any employees were hired.

The committee wanted to avoid the trap of breaking down tasks to such an extent that some employees would always be working on the same machines, performing the same operation. It therefore established the following job elements for production workers, all of whom would be called production technicians:

- All employees were expected to be multifunctional. They were to gradually learn as many different jobs as possible, so that they understood the whole system.

- This concept was further reinforced with the introduction of a pay-for-skill system, whereby production technicians would receive the same base pay. As they learned different production skills, they would receive additional compensation.

- Because all employees had obtained basic skills prior to hiring, they were given the opportunity to become even more highly skilled through job rotation.

This design was intended to give the company the flexibility it needed and provide employees with the challenges they sought.

The profile of the people hired for the Halifax plant reflects the orientation taken for the organizational design of the plant. They are people with good technical training, but not necessarily with a lot of hands-on experience. While working at Pratt and Whitney Canada, they progress from being apprentices, to journeymen, to fully skilled technologists. The employees want to learn. They are computer oriented so that they already see the computer as a tool rather than a threat. They have the ability to deal with abstractions and analyse a situation. Finally, they are people with the social aptitude to function as team members.

Organizational Boundaries

Determining the sub-organizational boundaries, such as the separation between unit, section, divisions, and so on, is critical in the design of any organization. Under socio-technical principles, boundaries should be located so that the unit's members have control over deviations that can occur during the transformation process. This ensures that unit members develop an identity with the outcomes and prevents the "exporting" of problems from one unit to another, a common occurrence in manufacturing.

In a socio-technical system, self-regulation within the unit is favoured over external control. Information, both data and feedback, should be provided to those who need it to take action or control the process, rather than to outside supervisors at a higher level in the organization. The social support systems, such as selection, training, payment, and promotion should be designed to be consistent with the philosophy underlying the organization design.

The design process for any plant is ongoing, because, as circumstances change, revisions and adaptation are required. A good design, therefore, provides for built-in mechanisms that will allow employees themselves to redesign, adapt, and improve the system as necessary.

Social Versus Technical Needs

When the design committee got to work, the engineers had already developed the technology strategy and transformation process to be used at the Halifax plant. It was up to the committee to review the technical design against socio-technical criteria.

The design committee listed the main steps, or unit operations, in the transformation process and looked at technical alternatives available at each stage in terms of socio-technical criteria.

There were some instances where the imperatives of a satisfactory social system seemed to conflict with the technical system. Engineers, for example, had planned for a control room to provide a central information and overview centre. While this would be a normal feature in any traditional FMS, it appeared to conflict with the desire to make all workers responsible for their own activities and, in effect, be self-supervising. When the conflict was brought to light, it was decided to do away with the planned control centre. The committee felt that it was better to disperse responsibility for control to the people doing the work. Terminals at individual work stations are linked to the plant's VAX computer system, so that events in any area are instantly communicated to all other work stations in the plant. Employees are responsible for the quality of their own work and can see the repercussions of their actions in a plant-wide information system. To date, no one at the Halifax plant is asking for a control centre to be installed.

Designing the Work System

The design committee developed the work system for the plant. It was difficult for them to imagine what it would be like to work in an integrated system. The tendency was to focus on the tangible physical layout, with its visible components and unit operations, and to assign people to them. The first organizational charts thus followed the traditional pattern: hierarchy and functional divisions.

It soon became clear, however, that in a computer-integrated system where operations on the shop floor interact, the decision making is also integrated. Therefore, there is a need for people to understand the whole system, rather than only a small portion of it, if they are to make the intelligent decisions required. It is important that all employees understand how their action affects other parts of the system and relates to the logic of the whole computer system.

The design committee looked for an integrated work system built around teams and roles, rather than a fragmented work system built around functions and jobs. They analysed what work roles would be needed to complete each stage in the transformation, listing the skills and skill levels needed for each role, looking at how the workers could be grouped in teams and which workers should be included.

The issue of how to divide the work into meaningful units for the teams was one of the most hotly debated. The other was that of deciding on the content of production jobs.

The Teams

It was decided that the organization would have three types of teams: a management team, support teams, and production teams.

The production and support teams are involved in many of the traditional management functions. These include:

- control of absenteeism, attendance, and vacation;
- selection of new employees and performance improvement or dismissal of unsatisfactory employees;
- performance evaluations and the reward system, including a pay-for-skill program;
- training opportunities and nonfinancial rewards; and
- descriptions of roles internal to the teams.

The design committee opted for a single production team on each shift, which would include all functions, from receiving to shipping, and cover all steps in the transformation process. This was preferred over teams organized across shifts, around different product mixes, or grouping different unit operations together.

The design committee knew that eventually, the chosen solution would need to be revised. When the plant became fully operational, the flow-through of parts would require a total of 200 people, clearly too many to organize teams around each shift. A new configuration was therefore designed for the production teams, without, however, changing the basic principle of integration. When the plant became operational, it was decided to organize the teams around each identifiable piece of the transformation process. Thus, material handlers constituted one team on each shift, as did each machining centre of about seven people per shift.

The production teams have a full range of responsibilities, including:

- monitoring their performance in terms of lead time, quality and cost; making suggestions for improvement;
- understanding the key variances in the product resulting from the process and knowing how these variances affect subsequent operations;
- inspecting their production to ensure conformance to product requirements;
- doing routine maintenance on their equipment;
- alerting the management team if unexpected events put their production plan in jeopardy; and
- ensuring inter- and intra-team coordination.

The main function of the support teams is to provide specialized technical advice to the production and management teams with regard to planning, computer systems, chemical technology, special maintenance, and so on. They also develop training programs that will upgrade the production teams to a level where they are essentially self-sufficient.

In the Halifax plant, workers rotate from duties on production teams to work on support teams. In this way, workers become truly multi-skilled and develop a comprehensive understanding of the interrelation of production and support systems in the plant.

The management team includes all managers and functions just as do the support and production teams. It is accountable for the performance of the factory and responsible for its long-term evolution. This team manages the plant's interaction with its environment, with particular emphasis on PWC's Longueuil corporate headquarters, local government bodies, and the local community. It also manages the socio-technical design and ongoing redesign of the plant.

Outlook for the Future

Pratt and Whitney Canada was satisfied that in Halifax it started with a compatible technical and social design. Overall, the computer-integrated manufacturing system had the potential to address the overcomplication and inadequacies of the old system. It was expected to provide the company with the level of flexibility required in its particular business environment and lead to significant reductions in direct and indirect costs.

As to the organizational design, mechanisms were planned to allow employees to take full ownership of the design and to make improvements as they went along. It was hoped that the Halifax plant would serve as a model which could then be applied to other parts of the organization.

Managers anticipated some difficulties in implementing the organizational design. "There are still a lot of skeptics out there," said one manager. "They can't see how it can work and we have nothing really to show them at this point." Management knew it would have to reinforce the initial resolve of all those involved in the Halifax plant, as old habits would tend to surface in difficult times.

Difficulties were also expected in reconciling the new way of doing things in the Halifax plant with the old system in the rest of the organization. Little by little, however, PWC planned to bring the entire company in tune with the Halifax model by redesigning the technical and social systems of existing facilities.

Postscript

In 1989, PWC began an expansion of its plants in Halifax and Longueuil, to accommodate the new engine families and the auxiliary power units it added to its product line, and to supply units to meet its increasing market share. Its new markets also necessitated expanding its network of service facilities in Canada and worldwide.

In Halifax, the steering committee evolved into a change committee after the planning work for Halifax was completed, and, in early 1989, was merged with the design committee. The change committee includes participants from senior management and from other PWC facilities. The Halifax plant also continues to use the subcommittees that had reported to the design committee and that now report to the change committee, to develop and amend its social support policies such as pay and training.

The socio-technical approach to organizational design has not been applied to PWC's Longueuil plant, but its evolution in Halifax seems to have met the company's goals. Workers are involved in designing their work environment on an ongoing basis; they are multifunctional and highly skilled; the plant's expansion is testament to its productivity; the company's expansion is evidence of its continuing success.

6 The "Plus" Is Employee Involvement: Gain Sharing in the Appliance Assembly Industry

The plant's technology was right, its people were good, and the market was strong. But in 1982, the Orangeville, Ontario, plant of Camco Incorporated (the Orangeville plant), then Canada's largest manufacturer and distributor of household appliances, was facing stiff and increasing competition from appliance manufacturers in Japan. The plant, which produced microwave ovens and "comfort conditioning products," had not been able to increase its productivity in five years. To improve the plant's market position, its managers felt that something "new and different" had to be done.

They decided to investigate gain sharing, a program linking employee compensation to productivity, as a means of improving both their productivity and market position. They also felt that gain sharing would increase employee involvement and improve labour-management relations. Two consultants from General Electric's industrial engineering group in the United States undertook a one-year study of gain-sharing plans on their behalf. The plant's managers visited plants in Canada and the United States that were using various forms of gain sharing. They even had extensive computer modelling done to find out what possible impacts, outcomes, and costs gain-sharing plans could bring under a variety of conditions.

The plant's managers found a host of gain-sharing programs from which they could choose (see box). In the end, they took the principles of productivity sharing, a form of gain sharing, and adapted them to the special circumstances

Incentive Programs

Equity-sharing and stock-ownership plans distribute actual ownership in the firm among employees.

Individual incentive programs boost productivity by tying each employee's compensation level to his or her individual performance.

Gain sharing refers to plans linking overall employee compensation to productivity. The plans can also be used to encourage employees' participation and identification with the firm and increase labour-management cooperation. Gain-sharing plans fall into three general categories:

Types of gain-sharing plans:

Profit-sharing plan

Profit sharing is the oldest form of gain-sharing plan, providing for a shared distribution of corporate profits. Profit sharing is not based on sales performance or output per hour.

Cost-savings plan

Cost-savings plans take a variety of forms. Generally, allowable costs such as labour costs, scrap, and downtime are determined during a base period. Reductions in those costs, usually excluding savings due to technological change, are then shared by the company and its employees.

Productivity-sharing plan

Productivity-sharing plans emphasize employee involvement and provide group incentives for increased productivity performance. The three main types of plan – Scanlon, Rucker, and Improshare – pay bonuses for improvements in productivity over a base period.

of the Orangeville plant. Their tailor-made plan, called "Orange Plus," for "Productivity Lets Us Succeed," had its own advantages and disadvantages, as this case study will show.

The Orange Plus gain-sharing program at the Orangeville plant is relatively new, but its experience in the first few years of operation provides a useful example of the benefits and problems that many firms may face in implementing gain-sharing plans.

The Orangeville Plant

The Orangeville plant was originally constructed as a Westinghouse facility in 1979. In 1982, the "comfort conditioning products" Camco manufactured at the plant under several brand names and private trade labels included room air conditioners, humidifiers, and dehumidifiers, in addition to its microwave oven line. In July 1988, after this case study was completed, Camco succumbed to the overseas competition in the microwave oven market and ceased production of the ovens. Its product line after that time was limited to air conditioners and dehumidifiers. Then, in December 1988, Camco's Orangeville plant was purchased by Fedders Inc. This case study focuses on the production lines in place at the Camco plant in 1986 and provides an update of the conditions at the plant and the status of Orange Plus since that time.

In 1986, although some metal parts fabrication was done on-site at the Orangeville plant, the majority of parts were purchased from outside suppliers. Production at the plant was organized into assembly lines of various sizes. Three large lines of 70 to 100 people, each spending about 20 seconds working on each appliance, assembled microwaves, dehumidifiers, and humidifiers. The actual product and the volume of production fluctuated seasonally and according to customer orders. A smaller line of 15 to 20 workers produced room air conditioners. By 1986, the plant had also introduced a seven-person line on which each worker performed a variety of tasks, spending from 40 to 45 minutes on each appliance.

In addition to production staff, which was predominantly female, the plant had approximately 40 people, mostly men, working in administrative and clerical jobs, the engineering and marketing departments, shipping and receiving, maintenance, and quality control. In total, the plant employed about 300 people during peak production periods and was the largest employer in Orangeville. The level of employment at the plant rose fairly steadily, from 210 in 1982, but fluctuated considerably throughout the year as the volume of production varied, and as product lines changed.

Labour-Management Relations

Unlike Camco's other manufacturing plants, located in Hamilton, London, and Montréal, the Orangeville plant's work force was not unionized. Wages in the plant were determined unilaterally by management, based on a wage survey of comparable firms. For hourly wage positions, employers in the immediate community were surveyed; salaried positions were measured against firms in a wider geographical area. The information obtained in this survey was made available to employees. Employees were also provided with a range of benefits and a three-week paid vacation leave. Layoffs and recalls were done on the basis of seniority.

Before the introduction of Orange Plus, management used several means to encourage positive labour-management relations. A communications panel, comprised of senior management, met on a monthly basis to discuss general terms and conditions of work, including rates of pay, hours, and market trends. The minutes of these meetings were distributed among all employees and subsequently were discussed in smaller work station meetings. While the communications panel contributed to the flow of information through the plant, it did not give employees input to or control over management decisions.

Similarly, while there was no official grievance procedure, management, from the shop floor through to the plant manager, were said to have an "open-door" policy: that is, a willingness to discuss workers' problems or complaints.

In general, managers attempted to encourage employee input and suggestions. Several employees interviewed at the plant commented on the participative management style that had been in place for a number of years. This seemed to have provided an environment conducive to the introduction of a gain-sharing plan.

Use of Technology

Camco officials at the Orangeville plant considered its production technology as "state of the art." Management personnel had travelled extensively throughout Japan and the United States and pointed to a number of items in the plant that placed it at the forefront of technological innovation in appliance manufacturing.

Camco used two computerized microwave scanners to measure the leakage of microwaves from the assembled ovens. One of these was designed and developed exclusively for the company and was the first comprehensive scanner of its kind in the world. With the new technology, the scan was completed in 35 seconds; the function had previously occupied six line workers using hand scanners and, at the time of the study, was still performed manually in Japanese plants.

Camco also used robotics, in the form of an oven door sealer, which provided more flexibility and adaptability than the fixed-route mechanical arm it replaced. In addition, a computerized control panel tester provided a higher degree of quality control in a 12-second test than had the manual test, which had taken 1.5 minutes to perform.

Office automation had been introduced into several clerical, administrative, and engineering functions. Inventories and production schedules were all on-line, allowing material requirements, purchase orders, and receipts to be generated quickly and directly. Personal computers were used by office staff to prepare and calculate customs forms and freight bill audits. As well, a computerized preventative maintenance system had been developed for the plant.

Although robotics and computerized production functions assisted in productivity improvements, high technology and automation did not play a major role in the production process for these appliances. And given the technologies available at the time or in prospect in 1986, the plant's managers believed that there was not a high potential for the substitution of labour with capital. Where Pacific Rim manufacturers excelled was in their efficiency in materials handling. Camco, therefore, relied on just-in-time (JIT) inventory systems and statistical process control (SPC) to control production costs while maintaining product quality.

Just-in-time systems minimize on-hand inventories of parts and materials, thereby freeing up capital and reducing storage requirements and associated costs. Before the plant moved towards JIT, total plant inventories represented between 30 and 40 days of production materials. Between 1984 and 1986, that figure was reduced to 18 days. In 1986, the total parts stock was 13 days, exceeding the plant's JIT target of 16 days.

With a JIT system, a plant's incoming supplies are entered immediately upon arrival, and outgoing inventory is recorded at the end of each day. This provides an accurate account of parts in the plant on a daily basis and an up-to-the-minute record of available materials.

The plant also hired a consultant to assist in the development of statistical process control at the plant and to train employees in its use. SPC is a method of integrating quality control into the manufacturing process, by sampling and assessing parts as they move through production. A one-day training session in SPC was given to top management personnel, and a further three-day course was offered to line supervisors, quality control inspectors, and some operators. SPC measurements were then conducted by quality control inspectors and line workers at various points in the assembly process. The use of SPC contributed to a decline in the number of units rejected within the plant and an improvement in product quality.

Although the introduction of new technologies, including JIT and SPC, streamlined the production process, it did not result in permanent layoffs of plant personnel. The management of the plant attempted to introduce new labour-saving equipment only in times of growth, so that affected workers could be relocated to other jobs within the plant. At the same time, overall increases in sales and the volume of production seemed to have prevented new technology from having had an adverse effect on work force expansion.

Orange Plus

When the plant's managers were considering implementing a productivity-sharing scheme, they advised their employees, but did not involve them in the final decision or the planning of Orange Plus. Information sessions on the plan, held before and after work hours at the time it was first implemented, were attended by 94 per cent of the plant's employees. There was some skepticism about the plan. Although nothing similar had previously been attempted in the plant, many senior workers remembered other programs that had been introduced and later abandoned. Hourly workers and management alike stated their doubts as to the real monetary benefits to be derived from gain sharing. They were also concerned that any money realized through Orange Plus could detract from their traditional pay increases.

Employees did not fully understand or accept the plan until it was in place and the "bottom line" results of cash payouts began to build.

The Orange Plus productivity-sharing plan was and is based on output per hour. At its inception, it incorporated two main aspects: bonus payments and employee committees. All employees of the firm, with the exception of the plant manager, have always participated in the plan.

Calculation of Bonus Payments

Bonus calculations in the plan are based on reductions in the total number of labour hours required to produce the plant's units of output. An average productivity level over the previous four years (1979-82 at the outset) is calculated to establish a ratio between the standard labour value of goods produced and the total direct and indirect labour attendance hours the plant requires to produce those goods.

The standard labour value of goods produced includes only direct labour and assumes the best methods in production. The plant's attendance hours include all direct and indirect labour, such as shippers/receivers and quality control employees, as well as production workers, and exclude time worked by salaried staff such as clerks and supervisors.

To determine the level of the Orange Plus bonus in a week where 200 hourly employees work a total of 8,000 hours, their labour input is measured against the total value of good product produced. In the case where, for example, the 8,000 hours of labour input assembled 10,000 "plus earned" hours worth of good product, a 25-per-cent improvement in productivity will have been realized. The complete calculation is as follows:

Plus earned hours	10,000
Actual hours worked	8,000
Total hours gained	2,000
Fifty per cent employee share	1,000

The employee share of hours gained is then multiplied by the plant average hourly earnings to create a "pool" to be shared by all employees:

1,000 hours x $8.50 per hour = $8,500.

This pool is then divided by all hours worked by employees in the plant to determine a share rate per hour. With the 2,000 hours worked by salaried employees added to the 8,000 hours worked by hourly employees in that week, the share rate would be calculated as follows:

$$\text{Share rate} = \frac{\text{bonus pool}}{\text{all hours worked}} = \frac{\$8,500}{8,000 + 2,000}$$

$$= \$0.85 \text{ per hour.}$$

The share rate is then applied to the actual hours worked by each employee in that 40-hour week:

$0.85 x 40 hours = $34.00.

The weekly calculation of Orange Plus bonuses uses a rolling five-week average of "plus earned" hours and the actual hours worked for the period. Bonus payments are made quarterly, paid as a dollar-per-hour figure, rather than as a percentage of earnings.

When the Orange Plus Plan was designed, management had intended to roll the base period forward each year, thus including annual improvements in productivity into the standard against which future gains are measured. As well, the plan allowed the company to "buy back" (i.e., update) the standards if productivity increases consistently exceeded 30 per cent, by paying each employee a calculated lump-sum payment. To date, neither measure has been adopted.

Bonuses are also paid for productivity increases resulting from the introduction of new technologies, but these are calculated on a different basis. If capital equipment is installed at a cost in excess of $10,000, 80 per cent of the cost savings produced by the technology is retained by the company. The remaining 20 per cent is included in the Orange Plus bonus pool and shared under the plan. Savings from capital investments of under $10,000 are not considered technological change per se and are shared equally by the company and its employees.

Employee Committees

At its outset, the plan provided for two employee committees, called "plus committees," appointed by management and representing all plant departments. After the first year of operation, all representatives on these committees, with the exception of the coordinator, were to be elected by employees. In the second year of the plan, it was decided that only one plus committee was required.

The plus committee met weekly to evaluate employee suggestions and discuss ways of improving productivity. Minutes of meetings were recorded and posted in the workplace. The committee had the authority to implement productivity-related suggestions costing up to a maximum of $250.

A review committee, consisting of five senior managers, met monthly with alternating representatives of the plus committee to screen and implement larger-scale suggestions, and to review the Orange Plus bonus calculations.

Results of Orange Plus

In its first year of operation, Orange Plus was an unqualified success. After a five-year period in which productivity levels had not improved, the Orangeville plant realized a 24.1-per-cent increase in productivity in 1984. The level of productivity growth outstripped the expectations of the plant management, who had been modelling for an increase of between 10 and 15 per cent in the first year, and 25 per cent over a four-year period.

Other production measures experienced similar gains in the first year. Both return on investment and return on sales ranked 25 per cent higher than the previous year. On-time delivery rates improved, service calls were reduced, and production response time was quicker.

Orange Plus also seemed to be successful in garnering employee participation and response. Three hundred and thirty-seven suggestions from employees were received in 1984, 179 of which were implemented by the company. Employees' productivity suggestions even extended to areas that had a potentially negative impact on employment levels. For example, a "bridge" in the glass-door assembly section of one line significantly increased production speed and reduced the level of labour input required. In this and other instances, however, the company was able to relocate the workers directly affected by the changes to other duties within the plant.

Employee-recommended amendments to the production process tended to focus on individual work stations or smaller sections of the line, and most often represented alterations to work flow as opposed to new technological hardware. But employees felt free to adjust their work stations to enhance their productivity, a process that did not occur prior to gain sharing. This also resulted in fewer complaints and problems following the regular line set-ups that were required for each new product. The cumulative effect of even minor technological changes recommended by employees contributed to notable cost savings after the introduction of Orange Plus.

The most tangible benefits of Orange Plus were the financial savings achieved in the plant and the resulting bonus payouts to employees. Employee suggestions and new technologies provided $1 million in cost savings, which represented cash bonuses of $1,650 for each employee in the first year.

The dramatic first-year growth in productivity was not replicated in 1985, however. Increased production runs during 1984 had increased plant inventories of finished goods, leading to a decline in production needs at the start of the following year. Reduced labour requirements led the company to institute work sharing in the first quarter of 1985. Work sharing provided employees working only part of their regular hours with a supplementary payment from the Unemployment Insurance Plan. This constituted a *de facto* layoff of employees.

Partially as a result of this decline in production, productivity in the second year of Orange Plus did not increase beyond the level reached in 1984. And because Orange Plus calls for each year's productivity gains to be incorporated into the base level against which the following year's performance is measured, the cash payout to employees for 1985 was to have declined to insignificance. Recognizing that this would have seriously threatened employee confidence in Orange Plus and jeopardized its future, management chose not to roll the base period forward. Even with this move, the average bonus received by employees dropped to $1,100 in the second year of the plan. Management retained the right to roll the base period forward in future years based on their assessments of the situation at that time.

The number of employee suggestions received through Orange Plus also fell off, declining from 337 to 169 in the second year. Cost savings declined commensurately to $350,000, still not an insignificant amount.

With the elimination of the second plus committee in the second year, the remaining plus committee undertook to increase its visibility among plant workers and to take a more active approach to soliciting suggestions and employee input. Periodic bulletins regarding Orange Plus were distributed in the plant's cafeteria. Pairs of committee members also began visiting individual work stations on the lines to ask workers for their suggestions and to discuss the production process.

Also in 1985, new work committees were formed, each organized on a production-unit or "work-team" basis and representing each of the small lines, maintenance, shipping/receiving areas, and others. Committees were formed for salaried work groups as well. Line supervisors and quality control inspectors participated on the committees associated with their individual work assignments.

Each work committee met monthly, during paid working time. The meetings were chaired by the line supervisor and were attended by all employees working within that group. Past performance, line efficiency, and production quality data were presented to the group, and an open discussion was held on problems or suggestions raised by the workers. Management personnel were responsible for resolving problems or providing an explanation of the situation and the factors impeding a resolution.

The minutes of these work committee meetings, noting the responsibility centre for follow-up action on each suggestion and graph representing recent performance data, were produced by the following day and posted at work stations. Minutes were also forwarded to the Orange Plus committee, which reviewed suggestions involving more analysis or larger expenditures.

Management assessed that meetings of the 70 to 100 workers on each of the larger production lines would be too large to foster meaningful communication, and thought that breaking these lines down into smaller group meetings would sacrifice the necessary overview of the entire line. They therefore decided to solicit suggestions from these workers by other means; a suggestion list attached to a unit and sent down the line elicited over 70 responses; as well, at the end of each production run for a particular model or appliance, a meeting was held with a dozen or so selected workers from the line to discuss the operation and ideas for improvements. These approaches, however, remained more ad hoc and less comprehensive than the committee meeting process.

Overall, employee confidence in Orange Plus waned in the second year with the arrival of work sharing and the drop in bonus payment amounts. Employees stated that there was some feeling that work sharing was necessitated by excessive production increases in the previous year, made possible, in part, by improved productivity. As well, the annual wage increase was somewhat lower than in previous years and was phased in through two increments over the year. Management maintained that the lower wage increase was due to the decline in inflation and in comparable wage increases.

Productivity sharing increased expectations, not only from senior management, but also from line workers, for production efficiency. Supervisors came to consider themselves more accountable to plant workers and shared more information and responsibility with them. One supervisor summed up his attitude by stating that Orange Plus, and its emphasis on employee input, made them all better managers.

Line workers and supervisors interviewed in 1986 believed that the productivity-sharing plan resulted in many modest, but cumulatively significant, improvements in work flow and efficiency at the Orangeville plant.

General economic conditions, perceived or real threats to job security and the quality of work life, information sharing, ergonomics, and the relative power of employees in the workplace, all influence the type and pattern of response to technological change. Gain sharing has been a significant, but not the only, element in the successful adoption of new technologies at Camco/Fedders. Where Orange Plus had its most direct impact on technological change was in employees' willingness to adapt to innovations and to seek out and implement improvements in production. When people were provided with a financial gain, they began to look critically at these aspects of the work process.

Update since 1986

Camco/Fedders were unable to continue the strong increase in productivity the Orange Plus Plan achieved in its first year of operation. To preserve employees' support for the plan, the plant's managers have never rolled the base period forward from its initial level, covering the years 1979-82. In the five quarters ending early in 1989, the bonus payments to employees averaged $325, or about $1,300 per year.

The number of employee suggestions submitted to the plus committees trickled to such a low number after the first two years of the program, that the work team committee system was folded into the plus committee, which in turn operates on a very informal basis. Suggestion lists are still sent down the three remaining production lines, each consisting of 40 to 50 people producing air conditioners and dehumidifiers, and meetings are held after each production run. Any suggestions are investigated by management and implemented if they are deemed useful.

The Orangeville plant has undergone a number of significant changes since 1986. In April 1987, after the employees decided to have union representation, the United Electrical Workers became the official bargaining agent for the employees of the Camco Orangeville plant.

Labour-management relations at the Fedders plant became more difficult than they had been in the pre-union days. Then, in mid-1988, management and workers alike faced trying days as product lines dwindled with the elimination of microwave oven and humidifier production. The work force was reduced to 175, from 300 in the plant's heyday. The plant also faced great uncertainty in the period before its sale to Fedders Inc. Through it all, though, support for Orange Plus endured.

The "Plus" Total

Plant productivity is dependent on a range of factors including employee skills and motivation, cost-savings, and new technologies, but is also affected by market activity, volume of production, economies of scale, and accumulated inventories. As with many Canadian manufacturers, Fedders Inc. faces the challenge of continuing to find ways of improving its productivity with a mature product line to remain competitive against low-wage countries using the same technologies. It also seeks to sustain employee support for Orange Plus in a new labour-relations environment. The future of Orange Plus is dependent upon the interest of plant employees and an atmosphere supportive of its goals; in this regard, senior managers' commitment to the plan, and to participatory management in general, may be its strongest asset in meeting the test of time.

The possibility that productivity improvements may have a detrimental effect on the size of the work force has been a major obstacle to the acceptance of gain-sharing plans among workers and unions in many industries. In the early days of Orange Plus, Camco was able to overcome some of the fears and negative attitudes of its employees because of the benefits accruing from high sales levels. Camco's strong growth at the time Orange Plus was introduced enabled it to avoid layoffs and realize immediate cash benefits from gain sharing. These factors helped change employees' skepticism to some level of enthusiasm for the plan.

However, even after its first successful year, workers' attitudes towards Orange Plus were not homogeneous. Perhaps 10 to 15 per cent of workers simply did not care about the plan and were content to do their jobs and draw their regular pay cheques. Outside of work team meetings and occasional comments on the level of the bonus, Orange Plus was not a topic of conversation among workers or a particular focus of their attention. There was no deluge of volunteers to participate on committees. Nonetheless, from the beginning, management was pleased with the concrete employee suggestions, reports from both wage and salary workers of cooperative approaches to work, employees' openness in line committee meetings, the generally improved communications, and overall attention to product quality.

The extent to which the successes achieved under Orange Plus can continue is unclear. If there are limits to which labour productivity can increase, most incentive plans will have a relatively short life span. In 1986, Camco employees felt that the viability of the plan was dependent on an ongoing financial benefit for employees.

The Orangeville plant's experience that gain sharing can contribute to increased productivity is consistent with reviews of other productivity-sharing plans. For example, a survey of 24 programs in the United States revealed average annual cost savings in excess of 16 per cent attributable to productivity sharing.

Productivity-sharing plans may also have an influence on the dynamics of technological change, as part of the broad spectrum of labour relations issues that are linked to industrial innovation. New technological processes require new management approaches, including efforts to improve communications and enhance participation and productivity in the workplace. If implemented carefully in a supportive environment, a productivity-sharing plan can assist in the identification of technological requirements, workers' acceptance of new technologies, and in a more equitable distribution of their benefits.

Productivity sharing cannot solve serious existing problems. It alone will not reverse low productivity performance or improve bad working relationships. It is not a substitute for effective and progressive management.

Nor is productivity sharing a replacement for competitive compensation packages. This case study illustrates the importance of a significant financial bonus in maintaining a plan's viability and acceptance. If that bonus is subsumed by low base rate wages, the advantages of the program would be lost.

Technological change provides significant challenges to labour relations as well as new opportunities. Gain sharing is not a panacea: it is not an answer to the many difficulties posed by industrial innovation. But as one element of a broader, supportive strategy, it may provide benefits for both employees and employers.

7 Synerlogic: Change Is the Constant

Some of the most dynamic and innovative Canadian industries are now in the service sector. In many of the rapidly expanding business services, for example, tomorrow's markets, organizations, and technologies are already here today. As the story of Synerlogic – an Ottawa-based information and systems management company – illustrates, the nature of these industries poses special challenges for the effective management of innovation.

While each of the preceding chapters focused on an episode of organizational and technological change, this is a case about constant change. Firms in high-tech business service industries are virtually always in a state of transition. Advances in computers and their potential applications mean that product life is short. And, as a consequence, these companies are in a never-ending cycle of extending existing services and introducing new ones.

Information management firms such as Synerlogic can only keep up through the knowledge, skills, and ideas of their people. When your real assets walk out the door every night, success depends on creating and sustaining an environment of creativity and commitment. While it may be critical, human-resource management is not a simple matter in the high-tech service sector. That is because "high tech" usually means "low stability" – not an ideal environment for implementing people policies that work. The case of Synerlogic illustrates the importance and, also, the challenges of managing human resources in such a setting.

In less than 15 years, Synerlogic has gone from a storefront operation running on a $5,000 bank loan to $20 million in annual sales as a strategic arm of the multinational service giant, Arthur Andersen & Co. The path between then and now, though, has been anything but straight. Typical of its industry, Synerlogic has experienced several ups and downs in its brief history: rapid expansion in the late 1970s, cutbacks during the recession, then growth through diversification, retrenchment again and, most recently, growth once more. Along the way, there have been branches opening and closing, head office moves, a series of ownership regimes and executive teams, and countless products and services.

Through it all, Synerlogic has depended on providing an environment where technically skilled and creative people could extend their talents and direct them to the goals of the organization. As the company has moved through the various stages of its development from an entrepreneurial outfit to a mature organization, it has had to make a series of adjustments in order to meet this challenge.

Flying by the Seat of the Pants

In 1975, the company started out as an offshoot of a Toronto temporary help placement agency renting out programmers and computer programs. While Synerlogic – or Bailey and Rose, as it was initially called – was born in Toronto, it started growing up in Ottawa. The Ottawa Valley in the mid-1970s was a very attractive setting for businesses offering computer services. In these years, the federal government was following a "buy-not-make" policy to meet its data-processing needs. That is, rather than attempt to build up complete in-house computing capabilities, departments and agencies were contracting out much of the work that they required. Noting the opportunity, Synerlogic opened up a shoestring branch office in Ottawa and started going after government business.

This was the "seat-of-the-pants" stage. Essentially, the business strategy was quite limited and straightforward: aggressively pursue contract opportunities. As is typical of entrepreneurial outfits just starting up, there was no real need for a conscious approach to human-resource management. Communication and decision making required no explicit structure. Nor did recruitment, development, or compensation. Relatively few people were involved, and those that were had the computer skills that the market was now demanding, and they shared a strong commitment to the new venture.

In a short time, Synerlogic began experiencing some success. Operating in a market where the demand for data-processing services was accelerating, the founders had the energy, enthusiasm, and technical know-how to profit from the favourable environment. By the end of the decade, they were selling consulting services through offices in Montréal, Calgary, Edmonton, Vancouver, and Victoria. There were even plans to expand into the United States.

In the first few years, the number one concern had been simply to stay alive. As survival became more assured, however, there were new issues to face. Planning had to become more conscious. For the first time, some fundamental organization decisions had to be explicitly considered. What were Synerlogic's longer-run objectives? What kind of a company did it want to be? What "culture" did the organization want to foster?

At the same time, personnel issues also began to emerge. The expansion meant that the firm's work force had to grow beyond the small group that had been closely involved in the start-up. While motivation and commitment had been taken for granted among the originals, this could no longer be the case. As the network of people involved in Synerlogic widened, the founders developed some sense of a general philosophy regarding human resources which was based on offering broad responsibility and initiative. The speed of the expansion, however, outpaced their ability to put together a concrete strategy. It would take the hard times of the early 1980s to start to work out a conscious approach to human-resource management.

Transition Years

The recession terminated Synerlogic's initial stage of growth through energy and enthusiasm. Times got tough, people were laid off, revenue was eked out. When company managers look back now, this was an important period. To survive, Synerlogic's maturing process had to accelerate. Energy and enthusiasm were no longer enough. A series of decisions regarding product diversification and financing were made. And, for the first time, an explicit human-resource management strategy was developed. These developments, together, altered the nature of the organization.

Diversification assumed great priority with the experience of the recession. To insulate the company from the vagaries of the market, a decision was made to diversify through software development. This process led to various commercial initiatives including the marketing of hotel software, the development of electronic data interchange capabilities, and consulting applications in the military.

Until 1987, however, the flagship of Synerlogic's diversification effort was in computer-based training and artificial intelligence (CBT/AI). The CBT/AI project was noteworthy on a number of counts: it was exciting, intellectually it was at the leading edge, and it represented an opportunity with huge commercial potential. It was also extremely risky, particularly for a relatively small company with a track record in consulting, not research and development.

The financial issue was perhaps the most pressing one. Certainly, the experience of the downturn injected a note of realism into the company's fiscal management. Cost-efficiency and cost-consciousness had become critical. And, if Synerlogic was to diversify into research, development, and marketing of software products, it needed more capital than it could generate internally through consulting revenues. Eventually, Synerlogic found what it was looking for when Vencap Equities (Vencap), a venture capital company started by the Alberta government, became a large minority shareholder in 1984.

Synerlogic managers identify the arrival of Vencap on the scene as a very important juncture for their company. Most obviously, the alliance provided Synerlogic with capital it needed to develop. Vencap also changed the way the company was managed. Until 1984, Synerlogic was still running as an entrepreneurial outfit. All policies and decisions were made informally by a small group – essentially the founders. Yet the company now measured its annual revenues in the millions and, in fact, it was looking to go over the $10 million mark with the diversification. To operate at that level and to handle what was in the pipeline, more conscious planning and more accountability in decision making were clearly overdue. This was required by Vencap as a condition for investing in Synerlogic.

The more conscious approach to management extended very much into the human-resource area. As Synerlogic's circle widened, it became critical to begin looking systematically at practices regarding recruiting, compensation, and professional development.

Recruiting was critical. The new software development initiatives called for skills that an information systems consulting firm is not likely to have in-house – particularly when the new initiatives had to do with esoteric matters as artificial intelligence and computer-based learning.

Hiring pressures were growing on the consulting side as well. The scale of the company's consulting activity required an ever-growing supply of technical specialists. And, since the consulting business depends on the quality of your consultants, these specialists had to be as good or better than the competitor's. To make recruiting even more challenging, the market for good computer experts is generally a "seller's market," where demand tends to outstrip supply.

The recruiting strategy Synerlogic developed in these years was really quite simple: do not stop interviewing. While this was a rational response to the realities of the labour market, as well, it reflected the fact that the company was not only on the lookout for technical expertise, but also for people with creativity and commitment.

Once the talent was in place, an environment had to be there to keep it and allow it to flourish. One Synerlogic manager characterized the objective of their human-resource policy as "providing system support to high achievers." The first step was to offer attractive compensation. With an interest in linking rewards to performance, Synerlogic began establishing individualized incentive-based schemes. Plans negotiated with managerial, professional, and sales staff increasingly tied some portion of total earnings to agreed-upon performance standards.

Compensation practices were not enough, however, particularly for a company that was too small to simply outbid its competitors. Synerlogic had to be able to offer opportunities for professional development. Here, it is important to recognize the importance of ongoing education and training for career development in the information management business. Professionals must stay on the "leading edge," but that edge never stays still. So they need to be in a constant state of learning. Synerlogic offered training in three forms. It subsidized university classes, sent people out for external courses, and set up internal training (where professionals had obligations both to teach and take courses).

As another component of its human-resource policy, Synerlogic introduced a "career system." On the belief that people have to be able to see where they are going, the company tried to develop individual career development plans. These plans incorporate personal ambitions, opportunities within the firm, and suggested training requirements. An interesting feature of career development at Synerlogic has been "succession planning" where the future occupants of senior positions are identified in advance and trained accordingly in anticipation of eventually moving up.

Refocus, Renewal, and Takeover

By early 1987, some disturbing clouds were appearing on Synerlogic's horizon. Most notably, the new activities, including the CBT/AI project, were draining company resources. Financially, they required substantial amounts of money and their prospects for becoming profitable were still not in the immediate future. As well, the management team was exhibiting signs of being stretched too thin. It was becoming apparent that Synerlogic was trying to do too much. There were now five divisions: CBT/AI, productivity software, hospitality products, and telemarketing had all been added to the original consulting activity. The drive to diversify seemed to have gone too quickly and ranged too widely.

After reviewing the operations, the board of directors decided to sell off or close down all of the divisions but consulting. With regard to the CBT/AI project, there was still excitement and, indeed, some good training products were being produced already. Unfortunately, to sell them, Synerlogic required a level of investment that was unmanageable for a company of its size. The company's forte was consulting – that is how it had grown and, in fact, how it still was growing. Despite the investments made in the other divisions, $15 million of Synerlogic's $15.8 million in sales in 1986 had come from consulting. And the management team had consulting backgrounds: this is where their expertise resided. As the marketing director put it, the decision to drop the other divisions was a "reaffirmation of faith."

Since early 1987, Synerlogic has focused once more on growth through consulting and information management. Diversification remains important. The difference now is that it is taking place under the consulting and information management umbrella. The company seems to be using its technical skills in this field as a springboard for taking on wider-ranging contracts in systems and project management. Electronic data interchange and systems integration are two examples of recent diversification initiatives along this line.

Electronic data interchange (EDI) is a means of electronically transmitting documents. Where these traditionally have been mailed or telexed between companies, EDI software enables them to be transmitted instantaneously from one firm's computer to another's via telephone-line hookups. Synerlogic first got involved with EDI in 1984 and, since then, it has developed the capacity to provide related consulting services such as advance impact analysis, application assistance, and integration support.

Systems integration (SI) has become an important initiative for Synerlogic. In effect, SI involves whatever is required to meet the client's information and systems needs. This can include everything from clarifying what those needs are, designing the appropriate system, managing the selection and acquisition of hardware and software, and systems maintenance. Synerlogic managers see SI as a natural progression from what the company has been doing, particularly in the defence field.

Synerlogic's renewed focus on consulting and information management proved to be an effective renewal strategy. Momentum built over 1987-88, and the firm was carrying out $20 million of business in 1988. At that size, a debt-free, high-tech company is an attractive proposition and, in October 1988, Synerlogic was purchased by the Canadian partnership of Andersen Consulting, part of a huge American-based multinational. While Arthur Andersen built its reputation in accounting, its information consulting business unit, Andersen Consulting, has rapidly become a major part of the overall operations. Looking to expand this division and wanting to grow in Canada, Andersen found Synerlogic. Synerlogic continues to operate under its own name as a wholly owned subsidiary with offices in five Canadian cities.

While the relationship with the parent company is currently being defined, it is clear that Synerlogic – and, more specifically, its approach to human resources – will be undergoing another series of changes. In finding its place within the Andersen empire, Synerlogic will have to give up some of the policies it developed. In the area of pay and benefits, for example, Synerlogic's individualized schemes are being replaced by more standard approaches in order to conform with Andersen compensation practices.

Under the new regime, then, personal incentives cannot be so immediately financial. To compensate, Synerlogic managers hope an association with a parent company that does over $2 billion of business annually will create a different kind of incentive, based on education, training, and career opportunities. Synerlogic has always placed an emphasis on professional development, but it now has access to resources that were unavailable before. Synerlogic employees can use Arthur Andersen's corporate university, the Center for Professional Education, outside Chicago. As an Andersen subsidiary, Synerlogic receives an annual allotment of training places at the Center, and this is expected to significantly increase opportunities for employee education and training.

Stable Principles, Shifting Practices

As Synerlogic has grown up, it has had to address the kinds of personnel issues that any entrepreneurial outfit must inevitably face in making the transition to a more formal organization. In the early days, when the circle was small, the necessary energy and commitment were more or less automatic. With expansion, however, more attention to human-resource management became necessary. Key principles had to be identified and approaches to apply them had to be worked out.

The principles, themselves, may never change but their application can, depending on prevailing circumstances. In a nutshell, the objective of human-resource management for Synerlogic has been to preserve the original creativity and commitment while making certain that the needs of the more mature and formal organization are met.

Synerlogic has attempted to do this by offering its employees professional development not only through education and training, but also through opportunities for taking initiative and responsibility. One approach to establish this kind of environment is to give employees room and even incentives to create business opportunities themselves. Some people call it "intrapreneurship." A Synerlogic executive called it "bottom-up planning." While most of the company's projects are initiated in the conventional way by management, some – most notably EDI – originated at the staff level.

The Synerlogic case offers some insight into the question of how an effective human-resources strategy can be sustained in a context of ongoing change – a context which certainly characterizes the high-tech sector. In these circumstances, Synerlogic has pursued a set of principles – first, implicitly and, more recently, explicitly – to foster individual creativity, initiative, and commitment. At the same time, the application of these principles has demanded continual adaptation to the changing environment.

8 Not in Our Best Interest: When Technological Change Fails

There is a rush towards technological change in many Canadian manufacturing companies, but the haste may be misguided. Some company executives, looking for a fast and easy way to increase productivity or expand production levels, charge ahead with technological changes that are inappropriate to their needs, or improperly introduced into their plants. Such managers may end up as losers in the competition for efficiency and profits.

As any good manager knows, sometimes more can be learned from failures than from successes. In this chapter, therefore, the examples of five manufacturing companies, which have experienced problems in introducing technological change, will illustrate the pitfalls of improper planning for technology.

These examples demonstrate, as do the other chapters of this case book, that the human-resource aspect of technological change can be as important as the technology itself. Peoples' attitudes, preparation, and training can be the critical factors bringing success or failure.

Fictional names are used for the companies studied in this chapter. The problems they experienced could occur in any manufacturing company.

The "Alpha" and "Beta" companies referred to in the first section purchased technological systems without first researching the systems' compatibility with their own or their clients' needs. And the Beta company mistakenly expected its employees to be able to handle large orders on the new equipment without the proper training. Because of this lack of preparation, the new systems did not perform as expected and, indeed, jeopardized both companies' futures.

The "Gamma" and "Delta" companies, discussed next, purchased the right systems for their needs. However, neither company managed the systems' introduction effectively or planned adequately for the systems' implementation. "Epsilon," the final company discussed, used technological change to manipulate labour-management relations. With an ensuing strike and poisoned labour relations, the company lost out on its new system's benefits. For these three companies, the right technology, without proper management support, became a burden rather than the asset it should have been.

When the System Does Not Perform

High-technology systems are often purchased in turnkey form, rather than having to be developed from scratch. Modern computers are usually reliable; problems related to software or to computer speed can usually be rectified quickly.

When there are serious hardware problems, it is often not the hardware itself that is at fault. Rather, either the wrong computer or the wrong software has been chosen, or both – in other words, the problems are really caused by human misjudgment. In such cases, it is usually only after the investment of considerable amounts of time and money that management becomes aware that an error has been made, and the firm often abandons the system rather than starting again with another computer or program.

The Alpha Mechanical Equipment Company

The Alpha Mechanical Equipment Company manufactures mechanical equipment for the pulp and paper industry. Originally run by its founder, the company was profitable and employed 450 people in a remote area whose economy and employment base relied almost exclusively on the company. With the departure of the founder, the firm lacked leadership. While its sales remained relatively solid for a time, profitability declined. The company became a Crown corporation, and its administrators installed a production planning and management system (PPMS) to increase plant productivity and so restore profitability. In addition, the administrators hoped to eliminate some 35 jobs, which the system vendor told them would be possible in a matter of months.

Although they were committed to making the system work and ensured adequate training for its main users, Alpha's administrators did not want to become directly involved in the implementation of the PPMS. As a result, the administrators were oblivious to the serious problems that developed as the system was used. Once the system was installed, Alpha found out that the PPMS's batch processing system was inappropriate for quick production of its customized items, and that the system was incapable of handling the 65,000 items in the company's product line.

Production was completely disrupted. A year later, the company had an additional 11 employees working on the system rather than 35 fewer employees as the vendor had promised.

To make a bad situation worse, the administrators hired a small consulting firm, which applied computer solutions to the problems, developing new programs to supplement the system; the system became even more overloaded, production continued to deteriorate, sales and productivity declined, and the already high cost of purchasing and installing the system rose by another $500,000. The company finished the year with a significant deficit.

Alpha was on the brink of bankruptcy when two businessmen purchased it, pulled the plug on the computerized system, and put the company back in the black in just 18 months, using traditional manual production methods.

Alpha's managers evidently did not research PPMS's adequately to determine whether the system it was purchasing could meet the company's needs. In addition, they did not recognize the importance of their continuing involvement in the system's implementation. The responsibility for the installation of new technology cannot just be handed over to middle management. All levels of an organization, from the shop floor through to top management, must be involved in consultations before the purchase and in ongoing evaluations of a system's use.

The Beta Workshop

The Beta Workshop, a machining workshop employing 20 employees, makes plastic-injection moulds, mainly for the automobile industry. The company was founded six years before the case study was undertaken, by a talented craftsman with leadership qualities. Convinced that digitally controlled machines represented the wave of the future, the owner purchased a machining plant equipped with a state-of-the-art control system. In order to reduce the system's programming time and increase its capacity, he also invested in off-line graphics programming, CAD/CAM (computer assisted design/computer assisted manufacturing).

The Beta Workshop's owner realized that in the near future large corporations would be sending magnetic tapes or diskettes describing the geometry of their CAD/CAM system-designed parts to their contractors instead of blueprints. By getting a jump on his competitors in purchasing a CAD/CAM system, he hoped to significantly increase his sales.

During the system's trial run with a large telephone equipment manufacturer, it turned out that the file format used to store graphics by the large corporation's system was not 100 per cent compatible with standards established by the U.S. National Bureau of Standards, and thus not compatible with the Beta Workshop's CAD/CAM system. Unable to read the diskettes on its own system, the Beta Workshop lost an important source of business.

Shortly afterwards, the Beta Workshop's owner informed representatives of the automotive industry and its main subcontractors that his company was now equipped with a CAD/CAM system and would be able to manufacture parts designed on their CAD/CAM systems.

This turned out to be a costly mistake. The Beta Workshop had no experience in receiving and reading files and data from the firms it had contacted. The workshop's owner had also failed to take into consideration that his staff had next to no experience with its own CAD/CAM system, and that the complexity of the work accepted by the company might prove more than its staff could handle at the outset.

The workshop was almost immediately swamped with machining contracts with relatively tight deadlines for which the employees were not adequately prepared. Although they were highly competent and worked 60 hours a week trying to meet the imposed workload, the employees using the CAD/CAM system were quite aware that their training on the system was inadequate. Production was delayed and the company's revenues fell. Over and above the problems connected with inadequate training and the complex nature of the contracts, the Beta Workshop experienced technical problems and system failures.

The Beta Workshop lost $75,000 in three months and saw a large portion of its liquid assets evaporate. The tool that had been intended to increase its productivity had brought the company to the brink of ruin. It turned out that some of the company's problems were, in fact, due to defective software and hardware, which were subsequently replaced. However, the in-depth training needed by users was not forthcoming. Although work thenceforth proceeded without hitches, the pace remained slow.

In the case of the Beta Workshop, additional research time spent on comparing the available CAD/CAM systems might have prevented the purchase of defective hardware and software. Adequate training for employees could have speeded up work processes with the new technology, and advance consultation with the system's users in the plant would have shown that they were not ready to cope with contracts of the magnitude sought by the president. Instead, the company took on too much too fast, and nearly ended up with nothing.

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In the case of the Alpha Mechanical Equipment Company and the Beta Workshop, a lack of planning and inadequate training were aggravated by poor internal communication. Alpha's administrators, by their reluctance to become involved with their new system's implementation, and both companies' managers, by not consulting the workers before purchasing the new systems or accepting major contracts, inadvertently sabotaged their own initiatives. Problems stemming from this lack of communication added to the burden of inadequate or faulty technical systems. The combination nearly destroyed formerly profitable companies. The technology itself was not to blame. Ultimately, it is a company's managers who must take the responsibility for properly implementing technological changes.

Who Can Make This System Work?

Even with the appropriate technology, companies must carefully manage the introduction of technical changes into their operations. A senior manager with the scope to oversee the changes necessary in all production and related processes should be identified, and planning systems, including consultations with labour, must be developed. In the following three case studies, the lack of appropriate management planning led to problems, even though the technology was capable of meeting the companies' needs.

The Gamma Heavy Machinery Company

The Gamma Heavy Machinery Company manufactures electrical and transportation equipment. It is a Crown corporation employing approximately 1,600 workers, who are represented by a very strong union. The company was one of the first manufacturing firms in Canada to adopt a CAD/CAM system, and did so on the recommendation of a consultant's feasibility study. Technicians and draftsmen were to be the main users of the system for their design work, and all draftsroom personnel were to be trained to use the system. Engineers were also to be given access to the system to do analyses.

The system's implementation was overseen by the company's Engineering Department, but no proper administrative structure was set up, and no one was officially designated in charge. In addition, the company did not set up a user advisory committee and, most importantly, did not develop an implementation plan and training program.

The consultants who had recommended the use of a CAD/CAM system had also recommended that two shifts should be used on each of the four work stations set up in the initial installation phase for the system to prove cost-effective. But the company's directors were convinced that the unionized technicians and draftsmen would never agree to work shifts and did not bother to consult them. When the system was installed, however, the unionized draftsmen and technicians immediately volunteered to work shifts and even to come in at night if necessary in order to learn how to use the system. They realized that CAD/CAM was still not in widespread use at that time, and that this represented an excellent opportunity for them to learn how to use a technology of the future. They never got that chance.

The young engineers who found it easier to learn how to use the system because of their backgrounds eagerly started to use it and, in fact, began to monopolize it. The draftsmen had little opportunity to receive the necessary training and so many of them abandoned hope of ever becoming CAD/CAM technicians. A gulf was created between engineers and draftsmen. Without training and access by technicians and draftsmen, the system did not prove productive in the draftsroom and was ignored completely by many unionized employees. As engineers found the system more productive than did the technicians and draftsmen, the engineering directors began to hire young engineers who cost less money than unionized technicians and draftsmen. As a result, the number of technicians and draftsmen began to decline.

As is often the case when a large computer system is installed, there were some major software problems; the lack of communication in reporting these faults to the supplier turned out to be a serious problem. In light of the poor results and lack of improved productivity in the draftsroom, some administrators concluded that the wrong system had been acquired, and that the system manufacturer was doing nothing to help them.

Without a clear company policy on the training for and use of the CAD/CAM system, the people who were supposed to be its main users were effectively muscled out of the way by employees in the Engineering Department who were used to working with technology and who could see the benefits of the system for their work. With no one designated in charge of the system's implementation, the problems that ensued for the draftsroom personnel were allowed to worsen, until the workers disregarded the system, and management doubted its value.

It was only after three and a half years that the Gamma Heavy Machinery Company's administrators took a serious look at the problems and gradually instituted corrective measures to make the system productive.

Without clear line responsibility for the implementation of the CAD/CAM system at Gamma, the system was not used for its original purpose, was not used to capacity, and threatened the jobs of technicians and draftsmen.

Gamma's managers' lack of communication with the union, the system's intended users, and the manufacturer, and the lack of communication between the engineers and the draftsmen and technicians led to a series of problems that were entirely avoidable. The lack of appropriate planning for training and system selection meant that the system was blamed for problems related to the company's own mismanagement.

The Delta Electrical Equipment Company

The Delta Electrical Equipment Company manufactures medium- and high-voltage electrical equipment for electric power transmission. It employs about 350 people and is jointly owned by a provincial government and a foreign government. In 1979, to bring forward delivery dates, the company installed a $500,000-computer-aided production planning and management system (PPMS) which would be integrated with the accounting system. The system was expected to pay for itself in three years.

Responsibility for the system was given to the director of data processing, who reported directly to the company's vice-president of finance. Because he was more familiar with the financial part of the system, the data processing director implemented it at the expense of the production management part of the system.

The company's other administrators had not been trained in the functioning of the system, and therefore had little idea of what it could do for them and little motivation to use it. All potential users of the PPMS should normally have been trained in the systems' use and application in their areas months before the system was installed. In this way, the system could have been used to its capacity from the start.

Instead, two years after the system was installed, the company still had experienced no significant reductions in the time required to manufacture its products. Its competitors, meanwhile, particularly at the international level, had managed to shorten their delivery dates significantly. The Delta Electrical Equipment Company lost out on several contracts, which cut into its sales and led to the loss of some jobs. Five years after the system was installed, the inventory module of the system was operational, but none of the production modules had yet been implemented; the half-million dollar system was being used to only about 16 per cent of its capacity.

In 1984, the company hired a consultant, who immediately pinpointed the urgent need for training and drew up an 18-month plan. Even after the training was completed and all modules had been installed and were ready for operation, however, some modules were not being used. The main reason for this was that a feeling of distrust of the system had spread through the company. Because the system worked by batch processing, employees were unable to make changes and see the results interactively; instead, they had to consult long printouts. Users found this method of consultation too time-consuming and had little confidence in the real benefits of implementing the system.

In addition, the leadership issue had not been resolved. Responsibility for the system's implementation would have been more properly placed with a senior manager who could oversee its use in all departments, rather than with the data processing director.

Also in 1984, the company commissioned a feasibility study on the possible implementation of a CAD/CAM system. The results indicated that Delta would be well advised to use the technology to design new, more competitive products and to reduce engineering time, which represented the largest component of production time. In light of the problems they had experienced with the production management system, the company's directors were reluctant to install another new system, and a CAD/CAM system was not acquired.

If Delta had developed an appropriate planning and training plan and had designated a senior manager responsible for implementing all aspects of the system, sales could have increased, leading to the creation of new jobs. Proper human-resource planning could have had a positive impact on the bottom line. Instead, the failure of planning was blamed on the technology.

While Delta's competitors were increasing their sales with the use of technology, Delta Electrical Equipment was mulling over the "failure" of one new technological system and shying away from the introduction of another.

The Epsilon Manufacturing Company

The Epsilon Manufacturing Company is a multinational enterprise manufacturing equipment and machinery for the pulp and paper industry. It employs 1,200 people in the location of the case study. The employees are represented by a very strong union.

At the time the last collective agreement had been negotiated, the company was under pressure to make concessions to the union on wages and job descriptions in order to complete production without delay on about $200 million worth of contracts already begun at the plant.

Between periods of contract negotiations, Epsilon implemented a comprehensive production planning and management system (PPMS), which involved installing a number of VDTs in the plant. The company trained its employees in the use of the system, which was designed to be used in "real time."

With the new system, each employee was to be given a list of all the tools he would be needing that day, when he arrived at work in the morning. Before the new system was introduced, employees had been given the tools required at the times they were needed, by a "tool chaser."

Once PPMS was implemented, employees were to enter into the computer at specified times during the day the number of items manufactured, as well as how they were spending their time. Before the new system was introduced, production had been monitored by a "timekeeper." Because the positions of tool chaser and timekeeper had allowed employees to move freely throughout the plant, they had been taken over by union leaders.

In negotiating the latest collective agreement, Epsilon's management had made it known that the positions of tool chaser and timekeeper might be abolished. This represented a direct threat to union officers and became a major negotiating issue during the subsequent strike.

The strike lasted four months. The VDTs installed in the plant, and the entire computer system, were moved to a secure site over 50 kilometres away, to protect them from harm. Production came to an almost complete halt, but the company was able to go outside to have the machine parts manufactured for contracts it had under way. Being a multinational firm, it had these machinery orders completed by foreign subsidiaries and so was able to make do without its employees for as long as it wished. No work was started for new orders that had not been begun before the strike, however.

The mobility of the system, which allowed it to be moved out of harm's way, and the fact that it could be used to schedule production and to manage operations, thus threatening the jobs of union leaders, were used to exert tactical pressure throughout the strike. The strike ended when employees made concessions. However, when the system was brought back, it was not set up to operate in real time and the tool chasers and timekeepers kept their jobs.

Although the implementation of the computerized system was not the only reason for labour unrest at Epsilon, it was a contributing factor, leading to loss of income for hundreds of workers and loss of revenues for the company.

Epsilon's use of technical change to gain tactical advantage over its union was one of the factors leading to a strike that hurt both employees and the company. Even though the company was able to complete contracts under way at its subsidiary firms, production on new contracts was delayed by the strike.

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The failures associated with the improper introduction of the right technologies in these three case studies amplify the need to undertake planning and consultation before implementing technical changes:

- Training is essential in advance of the installation of technology. A training and implementation plan must be prepared.

- Ongoing involvement by senior management and the identification of a manager with an overview of all departments' potential need for and repercussions from the technology is important, both to implement the plan and solve the inevitable problems that will appear.

- Consultation with unions may result in increased acceptance by workers of the new work methods and the training required to perform the new duties.

In Our Best Interest

In an increasingly competitive world, technological innovation is essential to improve productivity and product quality. Canadian companies must innovate. However, as the five case studies in this chapter have illustrated, technical change must be properly managed in order to be of benefit to a company. Changes in technology demand adequate planning, continuing management involvement, and increased consultation and communication with employees.

With innovations in technology, we must adopt new approaches to human resources. Effective communication is critical to achieve the potential benefits of technical change. Management, unions, and all workers must be involved in planning for new work methods.

Training cannot be ignored or delayed when technological innovations are introduced. Only well-informed employees and managers can extract all the benefits and rectify the problems of the new technologies.

9 Two Cases of Innovation in the Public Sector: Impact on Women Workers

Women in clerical jobs have frequently been cited as the group most adversely affected by new technology. In the process of office automation women performing clerical tasks have found their skills redundant and their jobs in jeopardy. This is clearly a cause for concern, since the pace of technological and organizational change is unlikely to slow markedly in the coming years and since, in addition, clerical work is still the largest source of female employment.

The two cases in this chapter describe the introduction of new technologies in federal government office settings staffed mainly by women. The cases illustrate two different processes of adaptation to new technologies. In the first case, adaptation was preceded by extensive strategic planning for a nation-wide project; in the other case, new technology was implemented rapidly and intensive training programs were designed to meet the needs of the moment.

No attempt is made here to compare the relative efficiency of each approach to change; rather, we are interested in reporting two different situations where technical innovation can improve the service to the public as well as provide opportunities for professional mobility and new positions through internal transfer. More specifically, we are reporting how aspects such as planning, training, new responsibilities, and surplus personnel are handled.

It is important to note, however, that these results concern only those employees with "permanent" positions at the time the changes took place. "Temporary" and "contract" employees lost their jobs when their positions were abolished as a result of new work methods and accompanying budget cuts.

Choice of Organizations

Our criteria led us to choose two departments of quite dissimilar size and mandate. We were looking for situations where a recent technological innovation had reduced staff, where women had borne the brunt of these changes, and where organizational restructuring had been closely tied to the technological innovation.

The first group studied was part of Employment and Immigration Canada (EIC), and the second, part of Statistics Canada (StatCan), the federal statistical agency that resides within Supply and Services Canada. The former deals with the administration of the Unemployment Insurance Program in the province of Quebec, and the latter with the collection and dissemination of socio-economic data. EIC is one of the largest departments accounting for 11 per cent of the public service employment. Six out of 10 employees are women. At Statistics Canada, women account for just over half of total employment. In both cases, however, the representation of women in the administrative support category was well over 60 per cent.

The On-Line System at Employment and Immigration Canada

One of the responsibilities of EIC is the administration of applications for unemployment insurance benefits. The services available to Canada's unemployed have changed over the years as unemployment has reached high and persistent levels. In order to improve service while reducing both administrative and social costs stemming from administrative delays, the solution adopted was the automation of benefit application processing.

The Insurance On-Line System (IOLS) is a computerized system for processing applications for unemployment insurance benefits. Each Canada Employment Centre (CEC) has one or more video-display terminals (VDT) linked to a regional computer centre by telecommunication lines. The information for each application is entered directly at the terminal and transmitted to the central computer for file storage. The file may be consulted and updated from the remote terminals. The role of the regional computer centre is to centralize information processing by accepting data, compiling statistical reports, and controlling payment vouchers submitted to the central cheque-issue system.

The purpose of the IOLS was to provide better service to unemployment insurance recipients, facilitate file maintenance, improve control methods, reduce paperwork, facilitate data access, and reduce the number of requests for information. It was also designed to make it easier to share information with other services, such as job search and other programs administered by EIC. The implementation strategy was drawn up by a team of computer specialists. The task was to install 3,000 terminals in 600 offices across Canada.

After a three-year pilot project, the department began its implementation of the IOLS across Canada in 1976. Since the administration process for application processing was made simpler by automation, and start-up costs were high, the Treasury Board (as the ultimate employer and administrator) was prompted to stipulate a reciprocal cut in person-years. IOLS made possible the elimination of 430 person-years (less than 2 per cent of the department's total work force) by the time the system was completely operational across Canada. The person-year reductions were allocated according to the size of population serviced by each region. The two most populous regions, Ontario and Quebec, were assigned the largest person-year reductions. These two regions had to cut 122 person-years each, while the three other regions were required to reduce by 62 person-years each.

Implementation in the Quebec Region

The task was formidable: 90 employment centres were to be linked by means of almost 500 terminals, and over 2,000 employees in all regions of Quebec had to be trained to use the system. Managers at all levels were involved right from the beginning, and the union was kept abreast of forthcoming changes.

In order to ensure that the new system was used as efficiently as possible, it was decided to begin by training CEC directors in its use. This is a different approach than what is often reported in this type of case study. In many cases, the employees who will become the day-to-day users of the new technology are the only ones trained by either equipment manufacturers or internal training personnel. In such cases, managers do not really understand how a system works and expect miracles after a short training period. Sometimes this situation even leads to poor evaluation of such an investment in equipment and training efforts.

In this particular case, the training program was structured in such a way that eventually it reached all levels, from directors to the lowest clerical positions. At each centre a person was assigned as instructor for his or her colleagues. System maintenance responsibilities were given to another employee. This approach gave everyone the opportunity to learn how the system worked and encouraged cooperation among the various levels. Eight months later, the IOLS was up and running across Canada.

Impact Assessment

The most successful aspect of the new system was the expected improvement in the quality of service to beneficiaries. The system increased the efficiency of everyone working in the employment centres. Reduction in errors during transmission meant that the time-consuming process of error correction between the regional centre and the CECs was minimized. As expected, the IOLS revolutionized work methods in the CECs. An internal study was conducted in 1983 to examine how the new system had affected job content and, consequently, job classifications.

In the CECs, the duties directly affected were forms management, data processing, and information requests. The services offered to beneficiaries did not change, but the *methods* of carrying them out did. VDTs replaced pens and pencils as the main work "tool." But because the use of the on-line system did not alter job classifications, *positions remained at the same level.* Although some new duties appeared, such as system debugging and coordination, these were assigned to qualified technicians and not to clerical staff.

While the IOLS made certain manual tasks easier, a study showed that CECs actually saw little change in their normal activities. Changes were more marked at the regional data-processing centre. From the standpoint of total employment, the duties of control and coordination would, in the end, partially offset the displacement impact on the "data-collection" section.

Staff cutbacks at the CECs were kept to a minimum. Permanent positions were not affected, though contract employee budgets were eliminated along with overtime costs during peak periods. Thus, about 90 casual employees, mainly women and students, were the first to be affected by the IOLS's arrival in employment centres across the province.

At the regional office's Computer Systems Division, all work connected with forms management and data entry gradually declined in relative importance. Without exception, all such positions had been occupied by keypunch operators or clerks, and the majority were women. But then when technical and computer activities in other sections were expanding, few of the women whose jobs had disappeared had the necessary background to move into these positions requiring high technical aptitudes.

Over half of the 32 positions affected were held by temporary employees. They left during 1985-86. Again, there were no layoffs among the permanent positions. A small number of women quit on their own for personal reasons, and about a dozen others were relocated elsewhere in the organization.

As discussed with one manager of this project, in some areas of the public service, work environment and organization structure are developed slowly over a long period of time. Before the advent of new computerized techniques, only fundamental changes to a department mandate or to the nature of the service itself could deeply modify the organization of such a large operational unit. With technological changes, however, staff allocated to routine jobs could, with training, move into other fields where a different type of work presented new opportunities. Indeed, in this particular case, some transfers actually were made to a slightly higher level, offering better pay and possibilities to learn other skills. These opportunities contrasted sharply with the employees' previous "dead-end" jobs as data entry clerks.

Employee Relations

At a regional union-management meeting held when the project began, the feeling towards the IOLS project was very positive. *Permanent positions were guaranteed* and the emphasis was on the improved working conditions that would result from the introduction of the IOLS. No major labour relations problems were foreseen. The only issue raised by union representatives was the question of health and safety. Pregnant women working at VDTs should be able to apply for transfer to another position or could take annual leave, as provided for in the collective agreement.

Electronic Publishing

As the official statistical agency of the federal government, Statistics Canada releases some 600 publications each year. The Publications Division is responsible for designing, editing, printing, marketing, and distributing Statistics Canada's primary product – its publications.

In the early 1980s, Statistics Canada embarked on a full cost-recovery program. The combination of this criterion and the publishing mandate of the Publications Division prompted the changes that would eventually revolutionize this work unit. Between 1983 and 1986 new "composition technology" was installed that greatly changed both the work environment and work methods of the employees as a whole.

Electronic publishing equipment is an area where there have been some remarkable developments in the last few years. These sophisticated devices have quickly left behind their word-processor origins to offer a host of capabilities related to design and publishing. The division availed itself of such techniques as laser printing, electronic photocomposition, transmission of texts by integrated software packages, and creation of statistical tables and charts directly from the mainframe database. These new techniques made it possible for the division to increase its output while improving product quality.

Management opted for an incremental approach to planning, keeping up with current technological developments as they occurred in order to ensure that the equipment being used was always leading edge. The fact that the employees (at most 200) were all in one location worked in favour of this approach. Because of the rapid pace of change, however, there were other problems, which are discussed later.

The effect of the changes to the division's mandate and to its use of technology was to reduce the staff of the division over a three-year period. In accordance with Statistics Canada's policy to redeploy affected employees internally, there were no layoffs. About 15 per cent of the original group of employees were transferred to other divisions of the agency. As at EIC, the remaining staff reductions were accomplished through attrition and non-renewal of temporary contracts. The majority of those who remained at the division changed from being word-processor operators to computerized photocomposition technicians. Desirable as it may be, occupational mobility of this kind is rarely seen in practice.

On-the-Job Training

In 1983, the manager in charge of the division's word-processing personnel made a commitment to offer everyone the chance to learn to operate the new equipment. She also wanted to open up new career opportunities for her staff by offering them a range of computer courses. Initially, the operators did not display much interest, apparently unaware of the extent of the changes to come, but also because there were rumours that "new machines" would eventually replace them.

Whenever a new machine arrived, training courses were organized. It soon became clear that certain operators showed more talent than others for adapting to the new technologies. Those with particular ability in the visual conception of documents were assigned to expert teams. The general training strategy was modified. Those taking part were informed that, on the basis of aptitude, they would be either assigned to a team or returned to their previous positions to await new training opportunities on machines better suited to their abilities.

In this way, by offering a series of courses and by rotating personnel, the division streamlined its production methods and trained its staff in state-of-the-art technology. For at least 40 word-processor operators this new technology opened up new horizons.

Since technological innovation involves fundamental alteration of production methods, it inevitably entails organizational change. In this instance, computerization led to a restructuring of the division.

Major Organizational Change

The work environment changed radically. Work modules were created around the various pieces of equipment, each with its own organizational structure. This organization was quite different from the old system whereby operators were grouped in a "pool" and assigned their work by a supervisor. Because job categories were similar, it was possible to rotate activities among modules, creating a multidisciplinary resource base and allowing the staff to diversify their duties. Each module was independent and dealt directly with its clients (the divisions that had written the various publications). Each module also took responsibility for its own quality control. The adoption of a system of semi-autonomous teams promoted cooperation between levels and fostered within each group a sense of belonging and a sense of commitment to the quality of the final product.

As a result of this fundamental reorganization, some duties were reclassified at higher levels with correspondingly higher wages. And if there is a "down side" to this particular story of adaptation to new technologies, it is that the question of classification has been a thorny one. An uncomfortable round of unfulfilled expectations, communications breakdowns, and failures to fully appreciate the nature and complexity of some of the new technologies and their functions led to frustration for both operators and management. Grievances and appeals eventually gave way to recommendations by a committee established by the Chief Statistician and the question of compositor's classification has recently been satisfactorily resolved.

Employee Relations

There was apparently no union involvement during the difficult process of adaptation experienced in the Publications Division. While regular meetings were held with union officials, the subject of technological change does not seem to have been an issue. The situation at the time of the survey, however, was a bit tense, due to administrative problems that often occur when changes take place in a short period of time. As mentioned earlier, some positions were reclassified to higher levels. Once this reclassification was approved by personnel management, the new positions were to be filled by a competition process. Employees would have preferred a simpler way of accessing to those higher-paid levels and felt uneasy about the competition process. Management thought that everything would revert to normal once this "administrative" operation was over.

Survey of Worker Opinion

Now that we have looked at the different approaches to technological changes observed in the two departments, what do we know about the opinions of the women involved in these changes? A survey of 70 women was done in 1986 by means of a questionnaire.

These two examples are interesting in the sense that the consequences of the changes were viewed positively by the vast majority of workers concerned. Unfortunately, it was not possible to contact the workers who had left the organizations involved, so that only the opinion of those who had managed to keep their jobs is represented here.

The respondents were grouped by type of adaptation: learning the new technology and getting upgraded (40 word-processing operations at Statistics Canada); being relocated with or without higher work status; and duties changed (30 others at EIC).

The group of respondents was quite homogeneous. More than seven out of every 10 people surveyed were under 40 years of age. The same proportion had labour-market experience of between six and 20 years in the federal public service. Over half of the respondents had completed secondary school, and almost 30 per cent had some postsecondary education. Annual wages for 80 per cent of the sample fell into the $17,700-$28,000 range in 1985. Nearly 7 out of 10 had, within the previous two years, taken at least one training course.

Survey results indicated that, overall, the degree of job satisfaction was quite high. Several respondents noted that the "interesting nature of the work" and their "opportunity to make full use of abilities and skills" had improved as a result of the innovation. Most respondents felt that their "control over work scheduling" was good after the change, although a small group thought this aspect had deteriorated.

Overall, in terms of new job content, most women were happy with the technological changes that had taken place and with the new positions that some had been assigned. A study done in the private sector within the Montréal area had come to very similar results.

A fourth criterion of job satisfaction, "opportunities for promotion," yielded more mixed results. Half the people working with the new technology in the Publications Division felt that opportunities of this nature did not exist either before or after the change. Most of those who had received promotions gave this criterion a higher rating. Clearly, improved status (together with higher wages) is tied to re-evaluation of duties and not to technology. Office workers in this survey felt that technology was now a fact of life. They stated that, in order to retain their jobs, it was important to become familiar with technology, but that they did not feel that such knowledge was a factor in promotion.

Finally, although technological change is often cited as an isolating factor, our results do not bear out this conclusion. Survey responses indicate that the change did not alter the respondents' contacts with other employees; most felt that communications remained good. It is interesting to note that respondents who had taken more than one training course reported a higher level of job satisfaction.

Lessons from the Cases

The main lesson from these two stories is that even in a work environment that is traditionally considered to be less inherently "innovative" than establishments in the private sector, technological change may provide the opportunity to make innovative decisions about organizational design and human-resources management. The reallocation of staff to more interesting positions and the profound organizational change of one division from a "pool" to semi-autonomous teamwork are two notable innovative techniques in office management. Recognition of the technical skills acquired by the group of word-processor operators is also an illustration that technology can provide higher paying jobs for women who are offered and are willing to take the appropriate training.

Lessons for the Future

EIC computer experts are continually striving to improve the system. No further job cutbacks as a direct result of technology are foreseen by management. Any that do occur will stem from the government's desire to reduce public administration budgets.

Management's concerns about future cutbacks are tied to the future of the Public Service Commission as a whole, where the work force will inevitably grow older as the flow of new entries slackens. Concerns have been raised that there will be a "hardening of the arteries" for lack of new blood entering this vast organization. Some divisions, which up to now have been very dynamic because of efforts by young administrators and technicians to develop innovative work methods, run the risk of losing sight of this sense of renewal because of scheduled budget restrictions.

As for the women affected by recent changes, will they ever have to go through such an experience again? Higher-level positions will undoubtedly remain out of reach, especially if the hierarchy closes up and loses its flexibility. One manager stated that as long as the Unemployment Insurance Act remains as complicated as it now is, a large number of clerks will be required to keep it operating smoothly.

Management at Statistics Canada's Publications Division intends to continue its efforts to increase productivity and improve production quality.

Our interviewees did not feel that technology would lead to staff reductions in the future because of the diverse nature of the services offered; it would be difficult to make further cuts without endangering the quality of service. Since there are no longer any contract employees, staff would have to be reassigned. Would experience gained in the divisions be useful elsewhere? Again according to management, knowledge of integrated database communications systems would be considered an asset anywhere in the agency and, in fact, in any department.

Conclusion

These two studies, while on the surface quite different in terms of their implementation, training, and personnel plans, have several points in common. In both cases decisions were made by management. Union representatives were kept abreast of the changes, but their role was limited to ensuring that permanent positions were not lost and that health and safety concerns related to pregnant VDT operators were addressed. Thus the situation resembles what happens in private firms of similar size.

These two examples also serve to demonstrate that when new technology replaces a number of older duties, other sections of the organization may benefit from the experience of displaced employees. This type of change may even bring opportunities to many employees to leave dead-end jobs for more challenging ones that they might never have contemplated.

Commitment to permanent staff on the part of the employer is, in our view, a desirable human-resource strategy; however, it highlights the relative job insecurity of those outside the protected group. So-called "contingent" workers – term, contract, and part-time employees, for example – occupy a growing proportion of employment in the federal public service and elsewhere. Since many of those workers are women, legitimate concerns remain about the impact of technological change on the female labour force.

10 Breaking Down the Barriers: Technologies for the Disabled

The specific story on which this chapter is based has many of the familiar themes of the high-tech world: the tireless, dedicated visionary single-mindedly applying technologies to a perceived need; the never-ending search for funds; and the struggle to convince a variety of agencies and individuals of the viability of the projects. More generally, however, it is about the adaptation and use of new technologies to enhance the self-sufficiency and quality of life of the disabled, facilitate their access to educational opportunities, and improve their employment prospects.

The Story

Perched on the walk-way high above the giant cyclotron, I clutched the metal handrail as Bill Cameron talked of experiments in subatomic research involving beams of pions, muons, protons, and neutrons. Housed at the TRIUMF complex on the campus of the University of British Columbia, the cyclotron accelerates negatively charged hydrogen ions to 225,000 kilometres per second or 75 per cent of the speed of light. The speeding particles are then directed along "beam-lines" to experimental stations situated in two large experimental halls. In the Meson Hall, the beam of particles bombards a target of carbon atoms to produce infinitesimally short-lived particles called mesons. The TRIUMF cyclotron is the largest in the world, and its intense beams of particles facilitate path-breaking research into the structure of matter – the basic building blocks of nature.

This aptly named Canadian research establishment has had a hand in many global advances in pure science but has, in addition, mounted a variety of exciting applied programs. While pure research experiments continue uninterrupted, beam time is borrowed to develop biomedical research tools such as:

- the Positron Emission Tonograph (PET) scan for the painless examination of the brain of a comfortable, conscious, and alert patient; and

- the treatment of cancer with pion beams that concentrate the cell-killing power of the radiation more selectively than conventional methods, and thus reduce inimical effects on healthy tissue surrounding the tumour.

For such reasons TRIUMF would have made a fascinating case in itself: a world-class Canadian facility, jointly managed by four western universities, funded by the National Research Council (NRC), TRIUMF hosts international research efforts that are pushing back the frontiers of subatomic science while pioneering the application of cyclotron beams to medical research.

But it turns out that there is a case within the case. For Cameron's scientific skills have been directed not only to his "regular" job involving the use of robotics in the remote handling of a variety of service functions for the cyclotron. In recent years, he has devoted most of his spare time and energy to the use of technology to serve the disabled. Confronted in 1982 with the challenge of somehow helping a bright young student completely paralysed in a tragic automobile accident, he has experimented continuously to modify existing technologies for the disabled. For example, while the crash victim, Neil Squire, began to learn Morse code, Cameron worked on the modification of a ham-radio Morse translator to hook up to an Apple computer. Meanwhile, he experimented with various kinds of oral controls such as "sip-and-puff" devices and a tongue switch. With the help of the Morse code, Neil was able to emulate a computer keyboard for word processing. With a further modification he could play computer games.

Having seen the potential to transform the lives of the severely disabled, Cameron and his associates became obsessed with the idea of extending the range of assistance to those whose lives are otherwise all but written off. To provide a focus, the dedicated bunch of volunteers decided to form a charitable foundation in the name of Neil Squire, who had finally succumbed to his massive injuries in 1984.

Two important projects resulted. One was a program called "Computer Comfort" for persons with disabilities of varying severity in intensive care units. Computer science students were recruited and, with Cameron's devices and a sympathetic therapist at a Victoria hospital, they began to teach the patients how to use the computer.

Following those early beginnings, Bill Cameron crossed the country explaining the program. By April 1986, some 48 students were working in hospitals in various parts of Canada, supervised by hospital staff, under the auspices of the Neil Squire Foundation (NSF), which now enjoyed the services of a physiotherapist, an occupational therapist, and a speech pathologist. To date, over 150 instructors have introduced computers to more than 3,000 disabled adults in more than 65 extended care facilities, rehabilitation centres, and acute care hospitals, community homes, and private residences, right across Canada.

The second major initiative is in the field of medical robotics – something of a departure from the beam-line robots for remote handling of cyclotron servicing. Assessing the state of the art at a Stanford University conference in 1982, Cameron concluded that much of the relevant research was being done in isolated academic environments with limited communication of information and scarcely any transfer of technology. Cameron could not just wait for something to happen. By summer 1982, he and his colleagues were considering the specifications and criteria to be incorporated in the design of a medical robot arm.

With the help of a number of severely disabled people, the designers developed a "wish list," incorporating a range of tasks that the disabled would like to perform for themselves. These included such seemingly simple – but to them frustratingly unattainable – operations as picking up playing cards or turning the pages of a book. Several women described the frustration of wanting to look their best for the visit of a friend or relative and being unable to put on lipstick. Men missed the ability to shave themselves. So these were some of the abilities that the proposed robot arm should try to incorporate, along with convenient table-top mounting. The team then identified the relevant zones of work for the robot, the associated geometry, and reasonable cost guidelines for the finished product. There then remained the perennial question of funding.

Initial efforts to get backing from the regular funding agencies were unsuccessful. There thus began the now-familiar process of "beg, steal, and borrow," supported by an infectious enthusiasm. Though not officially sanctioned, Cameron's project enjoyed TRIUMF's tolerant blind eye and the help of summer and co-op students. One enthusiastic contributor was disabled PhD student Gary Birch who, as part of his senior laboratory project in electrical engineering at UBC, designed the controller for the robot arm.

The work of Cameron and his associates has come a long way since those days. A grant from the NRC helped the Computer Comfort Program and Health and Welfare Canada has funded the Robotic Arm project. In a particularly interesting development, the NSF helped demonstrate computer applications for the disabled at a special activities week at Expo 86. This was brought about in a characteristically Cameronesque way. Having heard about special events week at Expo, Cameron and the NSF decided this was a way not only to let the world know about his important work, but also to excite the funding agencies. They first secured a grant from Supply and Services Canada to make a video on the application of new technologies for the disabled. This helped them to make a very persuasive pitch to IBM for the donation of computers. A dozen videos sent to the federal department of employment (including one to then minister Flora MacDonald) secured the necessary funding to fly 20 disabled persons from various parts of the country to demonstrate the robotics and computer applications at Expo.

On 8 June 1987, the federal government announced support of $3.4 million over three years for the Neil Squire Foundation. Funded by the Innovations Program of the Canadian Jobs Strategy, the project's objective is to demonstrate that severely disabled individuals can become active labour force participants when assisted by appropriate technological devices.

> The Project "Removing the Barriers" is intended to make the participants computer literate and trained in the use of specially adapted computerized communications aids. A spin-off effect of the training will be the opportunity for disabled persons to become integrated into college programs as an alternative or prerequisite to employment.

But it has not been a straightforward project. First, official recognition, sanction, and support from TRIUMF were slow in coming. Most importantly, funding agencies have a bewildering array of criteria and jurisdictions. Were the development and modification of technologies eligible for federal government assistance under the NRC's Industrial Research Assistance Program (IRAP), for example? And for how long? Would Computer Comfort fit under the EIC's National Training Act? Are the provinces responsible for the remedial education that some patients need before computer literacy can be acquired? What are the respective roles and responsibilities of the hospital and medical systems? Or the welfare services on which many disabled persons rely? And how does one accurately assess the number of disabled persons when official statistics are lacking? These are just a few of the conundrums faced by the NSF. But the most important, as always, is money.

The story of Bill Cameron and Neil Squire is just one illustration of countless Canadian efforts to improve the lives of individuals with varying degrees of disability. In some cases, innovations permit them to communicate and perform simple personal tasks; in other cases, the technologies liberate them from institutional care; and in still others, they help people to enter the work force. How significant are these developments? What are the technologies involved? What are the problems and the prospects?

Numbers and Costs

A recent Statistics Canada survey, concluded in 1983-84, shows 2.4 million Canadian adults reporting some level of disability – 12.8 per cent of the population over 15 years of age. Of this group, 14 per cent were classified as having major disability; 23 per cent, moderate disability; and 54 per cent, some disability. The remaining 9 per cent were labelled "degree of disability unknown." The classifications are based upon 19 screening questions. Respondents were considered disabled if they had trouble performing one or more of 17 activities of daily living (such as walking up and down the stairs); or if they experienced a limitation in the kind and amount of activity they could perform at home, at work, or at school because of a long-term physical condition or health problems; or if they had a mental handicap.

There are three broad categories of disability: mental illness, mental retardation, and physical disability. Physical disabilities may range from vision or hearing impairment through various degrees of dysfunction associated with such diseases as multiple sclerosis, muscular dystrophy, and arthritis (to name but a few). All age groups are affected, though the predominance of various types of disability varies with age, and the overall incidence of disability in the population increases with age.

From the standpoint of economic cost, two manifestations of disability are important. In the extreme case is the inability to attend to one's personal needs, which has traditionally entailed institutionalization. A second serious consequence is the inability to work and be financially independent. In many cases, this has necessitated some form of income-support program.

The individual, psychic costs of mental and physical handicap are inestimable, as are the emotional burdens borne by the individual's friends and family. Clearly, there are also enormous financial costs involved. From the standpoint of public finance, for example, three major elements of cost may be distinguished.

First is the cost of institutional care. Over one quarter of a million people reside either in long-term care institutions or in chronic care beds in hospitals across Canada. According to estimates by Dr. David Symington of Queen's University's Department of Rehabilitation Medicine, this represents about 1 per cent of the population and is the highest ratio of institutionalized persons in the developed world.

Second, there is a complex array of income-support payments such as Workers' Compensation, public and private disability pensions, allowances, and insurance payments. When such costs are added to the costs of institutional care, Symington's conservative estimate of the total cost of handicap in Canada exceeds $20 billion per year.

Third, there is the social output (and individual income) forgone because of the low employment and labour-force participation rates of the disabled. Recent figures show that the unemployment ratios of the disabled and non-disabled populations do not diverge greatly, although the rates for the disabled are clearly higher. But the major labour-market costs of disability show up in the considerably lower labour-force participation and employment rates of the disabled population.

These enormous social costs, plus the incalculable psychic burden of disability, are the target for programs of rehabilitation.

The Goals of Rehabilitation

To reduce the social costs of disability, certain initiatives are essential. First, to ensure that all disabled persons have the opportunity to achieve maximum independence, a comprehensive and integrated system of rehabilitation and community support services is required. Rehabilitation affords many disabled persons freedom from institutional care and prospects of employment – prospects which can be greatly enhanced by new technologies. But while gains are being made with particular individuals or areas of disability, other groups and individuals are missing out.

Thus the efforts of the scores of voluntary organizations, associations, institutions, and government programs desperately require coordination. For example, the efforts of organizations such as the Canadian Rehabilitation Council for the Disabled (CRCD), the Coalition of Provincial Organizations for the Handicapped (COPOH), and the Canadian Council on Rehabilitation must be meshed with scores of provincial government programs such as those of the Vocational Rehabilitation Services Branch of the Ontario Ministry of Community and Social Services, as well as federal initiatives like Health and Welfare Canada's Vocational Rehabilitation Program, the activities of the Disabled Persons Secretariat at the Secretary of State, and the opportunities afforded by the Canadian Jobs Strategy at the CEIC. These, in turn, must be coordinated with the work of scores of voluntary organizations such as the March of Dimes, the Multiple Sclerosis Society of Canada, and the Canadian National Institute for the Blind (CNIB), myriad rehabilitation centres like Calgary's Walter Dinsdale Centre for the Physically Disabled, and the developers and distributors of technological aids such as the NRC's Rehabilitation Technology Unit, Technical Aids and Systems for the Handicapped (TASH) Inc., and Designing Aids for Disabled Adults (DADA). More specifically, rehabilitation services and community support services (including accessible housing, transportation, and home-care support) must be designed to be mutually supportive. The potential of even the most exciting technical aids may be thwarted by the absence of the necessary support services. Conversely, the efforts of caring and dedicated community support can be frustrated by the inability to acquire the most efficient technological aids.

The development of a coordinated action strategy has been a major aim of the NRC's Associate Committee on R&D for Rehabilitation of the Disabled. With the support of such organizations as the CRCD, the COPOH, the Canadian Council on Social Development (CCSD), and the Ontario Advisory Council on the Disabled and Handicapped (OACDH), the committee has proposed highly specific targets that include:

- a reduction in the need for institutional care beds by 30 per cent in the next decade; and
- a reduction in disabled people's unemployment rates to the national average in the same period.

The action strategy then calls for a variety of initiatives to pursue these goals, such as improved:

- research into handicap and rehabilitation;
- programs for prevention of disability and handicap;
- application of new technologies for the handicapped; and
- community service and other support programs.

Clearly, all of these ingredients are required for success. But in keeping with our major theme, of course, we concentrate on the potential of the new technologies.

MOM, DADA and Other Members of the High-Tech Family

The ultimate aims of rehabilitation are an improved quality of life and increased independence and self-sufficiency for the disabled at a lower cost to society. Innovative approaches can unlock important supplies of much-needed skills for the unfolding information economy.

In this context the fundamental generic technology consists of Environmental Control Systems (ENCOS), which permit independent control of immediate surroundings such as lights, radio, TV, computer, stereo, telephone, door locks, and so on. They enhance environmental control at home, in school, and at work. In the hospital setting, they provide security, communication, and comfort while promoting independence and reducing the nursing care required.

The cost of a multifunction ENCOS including installation, training, and maintenance could easily exceed $5,000. But benefits may include tangible income gains, reduced attendant care, and improved individual services, as well as intangible improvements in quality of life and decreased anxiety and tension in family and attendants.

A specific aspect of the general ENCOS concept is the robotic arm described earlier. Following the consultations with disabled people to develop a wish-list of self-help activities, Bill Cameron and his colleagues at the Neil Squire Foundation have taken the arm from the design stage through extensive testing, and, at time of writing, the first installation in an extended-care environment in Vancouver is imminent.

The arm, nicknamed MOM (for manipulative obedient machine) is mounted at a work station and, in addition to personal-care functions such as shaving with an electric razor and applying make-up, can perform such business task as:

- picking up a manual from a bookshelf and placing it in front of the user;
- turning pages; and
- loading a diskette.

The basic design criteria for MOM were low cost, reliability, safety, and ease of use. Using only readily available standard components, rather than starting with a commercial arm, the engineers have sacrificed some performance characteristics (like speed) to keep the cost comparable to that of an electric wheel chair. Safety is paramount for a machine designed to touch human beings, and the NSF engineers have built in a variety of continuous monitoring safeguards and simple and instantaneous cancel or abort functions.

The arm can be driven by most home computers. Disabled persons may use their usual interface with the computer – a puff-and-sip switch, for example, or voice recognition – to issue commands.

MOM can be "taught" or programmed to perform a certain operation by taking the robot by its gripper and actually leading it through the required sequence of motions. The computer "learns" the moves and the arm reproduces them perfectly. It even changes its own gripper for special tasks (such as the delicate job of turning pages)! Good for MOM; now meet DADA.

Designing Aids for Disabled Adults (DADA) began official operation in May 1985 with the objectives of:

• researching and developing low-cost technical aids for the disabled;

• training the disabled, then families and support professionals, in the use of technological aids; and

• encouraging the engineering and computer science communities to get involved in socially beneficial applications of technology.

One of DADA's many outstanding achievements has been the development of PC A.I.D. (alternative input device). While IBM technology has dominated most business settings, disabled people requiring special input devices had hitherto been limited to Apple products.

With the support of various financial backers including the Ontario government's Applied Program Technology Unit, DADA's team worked for five months in cooperation with IBM technicians. Then, through a generous manufacturing arrangement with Automation Engineering Associates, PC A.I.D. became commercially available in 1987. For just over $200, one can obtain a unit that connects to the parallel port of a personal computer and will function with IBM's PC, XT, and AT, and most IBM compatibles. The user simply has to plug in the device, load the PC A.I.D. software, and then load whatever other software program is to be run.

Clearly, technologies like MOM and the PC A.I.D. improve the prospects for personal and financial independence of the disabled. They also open up for employers an additional supply of skills. Such developments and their application are the aim of more than 100 organizations across Canada. One of the largest is Toronto's MacMillan Medical Centre, a special rehabilitation hospital and school serving physically disabled children and young adults. Its Rehabilitation Engineering and Research departments under the direction of Dr. Morris ("Mickey") Milner are justly renowned for their contributions to the rehabilitation of young people in this country. Less glamorous than MOM but no less important are the host of devices, software programs, and databases. Perusal of the catalogue of TASH Inc. or the Regenesis Development Corporation reveals dozens of such aids, from switches to keyboards, from joysticks to ENCOS. What is fascinating, however, is the process by which the technologies are developed and applied. Two examples illustrate the increasing quest for a better solution.

The first concerns a disabled analyst in a government department who wanted to use the Symphony spreadsheet program on his IBM computer. His dilemma was that, though he could enter information by pressing one key at a time with the rubber tip of a pencil, he could not press two or three keys simultaneously, as Symphony requires. Now, with the aid of a short "program within the program" developed by an enthusiastic colleague, the analyst can use Symphony with only sequential key strokes.

The second is the story of a clever young disabled data analyst who worked for Systemhouse using a mouthstick to operate his computer. Despite his knowledge and dedication, the process was slow and cumbersome. To help their employee match his work-rate to the speed of his mind, Systemhouse sought a new technological solution. In cooperation with IBM and the provincial government, Systemhouse added an audio recognition unit to the micro computer to recognize and respond to his vocal commands. He was then able to operate the computer as fast as he could talk.

To be successful, of course, technologies must reach the people. In this regard, one outstanding Canadian example is the forementioned TASH organization. Established by the NRC in 1979, TASH facilitates the transformation of rehabilitation devices from the research and development stage to the marketplace. With funding and R&D support from the NRC, the company concentrates on production and marketing and is a unique illustration of cooperation between the government research, voluntary, and business sectors in the high-tech field. The Neil Squire Foundation's Rehabilitation Research and Development Network (RRADNET) initiative is also designed to address this need. To promote awareness of current research and development projects that will improve the quality of life for the disabled, the NSF

• publishes a monthly bulletin listing innovative projects involving technology to benefit the disabled; and

• provides an information retrieval service that offers free searches of appropriate database systems containing information on technical devices and services.

Another example is Kitchener-Waterloo's Physically Handicapped Information Resource Service on Technology

(PHIRST) LINK Program. It gives disabled individuals an opportunity for hands-on computer experience and up-to-date information on computers and technical aids and devices, and is a good example of federal-provincial-municipal support.

Computer-based technology is also providing the disabled with valuable labour-market information. For example, the CNIB maintains an electronic bulletin board of over 500 occupations held by the blind and visually impaired. Employment-related information for the disabled is available through the networks of the Disability Information Services of Canada, operating out of the University of Calgary under the direction of the Secretary of State.

Of particular importance is the federal government's explicit recognition in 1987 of the need for a nationwide system to provide employers with information concerning employment of the disabled. The Social Services Branch of Health and Welfare Canada is carefully evaluating the U.S. Job Accommodation Network (JAN), which has a toll-free number that companies can call for information and consultation. A human factors consultant discusses the employer's needs and concerns. Then a computer search provides suggested "accommodations" based on data concerning the functional requirements of the job, the functional limitations of the worker, and environmental factors. The service is free, and the accommodations themselves need not always be expensive, either. Here are some accommodations described by a major insurance company:

- Providing a drafting table, page turner, and pressure-sensitive tape recorder for a sales agent paralysed from a broken neck ($300).

- Renting a headset phone that allows a policyholder with cerebral palsy to write while talking ($6.01 per month).

- Supplying a telephone amplifier for a computer programmer with a hearing impairment ($56).

- Enlarging toilet facilities and installing a handrail for wheel-chair-bound employees ($500).

- Removing turnstiles in the cafeteria and installing lighter weight doors – as part of a general renovation – and having the cafeteria deliver lunch to a payroll technician disabled from polio ($40 per month).

A centralized, Canadian JAN-like system, especially if coordinated with other related databases of the kind we have described, could be of powerful assistance to the employment of the disabled.

Conclusion

This chapter has concentrated on a narrow range of the many technologies, programs, and organizations in Canada that enrich the lives of the physically disabled. Other segments of the disabled population, the hearing- or vision-impaired, or those with mental disorders of various kinds are served by other technologies.

Technological applications are not a panacea, but they do hold out the prospect of addressing in a positive way a major social problem. Experience suggests that progress will be slow: time is required to pass from the design stage to implementation; funding is uncertain; and the daunting array of organizations and government agencies at various levels poses major problems of communication and coordination.

On a more positive note, however, we have seen the potential for success when energetic innovators pursue challenging goals and that, when the will exists, individuals, governments, and industry are capable of working together to overcome obstacles. The chapter clearly illustrates how technological innovation can enhance human-resource development and serve the interests of individuals, employers, and society at large.

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