PEOPLE AT THE CENTER OF NEW TECHNOLOGY:

A PROCESS FOR SUCCESSFUL TECHNOLOGICAL CHANGE

by

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Abstract:

A recent North American study suggests how high-performing workplaces have succeeded with the application of computerized technology in economic terms and in development of "good" jobs.

Based upon workers' own definitions of the characteristics of "good" jobs, it was possible to identify important choices made in each of technology, work organization, and training. What influenced these choices was the participation by line managers and workers, alongside engineering staff, throughout the various stages of the change process.

The focus of this paper is on those organizational practices that guided and enabled effective participation by people in this select sample of office and manufacturing worksites. Together, these practices form an organizational framework of distinctive approaches in i) **Management style**, ii) **Business planning**, iii) **Engineering**, and iv) **Labour relations**.

1. The Search for Good Jobs with New Technology

With sponsorship from General Motors (Canada) and the Canadian Auto Workers Union (CAW), interviews and observation were conducted over a period of two years (1989 & 1990) at fourteen Canadian and American worksites that had sustained a distinctively high level of economic success with new technology. Half of the workplaces were newly-built operations, and the rest were redesigned facilities, from both the manufacturing and service sectors.(1)

New Operations:

- Crown, Cork & Seal (Beverage Cans)/United Steel Workers ofAmerica;
- Shell Chemical Plant/Energy & Chemical Workers Union;
- Canadian General Electric (Jet Engine Airfoils);
- L-S ElectroGalvanizing/ United Steel Workers of America;
- Tektronix Inc. (Circuit Board Manufacture);
- General Motors Vanguard Plant/United Auto Workers;
- A.T.&T. American Transtech (Shareowner Services);

Redesigned Facilities:

- Westbridge Computer Services/Energy & Chemical Workers Union;
- Manitoba Telephone System/Communication Workers Union;
- Northern Telecom (Business Telephones Division);
- Ontario Public Service Employees Union (Union Regional Offices);
- 3M Company (Video/Audio Cassette Division);
- Los Angeles Times (Editorial Department);
- Rohm and Haas Chemical Plant/Oil, Chemical & Atomic Workers.

The other distinguishing characteristic of this sample of workplaces was the requirement that the workforce feel generally good about their jobs. In fact, employees in these worksites rated their jobs very positively; on average, their degree of satisfaction was "8.0" out of a possible/ideal "10" rating. From detailed interviews with over 200 production and maintenance workers, the research identified a list of common characteristics defined by workers as constituting a "good" job. These interviews were combined with those of 100 managers and engineers, to answer the second main question of the research, namely, the process by which new technology was introduced.

Characteristics of "Good" Jobs:

- WORKING CONDITIONS THAT ARE CLEAN, QUIET, & NON-FATIGUING;
- EFFECTIVE AND HIGH QUALITY WORK PROCESSES;
- MENTALLY CHALLENGING WORK;
- SELF-ESTEEM: COMPUTER-COMFORT & CONTROL BY WORKERS;
- AUTONOMY: ABILITY TO VARY WORK PACE & MAKE DECISIONS;
- TASK VARIETY;
- CONTINUOUS LEARNING AND FUTURE ADVANCEMENT;
- ACCESS TO INFORMATION (WORK-RELATED);
- INFLUENCE IN PLANT-WIDE ISSUES;
- INTERPERSONAL SUPPORT THROUGH TEAMWORK & TECHNOLOGY.

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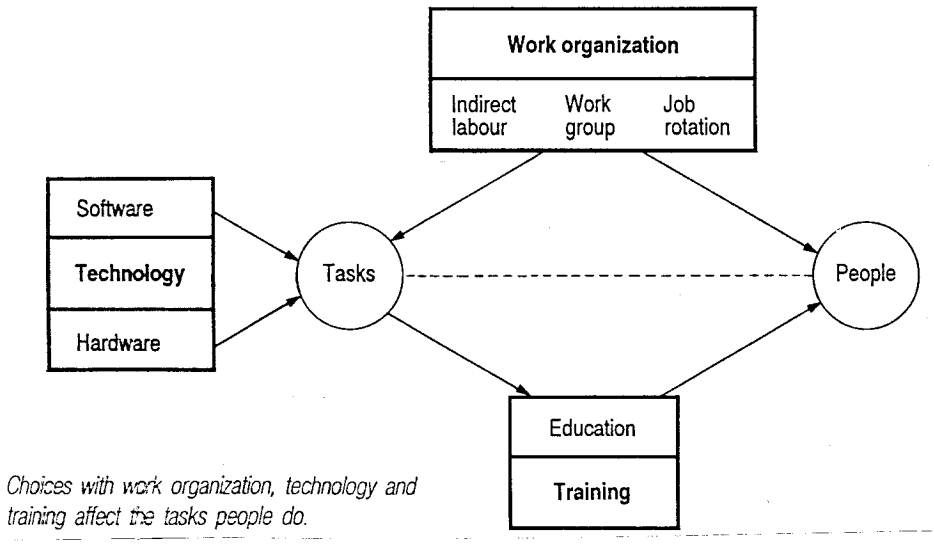
(1) Painter, Bert, "The Real Possibility of Good Jobs with New Technology", *B.C. Research document,* 1990

2. Elements of Good Job Design

The characteristics of what workers defined as "good" jobs were found to be a function of choices in **technology**, **work organization**, and **training**.

Figure 1. Key Decision Areas for good job design



Technology:

Choices in hardware design and machine layout affected ease of access to equipment for maintenance or materials-loading. Noise, debris, and safety hazards were mitigated by the design of special machine capabilities, such as the self-cleaning automatic lathes installed at a metal-working plant.

Choices in software design were apparent, first, in the user-friendliness of the software language. For example, programming for *The Los Angeles Times* News Editing System was deliberately written in editorial and journalistic terminology rather than more conventional computer language. The diagnostic power of software was also found to be a critical factor, in the ability of workers to solve technical problems independently.

The greatest impact of software was seen to be its potential for developing operator control and discretion. For example, the new drilling equipment of a circuit board manufacturer is controlled by software that was designed specifically to enable an operator to call-up and make changes in the drilling program, so as to link tools and maximize efficiency or convenience of operations.

The extent of operator control is often related to the degree and speed of access to information. In one chemical plant, a "steam optimization" program computes for workers the dollar value of their potential decisions to vary the steam pressure of the chemical process. The power of information systems to provide immediate feedback on workstation performance has been developed as an advantage and not as an issue in this sample of high-performing worksites. Contrary to common practice, these worksites have made the choice, *not* to use information technology to monitor individual workers.

Work Organization:

Design of technology does not, however, provide a complete solution to the development of good jobs. Maintenance and engineering demands of new technology, the rapid pace of operations, the increasing integration of technical systems, and the human void created by automation of many production tasks present challenges that were met, in the research sample, by innovations in the organization of work.

Production workers were found to be making a transition to operating maintenance functions and other forms of indirect labour previously the domain of staff specialists (eg. quality control), or supervisors (eg. scheduling and administration). Maintenance workers reduced their involvement with operating maintenance and added "predictive maintenance" as well as some system trouble-shooting previously performed by engineers.

The innovative worksites had made two distinct but often related choices in work organization, namely, job rotation and a work group structure. Job rotation had two-sided flexibility, affording workers the discretion to rotate according to their personal needs as well as operational concerns. Otherwise, the main benefit of job rotation, stress relief, may not be avaiilable. The work group structure is a response to the interrelatedness of tasks within a highly integrated technical system. It is also the organizational basis for workers to assume responsibility for self-regulation and many of the tasks previously the prerogative of management.

Education & Training:

To realize the potential for human creativity designed into technology, and to develop the ability of people to perform in the new work roles of an integrated work organization, the research sample of innovative worksites made important choices in the timing, quality and extent of training for new social and technical skills.

Extensive education and training before and during the installation stage has created worker confidence and understanding of new technology. This required innovative relationships with vendors and educational institutions. (The comfort which 20-year seniority auto workers achieved in working with computers at an automated *General Motors* machine-tooling plant has been attributed to the computer instruction that was part of the 1000 hours of pre-startup education workers received from a local community college.)

Another benefit of effective training has been the ability of individuals to be creative with the technology, like the writers and editors at *The Los Angeles Times* who have developed their own customized programs to perform special editing functions.

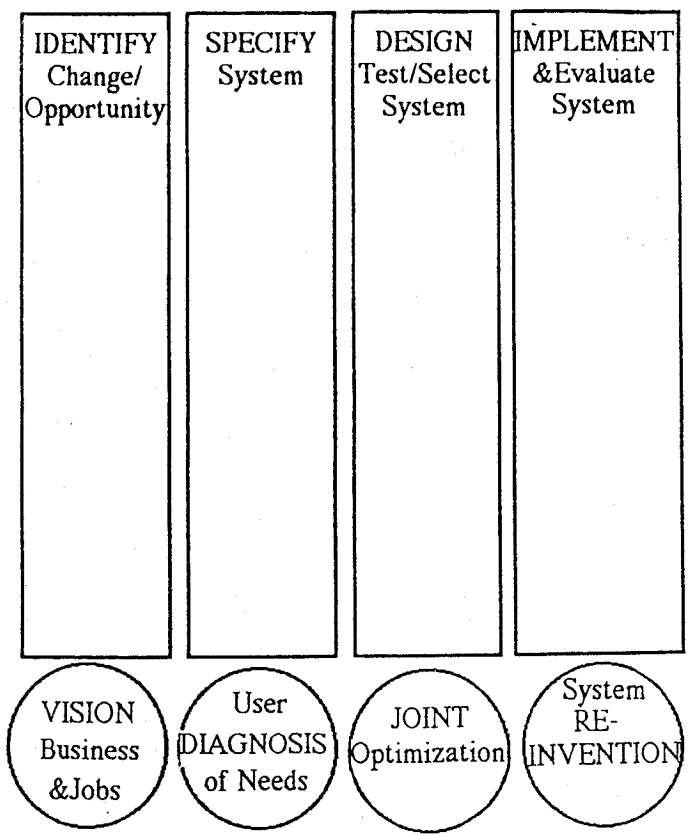
Unfortunately, many of these innovative worksites discontinued their emphasis on training after the initial startup period. However, the continually changing nature of computerized technology has led most of these worksites to re-establish education and training as an ongoing part of everyone's job. These workplaces now invest an amount equal to 8-10% of their labour costs in continuous worker training.

3. Four Stages of Change & Participation

Within the research sample of high-performing workplaces, there had been periodic, but not systematic and constant recognition of the elements of good job design. Rather, there were systematic approaches to the involvement of workers and managers throughout the process of change. Participation enabled people to decide upon or influence choices in the key factors that were important to them as people, and thereby, technological change evolved in the direction of developing good jobs.

What respondents said about the critical timing of their participation corresponds closely to an established model of the stages in technological change (2) .

Figure 2. Stages in the Process of Technological Change



The stage of **Change/Opportunity Identification** embodies decision areas which produces a Vision of the Business Outcomes including Good Jobs. Next, **System Specification** yields a Diagnosis of User Needs and Readiness for Change. **System Design** balances technical and social needs in a Jointly Optimized Architecture. **System Implementation** is phased so that people can participate in Continuous Improvement and System Re-Invention.

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(2) Spiker, Barry K., and Paul, Brian K.,"CAMP/Change and Manufacturing People: 2000", in Success Factors for Implementing Change, ed. Blache, Klaus, *Society of Manufacturing Engineers*, 1988, pp.347-359.

4. The Stage of Opportunity Identification

OPERATIONS-DRIVEN

QUALITY FOCUS

AUTOMATION CRITERIA

EMPLOYMENT PROTECTION

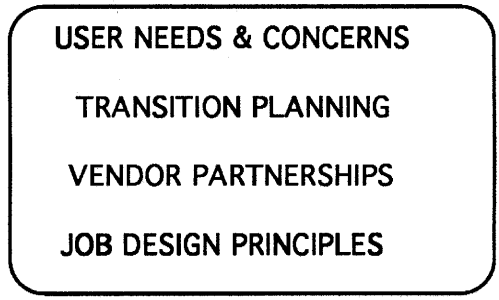
The subtle and less formal stage of Opportunity Identification includes the choice made by many of the high-performing worksites to have technical development led by operations personnel, and thereby, guided by priorities that are **Operations-driven**. To facilitate this process, *A.T.&T. American Transtech* and several other companies have located or moved engineering staff into a reporting relationship within business units, rather than maintain discrete engineering departments. Usually, this organization structure has been unconventional for the larger corporation, and many times, the development of this structure was controversial and dramatic for the particular company/division. This choice of management style has most certainly opened-up the technical process for operating managers, and it has enabled more worker participation.

A striking characteristic of technological change in the workplaces within the research sample is that the business rationale for new technology has been improved consistency and quality of product as much as, if not more than, cost reduction. The **Quality Focus** has placed a heavy emphasis on effective application of technology, (as distinct from a pre-occupation with the sophistication of technology).

Many of the workplaces have implicit or explicit **Automation Criteria**. *General Electric* and other companies have apparently learned from their mistakes, that any process to be automated must be technically well-understood. Secondly, the automation should be an aid to the Operator. Thirdly, the operator function to be automated should be routine. At *Westbridge Computer Services,* the criteria are simple: the automated operation must make the work faster, and at the same time, easier.

In order to encourage people to identify new technological opportunities, *Westbridge Computer, 3M,* and several other organizations (union and non-union) in the research sample have established **Employment Protection** policies. These policies have committed the company to re-train and re-deploy workers displaced by technical innovation.

5. The Stage of System Specification



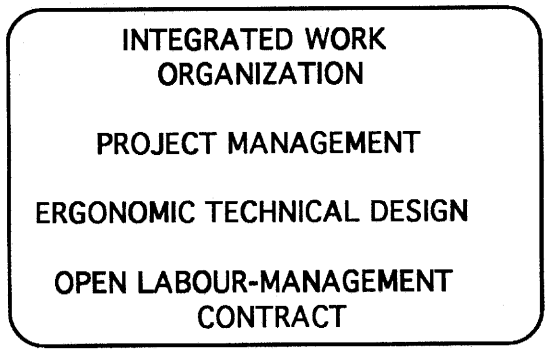
Noteworthy with the sample of high-performing workplaces has been the effort made to clarify **User Needs** and concerns. For example, the first year of developing a News Editing System at *The Los Angeles Times* was devoted to orienting editorial staff, using a small, leased editing system. After their having gained some familiarity with electronic systems, staff were asked for a detailed description of their jobs, the problems which they faced, and the opportunities which a new system might offer. From this information, the objectives for the new technology were distilled. *3M's* "Maintenance-conscious" engineering is another form of user need identification. This review process that requires maintenance staff to sign-off approval of specifications for new technology has ensured consideration of maintenance concerns, such as availability of spare parts.

Transition Planning is an important part of the specifications and budget forecasting for new systems. Employee communications, training, organizational re-structuring, and performance measurement have all been issues requiring resources, that high-performing workplaces have addressed and provided for financially, in preparation for technological change. (However, the failure to specify training as part of the project budget for an automated *General Motors'* facility almost jeopardized the entire investment in new technology.)

The experience of this sample of high-performing workplaces indicates that an important part of the specifications for new equipment has been the provision for substantial and high quality vendor training. Another example of what can be gained from **Vendor Partnerships** is the manner in which workers at *Tektronix* and other companies have been involved in visiting vendors to trial different equipment, and then, concretely, to specify their own needs (as workers/technicians) for possible new technology.

Job Design Principles developed by management and labour stakeholders have also helped system designers to maintain a focus on the needs of people as well as the requirements of technology. Within *Shell Canada,* prior definition of the operating philosophy for a new chemical plant encouraged and sanctioned key departures from traditional engineering approaches to the layout of such facilities.

6. The Stage of System Design/Selection



A philosophical and political issue has been the readiness and willingness of worksites to develop a more **Integrated Work Organization.** Computerized systems increase the interdependence of people in different functions and at different workstations. An integrated work organization, which embodies cross-functional, networking, and less hierarchial relationships complements the technical reality and enables people to manage and use the potential power of new technology.

A challenging but necessary feature of developing high-performance systems has been a **Project Management Structure** to integrate plans for the diverse socio-technical system elements of equipment, plant layout, information systems, financing, marketing, and organization design. For example, a division of *Northern Telecom* gained significantly from the process of combining the development of a new flexible manufacturing system with a new product design and with extensive involvement from customers and suppliers.

Consideration for **Ergonomics** and the operational perspective of production and maintenance workers has been essential to the design of equipment and layout of facilities. *General Motors* made dramatic improvements in the working conditions of truck assembly workers by designing manual lift controls to enable adjustable work heights for engines or chassis being assembled; unfortunately, the same machinery was not designed in a fashion that provided easy access for maintenance workers. A significant example of office ergonomics was *The Los Angeles Times'* design of a keyboard with a large number of dedicated function keys that greatly simplified operations for writers and editors.

An important factor enabling innovation within unionized and non-union workplaces has been the willingness and ability of management and labour representatives to make changes and continuously evolve the employment 'contract'. The need to develop such sanctioned flexibility has led several non-union worksites in the research sample to create elected "task forces" or "leadership forums". More common within unionized worksites has been a practice similar to the "Letters of Understanding" developed by the *Communication Workers* and the *Manitoba Telephone System* to amend an existing collective agreement. In either case, what has been achieved is an **Open Labour-Management Contract.**

7. The Stage of System Implementation

CONTINUOUS TRAINING
& ORGANIZATIONAL LEARNING

PHASED, INCREMENTAL CHANGE

ENGINEER-WORKER
INTERACTION

ONGOING LABOUR-MANAGEMENT
CONSULTATION

Perhaps, what is most distinctive about the workplaces within the research sample has been their commitment to education and **Continuous Training.** What underlies this commitment is first, a strong belief of senior management in the value of people to the business, and secondly, an understanding that technical training needs to be continuous because the technology (especially software) is changing continuously. *Rohm and Haas* and other worksites have also made the investment to develop people's interpersonal skills to manage and work effectively within a more integrated work organization. Social skills training has also been continuous, because of constant personnel changes, and because the new forms of work organization place such a high reliance upon effective social interaction and participative decision-making.

Part of what has enabled training to be effectively designed and delivered is **Phased, Incremental Change.** Although, this has not always been the initial or preferred approach to change, these high-performing worksites have learned that a phased approach has helped to make change and uncertainty more manageable. Worksites have been protected from the potentially devastating impact of a total system failure. The magnitude of change has been easier for people to absorb. The rate of change has enabled organizational learning and continuous improvement to occur, from one phase to another. Nevertheless, to achieve this approach, an innovative technical design has sometimes been required to develop modular systems.

Consistent with phased change has been **Continuous Engineer-Worker Interaction.** Engineers have been involved in training production and maintenance workers, and in helping them make adjustments during testing and start-up periods. More generally, engineers at *3M* and other worksites have learned that continuous improvement of technology requires worker input, because only persons constantly on the shopfloor can have the familiarity with circumstances of technical problems as they develop. Engineers have also learned from workers about potential control problems for new technology, resulting from age or other limitations of existing equipment.

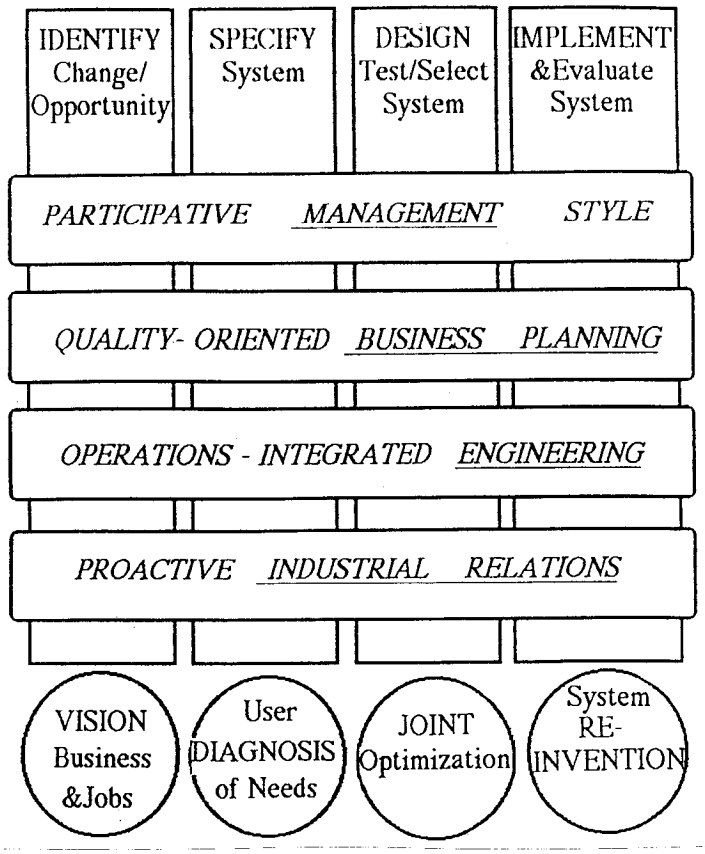
Indeed, a key factor for this sample of worksites to sustain and improve upon their level of performance has been a structure and process for managers and workers to learn collectively from their experience of socio-technical change. The ability to trust and take action on this learning has often depended upon **Ongoing Labour-Management Consultation** such as exists in the Trustee Group of the *Communication Workers* union and the *Manitoba Telephone System,* or in the "continuing dialogue" which the *Energy and Chemical Workers* have developed with their employers.

8. An Organizational Framework for Successful Technological Change

No one high-performing workplace in the research sample exhibited all of these distinctive practices, nor did all workplaces apply any one practice. What was, however, evident was a common set of values and organizational philosophies that appeared to link various practices and to operationalize them in how people defined their functions in these worksites.

These workplaces espoused a **Participative Management Style.** There was a strong **Quality-Orientation** to the planning and development of the business. Great effort had been made to have **Engineering Integrated with Operations**. And, consistent with the value placed on human resources, there was a growing tradition of **Proactive Labour Relations** that anticipated the need for change.(3)

Figure 3. The Framework for a Process of Successful Technological Change



(3) Painter, Bert, How Labour & Management Can Achieve Good Jobs in an Era of Technological Change, *Labour Canada publication*, 1991

9. The Significance of Participative Management

A participative management style emphasizes teamwork, particularly between technical staff and line managers. Participative management also values and legitimates expression of ideas from front-line employees on all aspects of the work process, including the possibilities related to technological change.

On the other hand, without a commitment to participative management, it is unlikely that indirect labour tasks and degrees of self-management would be delegated to the workforce in an integrated form of work organization. Telephone Operators would not be empowered to take "risks" to serve customers; Electricians would not be entrusted with software editing responsibilities; and, shopfloor employees would not have the respect and authority to be the "real-world" increment to systems development. However, all of these participative dimensions were designed into the jobs of workers within the research sample of high-performing workplaces.

There is a general belief in this type of workplace culture that people make a significant difference to performance. And, there is a trust that, with the right information and training, people will do the job right. Thus, managers regard continuous training as a justifiable investment.

10. The Role of Business Planning

Strategic, business considerations have tremendous influence on the priorities, financing, resource allocation, and timing for implementing new technology. Specifically, the pattern among high-performing workplaces in the research sample of implementing new technology for reasons of quality improvement, (ie. more consistency, more accuracy, less waste) has significant implications for the process of technological change.

By comparison, a cost reduction rationale reinforces the tendency of technical design thinking to view labour as a mechanical system, and to regard labour's presence in the production process as essentially due to the shortcomings of the technical system. On the other hand, a quality orientation emphasizes the application of technology and thereby increases the likelihood of involvement in the change process by people closest to the end-use of the technology.

In their planning and project management, workplaces in the research sample took a more comprehensive and longer-term view of technological changes than is common within industry, and indeed, within most of their own corporations. Here, senior managers played an extremely important leadership role in protecting the best interests of the change process.

11. Operations-Integrated Engineering

AUTOMATION.....VENDOR.....ERGONOMIC.....ENGINEER
CRITERIA PARTNERSHIPS TECHNICAL &WORKER
DESIGN INTERACTION

Integration of engineering staff within business units in the research sample worksites helped to ensure that technical innovation was related primarily to the needs of the business, rather than the needs of technical development. Through frequent contact with users and vendors, the effective application of technology was continuously emphasized.

Physically, as well as psychologically, engineers have, (sometimes under duress), been located in close proximity to the workforce. This interaction has relied upon a recognition of the different but equally important perspectives of engineers, (ie. more theoretically informed), and of operators (ie. more practically informed).

Managers' and workers' understanding of technical requirements (and improvement possibilities) has been greatly enhanced. Much of the technical trouble-shooting has been taken over by maintenance crews where they have been trained by engineering staff. Engineers have thus acquired time to focus on new system development, now, a much larger and constant task.

12. Proactive Labour Relations

EMPLOYMENT.....JOB DESIGN.....OPEN.....ONGOING
PROTECTION PRINCIPLES LABOUR-MANAGEMENT
CONTRACT CONSULTATION

The domain for formal or informal negotiation of the employment contract determines the tone and many of the conditions for technological change. This reality has been recognized and dealt with constructively by the worksites in the research sample. They have regarded labour relations as central to effective technological change.

Through open and continuous discussion of objectives and concerns, worker and employer representatives have developed high levels of mutual understanding, shared principles, and trust. The strength of this relationship has produced flexibility and open-ness in contractual arrangements. Perhaps more importantly, it has sanctioned and supported much wider participation in decision-making by front-line workers and managers.

Consistent with the importance ascribed to people's role in the business, line managers (rather than only labour relations staff) have been directly involved in working-through labour relations issues, including the needs of people associated with technological change. In a similar departure from conventional practice, labour representatives have developed a concern, a depth of knowledge, and an involvement regarding business issues which include the successful introduction of new technology.

13. Conclusion

The process for technological change which has been described in this report, and which has been drawn from the experience of a select sample of worksites successful with implementing new technology resembles participative 'models' for technological change reported by other recent studies.(4, 5, 6,7,8) The most similar findings were reported in the study of the successful introduction of electronic mail sorting technology within the Australia Post Corporation.(9) The "Australia Post Model" is distilled into a generalized 9-step process of change, which embodies organizational practices similar to the process outlined here.(10)

What is different about this B.C. Research study is that it began as a search for the characteristics of good jobs, as developed in conjunction with successful implementation of computerized technology. A possible conclusion from the experience of the study's sample of high-performing workplaces is that the concern to develop good jobs is one of the ways to ensure a positive return on the investment in new technology. This may also be a reminder that technological change is an extremely human undertaking, and that people - managers, engineers and workers - need to be at the center of new technology.

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(10) Ibid, pp. 63-69