

Planning for the Introduction of Robotics

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Robots are being used in increasing numbers in offices and factories throughout the world. Current estimates put the number of robots in use in the United States in 1983 at about 7,000. Little is known, however, about how individual workers react to the introduction of robots or about how the use of robots affects the structure, functioning, and effectiveness of organizations. This paper aims to increase managers' understanding of how robots affect individuals and organizations. The paper is written for managers who are introducing or thinking about introducing robots or other forms of new technology into their organizations. We begin with a brief statement about what a robot is then turn to our own research work about robots. The major portion of this paper concerns recommendations for action.

Robots: Definition and Comparison to Other Technologies

The Robot Institute of America defines a robot as a programmable, multi-functional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks. The function of most robots in U.S. factories today are to transfer material and to do processes such as welding, drilling or spray painting. These are called level I or first-generation robots. Researchers are currently developing level II or second-generation robots. These robots have more sophisticated sensing and thinking capabilities than level I robots. For example, research is underway on the development of a level II robot with the capacity to identify the exact location of a particular part out of a bin of parts of different shapes and sizes.

We think that there are two factors that lead workers to view robots as qualitatively different from other forms of automation. Workers have been exposed to robots with glorified capabilities in films and television shows.

In addition, in many current applications, a robot directly takes the place of a human worker. Indeed, a recent study concludes that there are many more similarities between people and robots than between people and other forms of factory automation. For example, unlike most other forms of factory automation, robots and people are both somewhat mobile, can both respond to changes in the environment to a degree, and both perform multiple operations. We think these two characteristics of robots, their glorified media image and their relative similarity to humans, combine to make the introduction of a robot a more salient and more threatening event for workers than the introduction of other forms of advanced technology.

Our Research

Our information about the effects of robots on individuals and organizations comes from field studies we conduct at companies that are introducing robots. The organizations come from different industries and operate in different labor markets. We collect data before and after robots are introduced from multiple sources at each plant. We interview production workers in the department where the robot is introduced, supervisors, managers, and technical support staff from engineering, maintenance, quality control, and production scheduling departments. We also analyze records data that companies make available to us on productivity, absenteeism, accidents, and turnover.

The major questions in our research are the following:

- (1) How do individual workers react to and how are they affected by the introduction of robots, including changes in their beliefs, motivations, stress levels?

- (2) How does the organization change when robots are introduced?
- (3) What are effective strategies for introducing robots so as to realize productivity gains?

Findings from our first study of the introduction of a robot are described in a paper in the Spring 1983 issue of the Sloan Management Review. Major findings from the study are now highlighted:

1. Workers became less optimistic over time about the effects of robots. That is, after workers had more experience with robots they were more likely to believe that robots would increase the chances of an accident, increase costs, and lower the quality of the output produced by the department.

2. Operators' jobs changed with the introduction of the robot. The operators commented:

"The job now requires more skills ... You have to learn how to program the robot and run it ... With more skills, of course, comes more responsibility."

"Now it's mainly watching ... walking around the machines to be sure everything is running."

"We do more activities. Now you have to set up all three machines."

3. There was evidence that the operators experienced more stress:
"It's nerve racking ... there are lots of details .. it's an expensive piece of equipment."

"There is more stress now ... we have more responsibility."

4. Interaction patterns changed. There was more interaction between the robot operators and technical support staff from engineering and maintenance. There was less interaction between the robot operators and their

coworkers in the department:

"I haven't been able to talk as much ... I'm too involved with the robot ... You really have to concentrate ... I don't have time to talk with anyone ... I'm isolated now."

5. There was a discrepancy between what employees knew about the robot and what they wanted to know. In response to a question about what the company could do to facilitate the introduction of the robot, employees commented:

"Tell employees what's going on and who will be displaced by the robot."

"Get people better informed ... it seems like a big mystery right now."

"Company should inform people more about the robot and what the company expects to achieve by introducing the robot."

Recommendations for Introducing Robots

In this section we develop some recommendations for managing successfully the introduction of robots and other forms of new technologies. These recommendations are based on our research and that of others on new technologies.

Total Planning Perspective

A major problem in many introductions of new technologies is management's reliance mainly on an engineering perspective. The task of introducing a new technology is defined primarily as a technical or engineering problem. (The person who does the work is a lead engineer). Planning focuses mainly on decisions about where the machine will be placed, its operation, the workflow, and so on. The problem with the engineering perspective is that it does not account for the social and organizational consequences of the new technology. If the technology is perceived as having a negative impact on the individual employee, the work group or other organizational arrangements, the expected benefits of the new technology may not be realized.

The concept of "total planning perspective" means that planning should involve anticipation of both technical and social consequences. That is, any plan for introducing new technologies should include: (1) a diagnosis of the technological and social consequences of the new technology; and (2) a set of implementation activities which reflect the potential positive and negative consequences of the new technology.

It is unlikely that this planning can be done by one individual. Few organizations have employees who are experts in diagnosing both technological and social consequences. A team should be formed which brings together people knowledgeable in technological and human issues. The critical task for the team is first to chart out the effect the new technology will have on the individual employee and on the organization. Some illustrative questions that can guide this diagnosis include: how will the new technology change the workers' job activities? How will these changes in job activities affect worker attitudes, motivation and performance? How will the technology change interaction or communication patterns at work? How will these changes affect worker attitudes and performance? Where are the likely points of resistance to change? Is the resistance to change caused by fear of job loss, lack of understanding of the new technology, changes in worker activities or in social interaction patterns?

The resolution of these questions represents the basis of an action plan. Unless the plan reflects the total perspective of technological and social consequences, it is unlikely that the benefits of the new technology will be realized.

Managing Job Displacement

The introduction of new technologies often leads to some form of job displacement. By displacement we mean that workers may lose their employment with a company or they may have to accept a less desirable job within that company. The consequences of anticipated and actual job displacement may be negative attitudes toward the company and resistance to the introduction of new technologies. Job displacement is a reality that needs to be managed.

Attrition is a typical strategy used in dealing with job displacement. In one company we worked in, a robot was going to replace an operator. The new technological configuration was one operator at a robot which serviced two machines rather than the previous two operators on two machines. By allowing attrition to reduce the work force it was possible to introduce that robot without displacement.

Another desirable practice is to prevent or slow down job movement into a department where new technology will be introduced shortly. We have observed in some organizations that workers who most recently moved into a department where technological change is planned are more likely to develop negative attitudes since they are usually the first to be displaced. These workers' complaint is not the new technology but not being told that the new technology was going to be introduced into the department before they moved into it.

When displacement is going to occur we find that some firms tend to believe that it is better to be secretive rather than open about the displacement. The problem with not providing information is that rumors begin, employees feel anxious, and a lack of trust develops between workers and management. Our view is that you should figure who will be displaced and develop some mechanisms to find desirable work for these people. Once an employee knows that he or she will be displaced, the question is whether the

firm will engage in any activities to facilitate placing the employee in a new job. Some firms let the current job placement (or bidding) mechanism within the plant take care of people who lose their job because of new technology. Other firms offer various forms of in-house counselling to facilitate the placement process.

Another alternative is to review the current job placement mechanism within the firm to determine if it provides equitable placement for the displaced workers. The basic issue in the case of job displacement is whether the firm has a reactive or proactive strategy for dealing with job displacement. If job displacement is not managed correctly, we feel that employee resistance and negative attitudes can mitigate potential positive benefits of the new technology.

Implementing Change

There are a number of critical decisions managers must make in introducing new technology. Some of the critical decisions include:

1. Who should be involved in introducing new technologies?
2. What mechanisms should be used to introduce change?
3. What should be the content of communications about the change?

Involvement means who should be involved in the decisions about introducing new technologies in the workplace. A current ethic in many U.S. firms is to provide greater opportunities for worker participation in decisions that affect their organizational lives. Should employees be involved in decisions such as where to locate the robot, who should run the robot, how much should the operator get paid, how should the workflow be changed? The results of our research show employees usually are not involved in these decisions but they would like some (not a great deal) of say in these decisions. Our experience

suggests some limited form of involvement may be useful. A task force made up of members of labor and management, and including representation from production, maintenance, and engineering would form a suitable team. The role of the task force would be to generate ideas about the decisions enumerated above. The specific day-to-day experiences of employees should generate new ideas which could contribute to more optimal decisions. The final say, of course, rests with management.

There are a variety of possible mechanisms to communicate to employees about the introduction of the new technologies. In our work, some seem more effective than others. Actual demonstrations of a robot seem particularly helpful. Similarly, various forms of Audio Visual presentations seem useful. The foreman, of course, is the key person in management for explaining to the employees the nature of the introduction. In our research we have found the foreman to be under-informed. This creates pressure on the foreman and some distrust from the workers about the nature of the new technological innovation. Written communications and talks by higher level managers are good supplementary communication mechanisms.

There are two issues about the content of communications. First, presentation of both positive and negative consequences of the new technology is desirable. There is support from research on communication that one-sided, positive communication about the technology is more likely to generate feelings of distrust or expectations of the new technology that far exceed reality. Second, it is important to cover the central concern of the employee: How will the new technology affect me? A major concern is displacement. We found that managers sometimes prefer not to talk about this and related topics (e.g., who will get the job, the pay for the new job). Our

experience suggests that being more open will have better short-run and long-run payoffs in terms of employee acceptance of the new technology.

Anticipating the Effects on Individuals

The introduction of a robot usually changes operators' jobs from primarily manual (e.g., lifting) to primarily cognitive (e.g., monitoring) activities. Sometimes this change results in workers' experiencing more boredom. If this occurs some mechanism to alleviate boredom, such as job rotation, should be considered. The job rotation would add more variety to the individual worker's job and also build up the skills of other workers about how to operate the new technology. Having multiple people who could operate the new technology would give the company more flexibility in staffing. This would be especially useful when the primary operator was absent or if the company wanted to expand the use of the technology.

We have encountered factory workers who prefer manual work to cognitive activities. Clearly, for these employees there would not be a good fit between the job of robot operator and their preferences for manual work. It is important to analyze the requirements of the new job of robot operator and pick people for the job who both like and are capable of performing the new job activities.

Employees in our first study commented that they had less control after the robot was introduced. Possible reasons for this sense of a loss of control were the increased reliance on others, especially engineering and maintenance, that the robot operators experienced and the sense of having their work pace being driven by the robot's cycle time. Since individuals usually react negatively to the loss of control, it is important to build some control into the robot operator's job. This could be accomplished, for

example, through increased training and through designing the job so that the robot operator has some control over the cycle time.

Anticipating the Effects on the Organization

Introducing robots usually requires a re-evaluation and reclassification of the operator's job. The robot performs some of the activities a worker once performed. Hence, certain activities are eliminated from the operator's job and other activities are added. The question is whether the net change in job activities and responsibilities indicates that the new job should be a different grade and pay rate. This question is complicated by the fact that one is trading off very different types of activities. For example, the new job of robot operator may require less manual and more cognitive activities. It may be less fatiguing yet involve more responsibility.

How a company resolves the question of classifying the robot operator's job should be compatible with general principles the company uses to make pay decisions. Are workers paid more for doing hazardous jobs? Are workers paid according to the skills they possess or the responsibilities they have? How does the company make tradeoffs along these dimensions? We believe that it is important for a company to be very explicit about the principles it uses to make decisions about job grade and pay and that these principles should be consistently applied to all jobs, including that of robot operator.

The introduction of new technologies such as robots affects interaction patterns at work. For example, our research and that of others has shown that operating new technologies provides employees with less opportunities to interact with their coworkers. This increased isolation often leads to workers having more negative attitudes toward the new technology and may also be associated with workers' experiencing more stress. If management

anticipates that the new technology will lead to workers' feeling more isolated, alternative mechanisms for promoting interaction should be developed. Involving the worker in the change through a team or task force would provide the worker with an alternative forum for interacting with coworkers and offset the negative consequences of increased isolation. Similarly, enabling the worker to communicate with others through alternative modes such as electronic mail would offset some of the costs of increased isolation from one's peers.

While new technologies often decrease the opportunities production workers have to interact with their coworkers, new technologies often require more interaction between production workers and technical support staff. If this occurs, new coordination mechanisms need to be developed. These mechanisms are likely to be especially critical as the number of installations of the new technology increases. As more installations are put on line, technical support staff, especially engineers and maintenance staff, will have more demands placed on their time. A mechanism or procedure for deciding how to assign priorities to the various demands would reduce the pressure on support personnel as well as reduce the potential for conflict among support personnel and the robot operators.

Being Open to Change

Many of the effects of introducing robots can be anticipated. The more a company anticipates what these effects will be and develops strategies to deal with them, the more likely the company will experience productivity gains. Some possible strategies for dealing with consequences of using robots have been suggested here.

Some of the effects of robots, however, cannot be anticipated. These are new technologies that are just beginning to be used. There is uncertainty about how they will affect individuals and organizations. We believe it important for management to create an open culture where both management and employees can learn about the new technologies and how to use them most effectively. Such a culture is likely to evolve in companies where there is trust between management and employees, where management is willing to change and update policies and procedures as learning takes place, and where people are encouraged and rewarded for learning and finding out how to use new technologies more effectively. We believe that the more successful introduction will occur in companies where there is such a culture of openness to change.