Title: Management of Changes Affecting Human Resources Due to Introduction of Advanced Manufacturing Technologies

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Abstract: The aim of this project is to review the research conducted in the field of human factors in the manufacturing industry so that a prototype strategy for management of the workers during a transition period in manufacturing technology or business method. Managers can use a number of methods related to the human infrastructure of organizations to anticipate and implement new factor technology successfully. These methods include selecting employees with skills needed to handle the new technology, structuring programs to meet increased training needs, and using personnel policies that facilitate automation.

MANAGEMENT OF CHANGES AFFECTING HUMAN RESOURCE
DUE TO INTRODUCTION OF ADVANCED MANUFACTURING
TECHNOLOGIES

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ADVANCED MANUFACTURING MANAGEMENT METHODS

MANAGEMENT OF CHANGES AFFECTING HUMAN RESOURCES DUE TO INTRODUCTION OF ADVANCED MANUFACTURING TECHNOLOGIES

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1. INTRODUCTION

There has been a significant change in business methods and technologies employed in the manufacturing industry for the last 10 years. The change has a very high acceleration. This rapid process naturally affects labor force. The strategy for management of human resources during this critical period determines the faith of the company. The key to the success in implementing new technologies depends very much on human factors.

" American industry has been at the leading edge of new techniques and technologies. However, for a number of years, this industry has been trailing in implementing these new techniques and technologies. Why? Most of the focus has been on the tool and has, for the most part, ignored how the worker will use the tool" [1, pp 256]

Vanderspek while describing the challenge in manufacturing industry claims that " many chief executive officers and general managers are not prepared to deal effectively with the question of whether, when, how, and to what extent their manufacturing operation should be updated by the introduction of totally new methodology and equipment" [2, pp 6].

As it can be induced from the results of many surveys and research effort, all the workforce involved with the manufacturing industry has been affected by changes in manufacturing technologies and business methods. The important point to be kept in mind is that the workers on the floor are not the only ones who should be ready for the changes.

The strategies of managing operations, managing human resources may be managing the whole business should be reevaluated. That is management should get ready for the changes, they should go over the past mistakes and develop new dynamic strategies. The question is How?

Managers can use a number of methods related to the human infrastructure of organizations to anticipate and implement new factor technology successfully. These methods include selecting employees with skills needed to handle the new technology, structuring programs to meet increased training needs, and using personnel policies, such as equitable compensation and job security , that facilitate automation.[17] Majchrzak [17, pp 142-174] describes a "human infrastructure impact statement" that addresses many of these issues.

The aim of this project is to review the research conducted in the field of human factors in the manufacturing industry so that a prototype strategy for management of the workers during a transition period in the manufacturing technology or business method.

This project report presents the current changes occurring in the manufacturing industry. During the study of the project those changes have been analyzed so that the ones affecting human resources could be extracted. The report also presents this extraction. The report is concluded with a summary of rules for selecting and preparing the future workforce in the manufacturing industry.

2. FACTORY OF THE FUTURE

The "factory of the future" is thought to be a place where gleaming robots continuously monitoring and adjusting computerized machinery, rolling perfect, customized products down the assembly line. The excitement of the computerized "factory of the future" has captured the imagination of many people. As Meredith [14] describes Visions of robotized factories come to mind, whirring away in the dark throughout the night with only "ghost crews" to oversee them, or perhaps even totally unmanned.

2.1 Defining the Future Factory

Today's factories are not unmanned factories, and will not be in the near future. These factories are full of managers, workers, supervisors, staff and support personnel. Therefore it is important to consider the human side of manufacturing strategy in order to implement the latest in computer integrated manufacturing to make the factory of the future a reality.

As Maleki [1, pp 256] states, the factory of the future not only requires the implementation of advanced manufacturing technologies, but also totally depends on the kind of workforce that is knowledgeable about those technologies and has a high degree of motivation. This type workforce does not come easily and requires the attention of managers within different levels of organization.

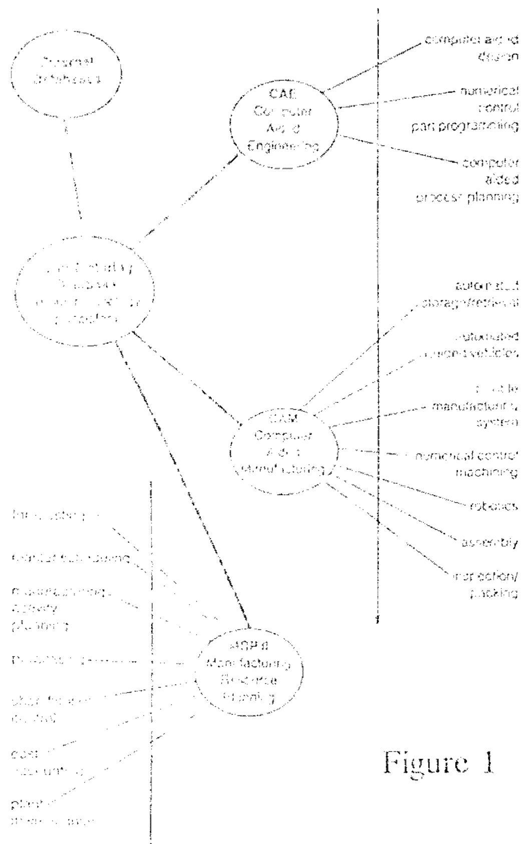


Figure 1 [14, pp 31]

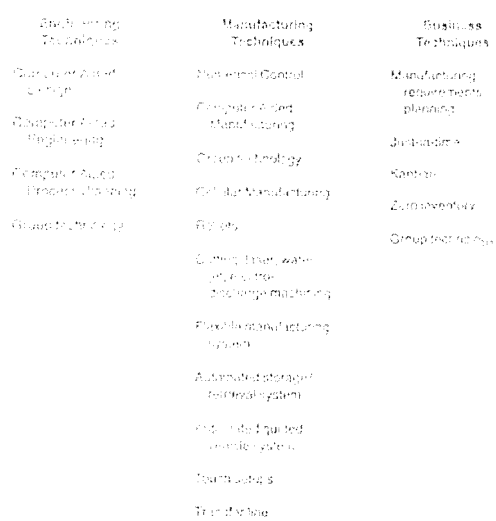


Figure 2 [14, pp 32]

Defining the elements of the factory of the future will help to identify the occurring changes and its effects on workforce. Meredith[14] classifies the current and emerging technologies into three groups: CAE; Computer Aided Engineering, CAM; Computer Aided Manufacturing, MRPII; Manufacturing Resource Planning (Figure 1) . And later he groups those technologies in three functional areas : Engineering Techniques, Manufacturing Techniques, Business Techniques. (Figure 2)

Even the techniques listed in this paper from 1987 is becoming obsolete and terms like total quality management, concurrent engineering, synchronous manufacturing, single minute exchange of dies, optimized production technology and agile manufacturing are becoming hot topics. Agile Manufacturing Enterprise Forum based in the Lehigh University claims that a new competitive era is emerging which they call Agile Manufacturing. According to the forum Agile Organizations will supersede mass[illegible] competitors.

"Agility is achieved in part by using science and engineering to leverage the information skills and decision making capabilities of the workforce for the success of the enterprise. This represents a major shift from our previous focus on using science and engineering to leverage the muscles, physical skills and dexterity of the workforce." [from the Agile Manufacturing Workshop 1993 brochure]

Therefore it can be claimed that the factory of the future is not just a collection of few hot buzz-words, but rather a dynamic environment which is flexible in all means. In a way factory of the future is the way of thinking rather than the way operation.

[illegible] Manufacturing Floor

Although the future factory plant is expected to be full of surprises and requires full flexibility, the main elements and the possible changes to occur can be estimated roughly. Carey [11] has done a very good job in highlighting the major differences occurring and having high tendency to occur in his paper.

In traditional manufacturing, the manufacturer deals with a large network of suppliers in all parts of the world. Delivery schedules for parts and suppliers are driven by the suppliers not the manufacturer. All parts and supplies are delivered to an inventory-control department. Production departments must wait for parts to be brought to the line.[11]

In the factory of the future manufacturer uses fewer suppliers, located in close proximity to the plant. Manufacturer schedules frequent smaller deliveries to eliminate inventory control costs. Few parts are stored centrally. Inventory is delivered, inspected, and stored where it is used.[11]

In traditional manufacturing departments are organized in clustered jumbles with similar machines in the same department. There is significant work-in-process, with unfinished products and raw materials all over the plant. There are long assembly lines where workers perform discrete highly specialized tasks. Quality assurance is performed at the end of the assembly line. Quality is inspected into the product. There is a high percentage of wasted work and scrap. Finished products go back to inventory-control where they are stored until they can be loaded and shipped. Separate maintenance department [illegible] machines and equipment throughout the plant.[11]

In the factory of the future shop floor is designed into cells to create several small assembly lines. Each cell has the machines required to build a complete product or component. The work-in-process is reduced due to fewer bottlenecks. There are several smaller assembly lines where workers control and perform many functions. Robots perform many manual tasks. Products are inspected as they move along the line. Workers are responsible for quality within their cells. Quality is built into the product. The percentage of rework and scrap is low. Finished products are shipped quickly and regularly. Workers are responsible for machine maintenance within the cell and conduct regularly scheduled preventive maintenance checks on all equipment.[11]

In the traditional manufacturing company, there are many layers of management. There are many job classifications for highly specialized personnel. Highly specialized training is provided based on a rigid job description. Hourly pay plan is based on seniority. Incentive compensation, if offered, is based on individual production quota. Centralized decision making is most used and problem solving is with power in the upper levels. Relationships are adversarial.[11]

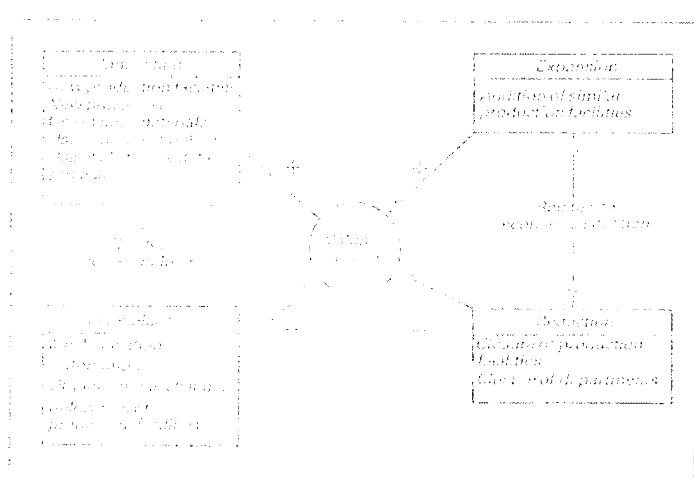
In the factory of the future, however, there are few layers of management. There are few job descriptions in which workers perform a variety of related tasks. Cross training is stressed to increase flexibility. Pay plan is based on pay for knowledge and skills based on training completed or skills acquired. Incentive compensation is based on group performance in such areas as production, quality, and innovation . Decentralized decision making and problem solving exist. Power is shared with workers through enhanced involvement. Relationships are collaborative.[11]

8. THE EFFECTS OF NEW TECHNOLOGY ON THE WORKFORCE

The new technologies are having and going to have numerous impacts on human workforce. The tendency now is increasing the level automation. This will cause a gradual decline in the number of employees just as the number of agricultural workers dropped as a result of farm mechanization.

[illegible] estimates that this decline will be offset to a substantial extent by an increase in demand for employees in other economic sectors that interact with manufacturing.

A study done in Germany [25] demonstrates that by implementing new technologies jobs are created to a very limited extent. However, new technology is used to [illegible] that these effects virtually cancel each other out. New jobs are more likely to be created by companies wanting to expand - in other words, changes in personnel are based on the positive development of demand, rather than on new technologies. This balance is summarized in figure 3. [25]



[25, pp 288]

[illegible]

[illegible] responsibility changes will be occurring for each position in the organization [illegible] blue collar workers. Vanderspek [2 pp 1[illegible]] summarizes the future job requirements as follows:

- Substantial basic technical education and knowledge
- Specific knowledge of the automated equipment they have to deal with including computers
- Willingness to learn new technology and new skills on a continuing basis
- Ability to troubleshoot equipment
- Ability to anticipate potential equipment malfunctioning and take preventive measures
- Ability to perform their tasks without close supervision and direction including making decisions
- Ability to function as a cooperative member of a team
- Flexibility and willingness to perform a variety of tasks as needed
- A highly positive attitude to their work and to the organization they work for

Majchrzak[1[illegible]], in her earlier study summarizes the above skill changes for different occupations in figure 4. [1[illegible], pp 142]

[illegible]

[illegible]	Skills				
Occupation	Perceptual	Conceptual	Manual Dexterity	[illegible]	Human Relations
Operator	Increased need for [illegible] skills and [illegible] Blueprint reading	[illegible]	Decreased need	[illegible]	Increased need for communication and coordination
Maintenance	Depends on responsibilities	Increased need for [illegible] electrical and electronic systems Increased need for diagnostic skills	Decreased need	Increased need for risk-taking [illegible]	Increased need for communication and coordination
Engineering and Systems Analysts	Stays the same	Increased need for knowledge about information and manufacturing system design	Stays the same	Depends on responsibilities	Increased need for group problem solving Increased need for communication and coordination
NC Parts Programmer	Reading engineering drawings	Cutting and tooling knowledge Math ability Ability to visualize objects in three dimensions	Stays the same	Depends on responsibilities	Increased need for coordination with machine operators

Figure 4 [19, pp 142]

[illegible] summarizes the effects of flexible automation on supervisors' job [illegible] as follows:

- [illegible] direct precise activities of subordinates is [illegible]
- The sphere of responsibility increases to encompass a greater [illegible]
- New ways need to be found to motivate and judge worker performance
- Complex systems demand investigations that cannot be solely [illegible] and that can not be completed by the supervisor alone
- The time needed for coordinating efforts among support personnel and other supervisors, as well as integrating information from multiple sources, is increased.
- [illegible] information systems decrease the amount of time [illegible] for scheduling, leaving more time for planning.
- Training of subordinates is an area of increased concern and involvement.
- [illegible] in performance appraisals is increased for some [illegible]

[illegible] the managers' responsibilities as well. They have [illegible] new [illegible] according to the above listed changes and later on set new criteria for the selection of workers. The managers are expected to resist to change as well. They might try to implement the things right away. Therefore the project group should convince the top management that implementing new technology will take time and [illegible] is the right way.

[illegible] Technology

The introduction of any change may cause problems such as psychological or social on the behalf of the workers. The change occurring in skill requirements or responsibilities is supposed to create some problems. Lack of motivation may be a significant [illegible] resistance, and managers will have to [illegible] performance, and [illegible] stage.[4]

[illegible] where robotics was introduced, [illegible] as follows: [5]

" [illegible] walking around the machines to be sure everything [illegible]
[illegible] then you have to set up all three machines
[illegible] you need to program the robot "

[illegible] professionals and technical employees, clerical workers [illegible] promoted to professional and managerial positions. [illegible] more difficult and less predictable. The [illegible] high technologies will be considerable, and [illegible] responsibilities for these activities will expect to be [illegible] might have an ascending effect.[4]

The results of [illegible] earlier are supporting the above statement very [illegible].[7]

" [illegible] You have to learn how to program the [illegible] skills, of course comes more responsibility.
[illegible] more skills...the job is more sophisticated. "

[illegible] will be created for workers because the new technology will [illegible] and will result in worker isolation. This could [illegible] Organizations might also experience an increase in employees' [illegible] problems resulting from displacement and the stress of [illegible]. Computers currently accumulate employees' record-by-record [illegible] and performances; when management utilizes this [illegible] make personnel decisions , greater stress [illegible] will result. Some employees will undoubtedly feel that [illegible] When problems occur, they will be of greater [illegible] a greater challenge. Those who can not cope will [illegible]

[illegible] survey were supporting [illegible]

- [illegible] responsibility...They want the robot [illegible]...That's hard because it is still new
- [illegible]...it's an expensive piece of [illegible]
- [illegible] with the robot...You [illegible]
- [illegible] don't want them breaking my [illegible] now.[6]

[illegible]

[illegible] technology will change the way in which [illegible]. In the past employees entered businesses [illegible] about working their way to the top. In [illegible] recruitment is geared to the employee [illegible] and interaction and communication skills [illegible] programs. Because there is a shortage of people [illegible] the demands of the new technology and are willing to [illegible] clerical jobs, personnel departments will have [illegible] ensuring that conditions within the [illegible] people. [illegible]

[illegible] the workers are important. The [illegible] security of their jobs. So before starting [illegible] concerns should be clarified with a series of [illegible].

[illegible] in such processes is the worker involvement. The workers [illegible] where to make changes and asked how to [illegible] accelerate the implementation process.

[illegible] on workers explained earlier in this report, [illegible] and the required skills of the new [illegible] selection and training strategies [illegible] are explained in the next sections.

According to Majchrzak [19, pp [illegible]-150], after identifying the skill requirements needed for [illegible] technology jobs, careful selection of workers for [illegible] questions to be answered to reach to the [illegible]:

1. [illegible] workers are needed ?
2. Where will they come from ?
3. What is the criteria for selection ?

[illegible] conducted by Majchrzak [19 pp 145], [illegible] provided by vendors is used for [illegible] operate the new equipment. But the [illegible] information about the indirect labor requirement.

The production rate at which the plant will be running after the new equipment is installed [illegible]. Due to poor planning initial rate may be [illegible] there may be need for fewer number of workers, but it [illegible] this number is going to increase.

Planning the [illegible] process appropriately will enable the project [illegible] installation. In similar cases the number of workers [illegible] [19, pp 147]. This is because the organization as a system has [illegible] additional workers into other production [illegible] for seasonal flux in inventories.

[illegible] of workers too. Job designs that are very rigid and [illegible] may require more people than flexible job designs that allow [illegible].

[illegible] the next step in selection process. Lay offs is [illegible] observed that lay offs were affecting the [illegible] were causing union problems. So the philosophy of [illegible] determines the pool of workers.

The last step [illegible] criteria so that the number of workers can be selected. The [illegible] called seniority and creaming off. Seniority is selecting the workers according to the number of years they have been working. This [illegible] having a few years to retirement or having a high [illegible]. Although their experience is valuable [illegible] older workers is not an efficient [illegible].

[illegible] the ones with the best skills [illegible] low cost for training but has been [illegible] get involved in the selection process [illegible] company in any hostile situation with the [illegible] a committee of worker and [illegible] management to apply [illegible].

[illegible] human relations or individual [illegible] applied and been successful.

[illegible] in-house training programs of plants with [illegible]

SKILL	% Plants Needing
[illegible]	95
[illegible]	89
[illegible] in manuf.	82
[illegible]	74
[illegible]	74
Developing knowledge of other depts	69
[illegible]	69
[illegible]	53
Basic engineering concepts	52
Basic reading, writing, and math	44
Basic physical science	34

[illegible] studies in implementation advanced [illegible] on the workforce were summarized. The [illegible] compared to each other.

[illegible]

1. [illegible] all manufacturing firms [illegible] will have only one chance of [illegible] they can not afford to mess the [illegible] to be cautious.

2. [illegible] the factory of the future is [illegible] going to be [illegible] their presence will [illegible] the percentage of [illegible] there will be a mix of [illegible] methods and the advanced [illegible] for a while.

3. [illegible] important factors in [illegible] manufacturing technologies and [illegible] and continuous part of [illegible] firms already offering [illegible] programming.

4. [illegible] worker involvement and feedback [illegible] of the important sources for the decision of [illegible] technologies. However one of the [illegible] customers as the source for [illegible] Although [illegible] is more [illegible] a good feedback, it won't [illegible] promoting [illegible]

5. [illegible] the [illegible] firms [illegible]

6. [illegible] discussed in this [illegible] of the [illegible] number of the theory of [illegible]

1. [illegible] Prentice Hall, 1991, pp [illegible]
2. [illegible] McGraw Hill, 1993, [illegible]
3. [illegible] "[illegible] Aspects of Flexible Manufacturing Systems", [illegible] Journal Second Quarter, 1989, pp [illegible]
4. [illegible] "The Effects of Robotics on the Workplace", [illegible]
5. [illegible] "The Human Side of Robotics: [illegible]", [illegible] Management Review, Spring [illegible]
6. [illegible] "[illegible] new technology: The need for training", [illegible] Publications, 1986, pp 3-12
7. [illegible] Education and Training [illegible]
8. [illegible] Technology" Education and Training in [illegible]
9. [illegible] "[illegible] Out", Manufacturing [illegible]
10. [illegible] "[illegible] with Technology", Personnel [illegible]
11. [illegible] of the future" [illegible]
12. [illegible] Education and Training in [illegible]

[illegible] Management and Organization of [illegible]", The Automated Factory Handbook, [illegible]

[illegible] of the Factory of the Future", [illegible] 1987, pp 27 - 41

[illegible] R., "Appropriate [illegible]

[illegible] and Computer [illegible]

[illegible] Technology [illegible]

[illegible] of Flexible Factory [illegible] Reactions [illegible] a Symposium [illegible]

[illegible] Automation, Jossey-Bass [illegible]

[illegible] Manufacturing [illegible] Management Journal, Vol 5, [illegible]

11. [illegible] of Advanced Manufacturing [illegible]

12. [illegible] in the Auto Industry", [illegible] 1983, pp [illegible]

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35. [illegible]". Human Factors, [illegible]