MANUFACTURING AUTOMATION MANAGEMENT

A Productivity Handbook

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ROGER W. BOLZ

Preface

Automation has been employed for many years to provide a multitude of reasonably priced products for the American consumer. However, it has become evident that its real character as a manufacturing systems approach needs to be examined carefully for a better appreciation. In this book the purpose is to examine automation technology in its broadest sense and develop not only an understanding but also present some of the engineering and organization "know-how" by which manufacturing management can more effectively utilize automation to improve productivity and combat rising costs in the years ahead.

Fundamentally, this book is addressed to manufacturing managers, and the material presented in a manner that will provide the knowledge for assuring success in automating. In addition, it highlights the manufacturing research and long-range planning that will be required for creating the new manufacturing technology so necessary for assuring success in future automation efforts.

One of the important facts emphasized in this text is that automation is *not* merely robotics or another kind or type of machinery. To effect true productivity improvement requires a fresh look at the *entire* production process or facility—as a completely integrated system. With the developments of the past few years, rapid advances in the technology and the "tools of automation" have brought this imperative goal within the reasonable grasp of manufacturing management in almost every segment of industry. However, to utilize this progress, it is necessary to acquire a working understanding of all facets of automation.

The key to management success with automation in the past often has been found to be elusive. Present revelations indicate that this is still true. In this book, based on extensive experience, the entire technology is examined in detail and placed in proper perspective. From this fundamental viewpoint, the chief executive can examine corporate goals, objectives, and activity in realistic terms. It is imperative that he or she face and answer the critical question, "On the day of completion, will this new plant *already* be obsolete?"

This text emphasizes a practical approach to the job of understanding the principles of automation, the engineering challenges it presents, and the sizeable rewards which automation can bring. In addition, engineering personnel enlisted to develop automated operations will find specific guidelines based on experience that will enable realistic profitable moves to fit a long-term program.

Most significantly, this book should make it possible for business and industry to develop a keener insight into the economic responsibilities implicit in automation and the opportunity to produce more and higher-quality goods with less manual effort. But, since this also implies considerably greater mental effort, it is imperative in the author's mind that businessmen consciously promote the well-being of the people associated with the enterprise they represent and also accept a more intimate responsibility in the technology of the manufacturing activity.

Automation technology helps support many personal interests and ambitions in a challenging context when its dynamic character is fully realized. This book attempts to offer this practical understanding in easily understood terms for a wide range of utility. Top managers and chief executives in business and industry will find it an important addition to their library of basic texts.

ROGER W. BOLZ
Lewisville
North Carolina, 1985

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Automation in Manufacture—Its Character and Growth

Successful automation demands the most rigorous adherence to the aims of maximum product quality as well as the least common denominator in equipment complexity. The all-too-common tendency of engineers to avoid risking the unknown and of management to expect success without risk adds up to achieving total mediocrity in productivity advance. A climate that fosters the new and untried is imperative if the real advances of automation are eventually to be realized.

THE CHALLENGE OF CHANGE

Any organization today, regardless of its situation will and must face the challenge of change. Unless it is ready to do so, the process of change will inevitably carry with it the seeds of failure.

Being ready to face the challenge daily, not merely accepting it but welcoming it and actively managing it favorably, has major advantages, the most important of which, obviously is survival.

Managing innovation so as to cope with change successfully is the major problem. General Motor's great innovator, Charles F. Kettering, pointed up the problem with his comment that "The greatest durability contest in the world is trying to get a new idea into a factory." Success tends to create a strong adherence to the status quo, an attitude of complacency and a basic resistance to change and new ideas.

Once the importance of innovation is recognized, there is the need to understand the key areas of activity. The usual conclusion is that the area of greatest need is for product innovation. Experience indicates this is not the case. Some years ago an advisory panel of the U.S. Secretary of Commerce found that manufacturing engineering was the most important area of need in successful product innovations.[1] In general cost distribution it ranged from 40 to 60 percent of the total, which also included advance development, product design, start-up, and marketing.

A new product which cannot be produced in the required volume and at a price acceptable to the market will become nothing more than a statistic. Innovation can supply the needed solution to the problem.

HOW SUCCESSFUL?

Although the technology to automate manufacturing operations is available, the parochial approach of most managements guarantees either minimal success in terms of the possible or none at all. Looking back, it was noted on page 82 in the June 5, 1971 issue of *Business Week:*

> Even the most successful computer operations have gone in where they help the industry least—into the hot metal stage of the process rather than the finishing mills. "Look at any cost sheet," says a steel engineer, "and you'll find that two-thirds of the costs are in the finishing end of the business. That's because two-thirds of your manpower is there." Blasdel Reardon, Armco's chief of management systems at the time, concedes the point. At the time computers were coming in, he explains, the industry was revamping its hot-metal production, not its finishing capacity."

History has proved he was right. And, it can also be observed that customer satisfaction would be achieved most easily through closer computer control of the gauge of cold-rolled sheet to permit sale by the foot versus by the ton, which is the general practice today.

Unless the problem is studied *as a total system* the benefits possible at one stage may be inaccessible because of changes needed at some other stage. Success of any process as an automated entity usually depends upon the integration of elements in several stages simultaneously.

From careful study of the process of innovation it can be concluded quite readily that it is to a singular degree an individual activity. Daniel V. DeSimone of NBS has contended[2] that it calls for outstandingly creative individuals who fit G. B. Shaw's definition of "unreasonable men."

Obviously, then, the introduction of a technological approach as basically innovative as automation follows a similar pattern.[3] Barring those developments such as computers and numerical control, where government stimulus created the market demand, the forces that open the doors of industry to automation can be listed as follows:

1. Products that cannot conceivably be manufactured in sufficient quantity or quality to satisfy market demands without automation.
2. Products that cannot conceivably be produced at all without automation.
3. Products that cannot be sold competitively without utilizing automation.

The need is growing. Innovative manufacturing automation will become imperative to the survival of many companies. Is it possible to speed up the introduction of new automation in manufacturing operations? What should the forward-looking company be doing? This book will try to provide answers.

PITFALLS

Management must personally champion automation. But in so doing, they must also insure that automation is practical and realistic.[4] In any workable program it must avoid, at all costs, problems such as these that invariably result in costly failures:

1. Unrealistic assessment of the technological possibilities.
2. Support for complex rather than simple solutions.
3. Conversion of specialties into independent disciplines for their own sakes.
4. Confusion of scientific information with technological innovation.
5. Aversion to external automation systems resourcing.
6. Lack of understanding.

Significant productivity achievement is an enterprising, creative venture, and it must be based on carefully planned and calculated decisions by management. The luxury of waiting for the competition to create production improvements is no longer affordable; and individual equipment suppliers seldom have the incentive or capabilities to risk the increasingly larger investment needed today (Figure 1-1). Only corporate management can really spark the creative efforts of the manufacturing staff in advancing profitable automation. Says Troy McAfee, manager of manufacturing at John Deere Components Works, an outstanding automated plant, "America doesn't have a technological gap (in automation), but there is a significant management gap."[5] Technically trained top managers are imperative for a company to remain competitive in the age of automation. Business managers will have to be extremely sensitive to the need for change. They will also have to be ready to accept all the risks that accompany the new and at times be ready to cope with making unpopular decisions if the business is to survive.

When long-range planning is not present to assist in the gradual introduction of automation, sooner or later changing economic pressures will force the issue on every company. The steel industry is a good example of this. And, as in the latter case, the real troubles arise when sufficient time has not been made available to assimilate some of the severe changes that must take place in order to return the industry to a competitive position. However, it is well to recognize that these changes are identical to those that beset any company that has remained in a static condition overlong and is forced into rapid corrective moves to avoid disaster (Figure 1-2).

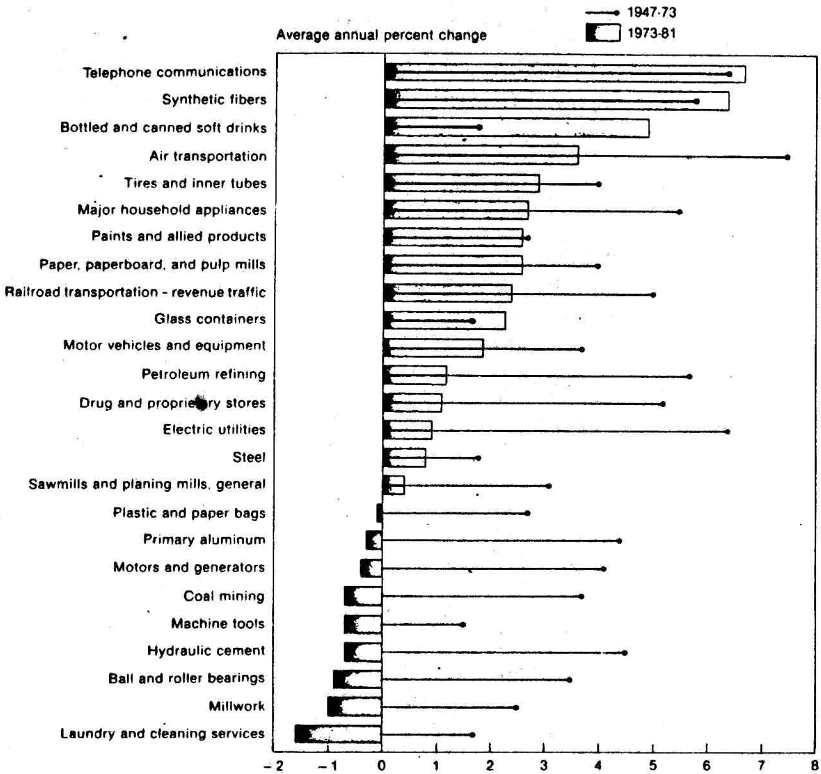


Figure 1-1 Productivity rates before and after 1973 highlight a need for automation. *Chart, Courtesy Bureau of Labor Statistics.*

AUTOMATION TODAY

The word *automation* is a contraction of the words *automatic operation*. It implies the process of doing things automatically. It is not synonymous with any other word. It does not mean mass production; mass production is volume manufacture of interchangeable products. For example, in the 1840s, Robbins, Kendall, and Lawrence of Windsor, Vermont mass produced rifles on a truly interchangeable basis completely by hand methods.[6]

Automation is based upon but goes a long step beyond mere mechanization (Figure 1-3). The term *mechanization* simply means doing things with or by machines, not *necessarily* automatically. True automation implies continuous or cyclic arrangement for manufacturing, processing,

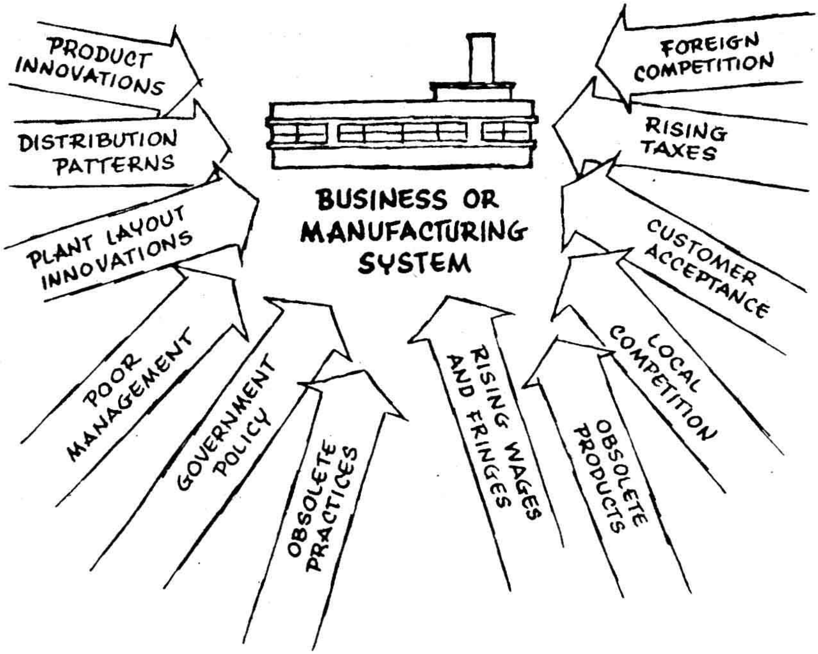


Figure 1-2 Some of the great variety of situations that force managements into rapid corrective moves, including automation to avert disaster.

or performing services as automatically as is *economically practical* or necessary.

The primary feature of mass production is standardization of component characteristics so as to permit complete interchangeability. This means that any product or element in a manufactured lot can be substituted for any like other one at diverse locations. Tolerances are such that all in any lot are sufficiently identical to permit random use or random assembly with other parts. Its basic feature is the elimination of separate individual fitting up in manufacture and assembly. Mass-production techniques constituted a major step in creating the possibility of providing large quantities of complex products with superior quality and uniformity at lower cost in time and money. But today, hand methods often fail to fulfill the requirements because of economics, market demand, speed, safety, and other factors. The solution is to add the succeeding step in the manufacturing picture—automation.

From the standpoint of the workman, automation eliminates the undesirable characteristics of mechanization in which the operator functions as an integral mechanical part of the production cycle. Instead it makes

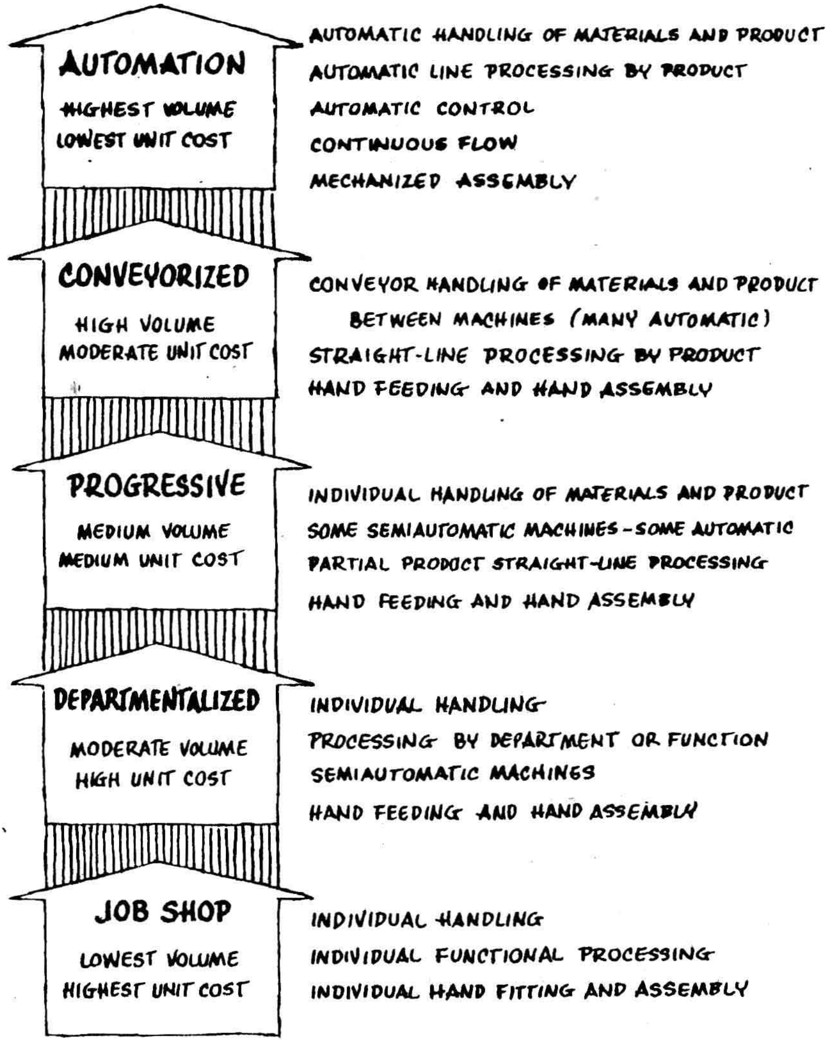


Figure 1-3 The typical evolutionary phases of manufacturing leading to the automation stage.

the operator a skilled director of an integrated production sequence; it requires greater knowledge of the product; it calls for increased responsibility; and returns in large measure pride in knowledge and workmanship.

With automation, single separate processing operations are linked into an automatic continuous system. Only a few separate operations or all operations from raw materials to finished product may be included. For example, instead of making pipe by a series of separate steps, steel billets enter the rolling mill and are rolled into sheet; the sheet is formed, butt welded, cut to length, and threaded, to emerge as finished pipe used for plumbing. By integrating the handling operations pipe is produced at speeds over 17 miles per hour.

There are many examples of automated plants today. Products such as toothpicks, matches, paper, flour, breakfast cereals, beverages, food products, chemicals, hardware, etc., make an impressive list, and there are, of course, many more. Today, automation *to some degree* can be found almost everywhere, from producing shovel handles to warehousing products. And the results are always similar—better products and distribution at lower unit costs.

TECHNOLOGY IS AVAILABLE

Automation technology is available now for solving many of our manufacturing and distribution cost problems. Some of today's automation accomplishments provide a glimpse into the areas of use throughout industry.

There are consumer product plants such as one turning out appliances at the rate of one every 30 seconds with 2,500 automatic and semiautomatic machines tied together with over 25 miles of conveyors.

Paper mills, for instance, produce more than 500 miles of facial tissue daily, 6 feet wide, on continuous automatic equipment.

By using continuous automatic production involving several steps, from raw materials to finished parts, the lamp bulb industry produces an estimated 6 billion lamps per year.

Systems recover high-purity iron from low-grade ores in almost totally automatic operation—processes economically competitive with foreign high-grade ores. The resulting concentrated ore improves the automation feasibility of subsequent steel production operations.

Telephone drop wire is produced on a round-the-clock basis at more than 2 billion feet per year. Copper is electroformed around steel base wire continuously, the wire is cleaned, lead and brass plated, inspected, and wound on reels at rates in excess of 3,000 fpm. Extruded insulating cover is applied in a continuous automatically controlled operation.

Dishwashers are produced on 3½ miles of conveyor with transfer machines, robots and assembly equipment, all computer controlled throughout.

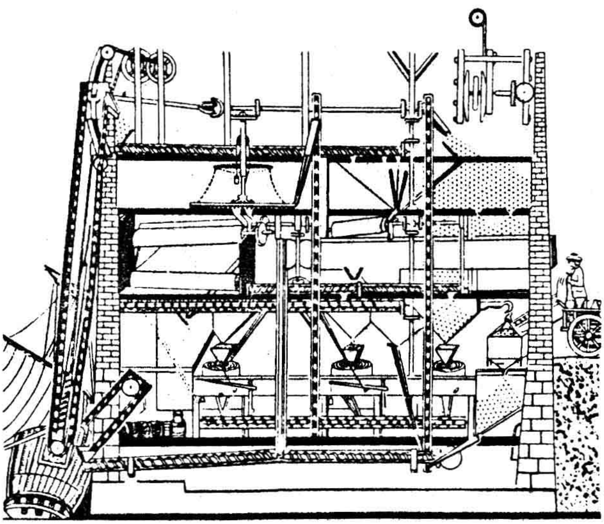
Where once a bank of workers tended loudly clacking weaving machines, now a single worker walks between almost silent shuttleless looms while jets of water shoot yarn back and forth more than 10 times per minute, turning out 100 yards of cloth every hour.

A flexible manufacturing system costing $16 million produces 5,500

A look at automation

Automation, from an engineering viewpoint, can be defined as the technology of manufacturing, processing, or performing services as automatically and/or as continuously as business economics demand. It all began in 1783 when Oliver Evans created the concept. Giedion (1948) puts it succinctly: "For Oliver Evans, hoisting and transportation have another meaning. They are but links within the continuous production process; from raw material to finished goods. . . . At a stroke, and without forerunner in the field, Evans achieved what was to become the pivot of later mechanization. . . . The mill could be loaded from either boats or wagons, a scale determined the weight and a screw conveyor carried the grain inside to the point where it was raised to the top story by a bucket conveyor. It handled 300 bushels an hour . . . without care of any attendant—cleaning, grinding, and bolting . . . without human intervention. . . . ."

For automation in manufacturing, basically, the key is economics. The stimulus is competition and customer demand. Whether the product is flour, matches, toothpicks, processed foods, eggs, light bulbs, chemicals, cans, bread, pretzels, wire, automobiles, or ball-pens, the story is the same: automate to the extent necessary to meet market requirements. Nothing less will do; anything more is economically impractical.



Cross section of Oliver Evans' Mill.