AUTOMATION - DEVELOPMENT OF THE MATERIAL - TECHNOLOGICAL BASIS- CHANGED CONDITIONS OF EFFICIENCY

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PREFACE

This paper by Dr. Hübner and Dr. Steinitz was presented at a joint seminar on flexible automation held in Berlin (East) from June 8-11, 1982. The seminar was a collaborative project between IIASA and the Academy of Sciences of the German Democratic Republic.

This paper deals with specific changes brought about by the application of microelectronic components in manufacturing automation.

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The report and the working material presented to the conference deal, among other things, with the influence of the flexible automation on the further development of the material-technological basis and on the whole system of the productive forces. Hence the following questions arise:

Firstly: What does the qualitatively new level of automation mean in connection with the development and application of micro-electronics and what is flexible automation?

Secondly: What are the constituent elements of the new level of automation and which are the consequences for the development of the material-technological basis?

Thirdly: Which changes within the conditions of efficiency take place due to the new level of automation on the basis of micro-electronics?

The presented paper offers some aspects regarding these questions:

I. To the qualitatively new level of automation

One of the deep-going effects of micro-electronics on the qualitative development of the productive forces is that it brings about - by automation of information processing - prerequisites to a new level of automation which is closely connected with a deep-going transformation of the whole technological basis of both the processes of production and reproduction.

The flexible automation is without any doubt an important tendency of the productive forces. However, it is necessary to determine unambiguously the position of the flexible automation within the total process of automation, first of all in the realization of the qualitatively new level which it gets by applying micro-electronics.

The new level of development or in other words the new quality of automation, which can be characterized as a new main direction of the scientific-technological revolution, goes far beyond the flexible automation. The flexible automation expresses, without any doubt, fundamental aspects of automation, but they are only specific sides of this new quality of automation.

This is meant in two ways:

- The flexible automation is firstly very strongly limited to the conditions of the metal-working industry, especially the discontinued small and medium batch production of machine building. However, the new level of automation is characterized by penetrating into all spheres of economy through the automation of information processes; it also penetrates into the non-producing sphere there leading to qualitatively new aspects of the production and reproduction process.

- Secondly, only certain sides of the higher quality of automation are covered by the flexible automation and thus are also the qualitatively changed conditions of the efficiency of automation.

The new quality of automation which also leads to drastic changes in the position of man within the social production - especially in the man-machine-system - is inseparably connected with its development both in the breadth and in the depth. It is beside the flexibility, as dealt with fully in the report, in our opinion first of all characterized by the following aspects:

(1) The sphere of automation expands fundamentally. Opposite to the classical machinery, where automation was directed first of all to the material and energy transforming processes, this means mainly to the direct treatment and processing, now mental working functions are being mechanized in an increasing amount. Thus automation is penetrating into such spheres of work which have been reserved up to now mainly for man. The effectively automatible sphere of human work is expanding essentially. These are the main trends of the development:

- mental working functions hitherto not or hard accessible can be automated or mechanized respectively;

- spheres, hitherto not accessible to an effective automation or only accessible with high economic expense, can be opened now. These are, for example, discontinuously running processes of the small and medium batch production of machine building, especially fitting processes;

- automation of information processing offers absolutely new possibilities for making the relations between the single levels

more effective. This development will lead to an essential qualification of planning and managing processes.

(2) The complexity of solutions for automation is increasing. Today continuously running processes show already a high degree of complexity of the automatically working machines and equipment. This is, among other things, determined by the technological force of the processes themselves (e. g. in chemical processes). In future, apart from the improvement of these processes, the direct production process will be connected with the pre and post steps by the help of "information processing".

In case of the discontinuous processes of the small and medium batch production, the complexity of the automatically running production process is considerably smaller developed. In future, micro-electronics and other technological processes will cause an intensified transition from automated single machines to the automation of whole production processes including several automatically running machines, robots with different functions and transport-, measuring- and control-systems.

The aim of the present development is the complex automation of industrial plants. The complex automation reaches far into future and provides preconditions for also realizing the so-called "man-less plant" which is causing great economic and social effects. Processes of operating statement and control, supply of materials, storing, transport, measuring and control, planning and management are increasingly connected with the automatically running production process.

(3) The availability of the automated working tools is increasing. The increasing of the availability of automation solutions, which means especially the conditions of a higher time capacity utilization of machines and equipment, is on the one hand closely connected with the level of the development and the using of the new technology, as e. g. micro-electronics, and on the other hand with the reached flexibility and complexity of automation solutions. As flexibility and complexity will strongly influence especially the automation of discontinuous processes, one can conclude that special effects will be obtained by increasing the capacity of the fixed assets in discontinuously running processes, especially in machine building. The possibilities for increasing the capacity of the working tools caused by micro-electronics derive from the higher availability of the automated machines and the complex solutions. These are determined by the following factors:

- increasing of the capacity of machines by an improved control technology;

- decreasing of the down times by a higher reliability of the technological solutions;

- reduction of the processing time of the subject of labour, especially by the possibility of a transition from discontinuous processes to continuous ones as well as a more rational organization of the whole production process including transport and storing;

- reduction of the time needed for maintaining and repairing;

- increasing of the complexity and flexibility of technological solutions.

By increasing the availability of automation solutions the degree of machine and equipment utilization, especially in the small and medium batch production of machine building, is further approached to the theoretically possible total time available thus counteracting the increased obsolescence.

(4) Both the demands to the quality of automation solutions and to the production are increasing. Here are offered some examples:

- Complex automation solutions must guarantee a high reliability of both the whole process and its single parts. The quality of such systems must be realized by the sum of its elements (among other things machine, periphery, control).

- Programmed robots keep once given technological data exactly, they work continuously and guarantee a small rate of rejects and an improved quality of the product; many examples of using industrial robots for welding, foundry processes, paint spraying and charging of spray casting machines underline these abilities.

- The application of process control on the basis of microelectronics allows an optimal controlling of the equipment which means, besides the reduction of expenditures by reducing the material, the energy, the maintainance a.s.o., generally an increase of output and quality of the production.

- The application of control processes based on micro-electronics is a decisive prerequisite for the development and using of principally new efficient technologies as there are nuclear technology, laser technology and cosmic technology.

(5) Automation of a new quality cannot be realized only on the basis of a highly developed hardware. Software and (for greater automatically running complexes) orgware are the new preconditions for using the new technology and they determine considerably the efficiency of the automation solutions. Software and orgware are a new element of the means of work which is inseparably connected with the new quality of automation based on the information processing technology. They are acquiring importance against hardware. One can conclude that hardware yields only as much as its users feed "intelligence" into them by the help of software and orgware.

All these factors, whereas flexibility as one of them has a special rank, show that there is forming a new quality of automation as a basic direction of the scientific-technological revolution. This new quality, marked by many factors of efficiency, is characterizing the further development of the material-technological basis. It can only be realized in the unity of these differentiated, manyfold effects of automation.

II. Constituent elements of the new quality of automation

The working material of the conference characterizes the numerically controlled machine tools, the industrial robots and the integrated flexible production systems as the basic elements of the flexible automation. We take this approach - regarding the discontinued processes of the small and medium batch production - for possible and under certain aspects for appropriate. However, one can also consider another approach; that means that the new quality of automation, whether as a comprehensive automation or a flexible one, can only be brought about in connection with the application of information processing technology based on micro-electronics. The forming of information processing technology is added to the up to now known energy and material transforming machines. It is an independent unit and thus part of an energy and material transforming system existing in the connection of both these systems.

Applied to the flexible automation the information processing technology is basis and precondition of:

- The new quality of controlling as a condition for:
  numerically controlled machines
  numerically controlled processing centres
  industrial robots etc.
  as a part of a four-limbed machine system.

- The forming of information processing systems, e.g. fields of:
  the technological and constructive preparation of production
  office automation
  communication technology etc.

- The development of flexible complex production systems based on the consolidation of the four-limbed machine systems with the information processing systems. Thus complex automated systems are formed going far beyond the material production and the limits of the enterprise.

Automation based on the comprehensive using of the information processing technology has many consequences for the development of the material-technological basis and its technological type. How are these changes characterized?

(1) By changed man-machine-relations. Fundamental changes are taking place in the working conditions and in the content of work. One has to consider that the character of the division of functions between man and machine is not necessarily a result of the higher level of automation but it can be influenced greatly by it. It even is the using of the possibilities of socialist conditions of production for forming such "relations of division of labour" between man and machine which promote a creative work rich in content and variation. These changed man-machine-relations result in consequences for the development of relations of substitution between the fund of fixed assets and the labour force. In future, redundancy should not be based on the increased use of the fund of fixed assets but must be caused increasingly by a

higher quality of both the solution of technology and automation which is realized in the fund of fixed assets.

(2) Thus there are changed expenditure structures of social work. The following aspects are of importance:

- The structure of the investment costs changes, the share of costs for the scientific-technological prelimenaries and for the provision of optimal application conditions for the new technology (among other things software) is to be increased considerably. Thus the technological level of the investment costs is increasing. The share of qualified work in the total costs for the production of working tools has considerably increased. On the other hand the share of system data is increasing, that means the materialized mental work (software) as part of the working tools. By these processes of a higher intensity of qualification and technology of the preliminary expenditures the level of complexity of the social work realized in the investment costs is increasing as a whole.

- Changes in the structure of the operating costs. The level of complexity of the operating costs is totally increasing. It shows a growing tendency caused by the higher level of qualification and complexity of living labour. This happens by the increasing share of scientific-technological work and by the higher complexity of work because of the more refined primary and auxiliary materials.

- Changes in the structure of the total expenditures in favour of a higher share of investment - research and development costs in comparison with the costs of material, wages, energy etc.

(3) Changing expenditure structures between the producing and the non-producing spheres are resulting. The increasing use of information processing systems in the non-producing spheres causes higher expenditures for modern equipment. Thus questions of the fund of fixed assets economy in these spheres arise. The increasing complexity of automation solutions cause new, changed relations between the funds of fixed assets of the producing and the non-producing spheres. Stronger dependencies of the fund of fixed assets of both spheres are forming.

Altogether, the conditions for a resource saving growth are essentially favourable, especially for a higher degree of refining of production and for the implementation of a comprehensive intensification. However, these results cannot be reached automatically. They can only be implemented by more effective system solutions and by a more efficient combination between automation and application of new, more effective technologies and production methods.

III. Changed conditions of efficiency

Higher efficiency potentials together with the qualitatively new aspects of automation result especially from the following, partly mentioned connections:

- intensified use and application of automation;

- new possibilities given by automation for the application of new technology;

- higher time availability of the funds of fixed assets;

- conditions for the multi-shift utilization of the working tools at low use of labour force in the second and third shift;

- saving of material and energy by optimal processes;

- higher, constant quality of products, among other things by integrated measuring and control technology.

The realization of the possibilities of the efficiency of automation takes place under complicated, partly contradictory and diverging conditions and effects. The main problem is how to use actually the qualitatively new possibilities of automation. The realization of the possibilities of efficiency is dependent on different conditions, first of all it is dependent on the integration of automation into the present material-technological basis and on the using of the technological possibilities by adequate software and by improving organization and management of the reproduction process.

The determination of the usage strategy and the fixing of usage preferences by the help of economic criteria becomes increasingly important. This is meant, expecially for the usage of robots, numerically controlled machine tools, electronic data processing etc. A main problem is how to limit the growing expenditures for sophisticated automation solution partly by favourable expenditures of new automation possibilities. One aim is to use more efficiently those new possibilities which improve the working tools. This means possibilities to reach the technological progress which is connected with the usage and the improvement of information technology - as a fourth relatively independent part of the machine system - by keeping the real machine body and the equipment respectively. An important futural task is the improvement of the automation strategy to exploit the qualitatively new aspects of automation, mainly its economic and social efficiency, in the interest of a further growth of economy and of the improvement of the working and living conditions of the people.