

# Introduction of Industrial Robots to Production and Tendencies of Respective Cost Requirements

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In my short lecture I would like to illustrate some problems of cost development in connection with the introduction of Industrial Robots, which we are faced with in the German Democratic Republic. First of all it is necessary to start with studying the different effects created by the introduction of Industrial Robots in the production. In this way we will find the basis for the proper understanding of cost development and ways of cost reduction.

## 1. Industrial Robots and Their Different Effects

At present we experience the acceleration of scientific-technological progress on a world-wide scale. This process involves a number of different main currents. Within this system of highly developed technologies the Industrial Robots hold an important

position. As you know, in absolute terms Japan ranks first among the countries of the world in introducing Industrial Robots. But also we in the German Democratic Republic do our utmost to extend the capacity of this new instrument for promoting economic and social progress. The following table shows the change in robot utilization:

Industrial Robots introduced to production\*)  
(number)

sectors \ year	1981	1982	1983	1984
national economy	13,680	22,418	32,117	42,000
industrial branches	12,372	19,764	27,267	

For 1985 the national economy plan of the German Democratic Republic provides for the introduction of 45,000 Industrial Robots and we even expect to be ahead of this quota.

Following the line of my talk we should now determine the place of Industrial Robots, how they are involved in the whole system of modern technology as well as the special effects which result in production.

In my opinion, we have to note three aspects and also three effects which are derived from the former. That means technological, economical and social aspects have to be distinguished and to be taken into consideration.

#### (a) Technological Aspect

Industrial Robot introduction is a part of the parcel in further extending automation and should be described as a component of the

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\*) Statistisches Jahrbuch der DDR, Staatsverlag 1984, S. 106.

new stage of—so called—flexible automation. Based on the well-known forms of automation, hitherto existing in special automated machines and transfer lines, a some kind of final limitation to technological and economical progress has been reached. This happened, on the one hand, because we could not extend the scale of mass production in every field—sometimes, even in opposition to this we had to accept that the diversification of production more or less led to the decrease in the quantity produced in a time unit. On the other hand, there are many special tasks to be solved in the working process which are especially characterized by complicated manual and mental activities which inflexible automation was not able to cover.

By contrast, Industrial Robot introduction makes possible:

- the automation of small batch production and also, step by step, individual job production on an economical basis,
- the transformation of technological processes as a whole as well as the introduction of other components of scientific-technological progress (informatics, sensorics, microelectronics).

Thus we come to define what an Industrial Robot is: Industrial Robot-technology includes as a component of flexible automation the totality of fixed assets which serves the independent handling of workpieces, tools and materials based on the special and flexible programming of positioning and actual manufacturing along one or several axes of movement.

Regarding the definition, there is a world-wide struggle of opinions in this field. Of course, different generations of robots are to be considered. We exclude pick and place instruments; however, we do include the first generation in the definition. On this point, we agree with the Japan Industrial Robot Agency terminology.

**(b) Economical Aspect**

From this point of view, Industrial Robot introduction makes it possible:

- to continue automation in spite of a background of limited investment in comparison with the cost required by big automated flow lines,
- to make cost savings, especially wage costs (release of manpower) and by improving the stability and the level of other qualitative features of production (quality, reliability etc.).

**(c) Social Aspect**

As you can imagine, in a socialist country this is a matter of utmost concern to us. In this field Industrial Robot introduction makes it possible:

- to take decisive steps on the way towards substituting human labour by automated machine systems to the ultimate point of more or less manless production,
- to relieve man of monotonous, dangerous and heavy work and in this way to open the door for him to be engaged in new interesting and more ambitious activities,
- to release manpower under conditions of maintaining full employment which would make man available for taking up new jobs in important sectors of the national economy (3rd sector) and as a basis for a further reduction of working time.

## **2. Industrial Robot Introduction and Cost Development**

A main aim in introducing new technologies is to increase profits and other economic results. In this case we have to consider the different generations of Industrial Robots with the respective investments and special conditions they require. Therefore we should now sort out the more general aspects of the matter.

### **(a) Tendencies of Cost Development**

For this purpose we should distinguish between investment costs and operating costs which, of course, are different and adequate to the different generations of Industrial Robots. The following figures show the main proportions of investment costs:

52%—Industrial Robot investment

20%—peripheral devices

11%—adaption

17%—preparatory activities prior to operation, including qualification of staff.

Main ways to reduce these costs are:

- to achieve an increase in the mass production of Industrial Robots (during five years it was possible to reduce the costs by approximately 50%—first generation robots),
- to make maximum use of existing software programmes for the adaption and pre-production preparation of robots.

For a discussion of the tendencies in the cost of operating the following example is offered:

## Industrial Robot Introduction

Costs	before	after
factory floor space	0.5%	1%
energy/interest	3.5%	11%
maintenance	5 %	18%
amortization	10 %	43%
wages	81 %	27%

The table shows the consequences in substituting living labour by materialized labour (Industrial Robot). In order to make efficient utilization of new technology, shift work (around-the-clock) was to be introduced. We should also be anxious to the preconditions for a reflux of capital within two or three years. Therefore a high level of management and factory organization is required.

**(b) Problems of Ensuring a High Level of Efficiency**

In order to guarantee such a high level of efficiency we have laid down some principles which have to be observed in Industrial Robot introduction:

- release of manpower (on average: 2.5 workers in each case of introduction),
- payback period for investments less than three years,
- operating costs (material, energy etc.) should be minimized,
- utilization of Industrial Robot in 3-shift-work,
- increase in labour productivity by 50% and more,
- improvement of working conditions.

A complicated problem consists in the planning and assessment

of the efficiency in Industrial Robot introduction.

To tackle the problem, we have to analyse, on the one hand, the benefits achieved and, on the other hand, expenditures involved:

### Benefits

—one-time results by

- savings from fixed assets sold
- savings in operating costs
- savings from further investments not required
- savings in production floor space

—increase in profit by

- higher production output, improvement of production structure and quality
- prime cost reduction
- redevelopment of manpower released
- other benefits emerging in the pre-production and post-production fields.

### Expenditures

—investments for

- Industrial Robots
- qualification of Industrial Robot specialists and manpower to be released
- other onetime expenditures in the pre-production and post-production fields to ensure the full efficiency of Industrial Robots

—operating costs

- costs related to machinery used:

amortization

energy

indirect material

maintenance

production floor space

tools

• costs related to manpower

wage costs

other costs

• costs related to production

basic material

transport

quality inspection

technological preparation and programming

low product quality

product quality claims.

Based on the analysis of the different cost factors we can establish the efficiency by division of benefits and expenditures. This can be demonstrated in a formula:

$$\Delta E = \Delta \frac{B_p(B_o + P)}{A_p(A_o + A_c)} > \Delta \frac{B_b(B_o + P)}{A_b(A_o + A_c)}$$

legenda:

$\Delta$  = rate of increase

$E$  = efficiency

$B$  = benefits

$A$  = expenditures

$P$  = increased profit



$o$  = one-time

$c$  = current

$b$  = basic period

$p$  = utilization period planned (Industrial Robot)

### 3. Consideration of Social Effects

Industrial Robot introduction may enhance social progress in many directions. Also we, under socialism, do not automatically meet this great challenge in the development of human society, but all its main and side effects have to be carefully planned and accomplished. This social objective confronts us with some new theoretical and practical problems.

In the past, any evaluation of economic benefits was restricted to a mere calculation of direct material cost effects. Our new approach is to take social effects into consideration, too. In our definition, social effects could be the following:

Effects in the working process created by the introduction of new technologies suitable to enrich the working characteristics of individuals, to improve working conditions generally, to reduce work hazards as well as to increase the motivation of workers towards higher performance.

These fundamental social changes often create an additional category of economic effects. These effects may sometimes result instantaneously and in a direct way, but, in other cases, effects are felt at a later date or they are more indirect ones.

In our experience and concepts of social life we have accepted the task of planning such effects for the benefit of individuals and

society as a whole. In a word, we want that social changes for the better of effectiveness in our economy become an integral factor.