PROFITABILITY AND INDUSTRIAL ROBOTS

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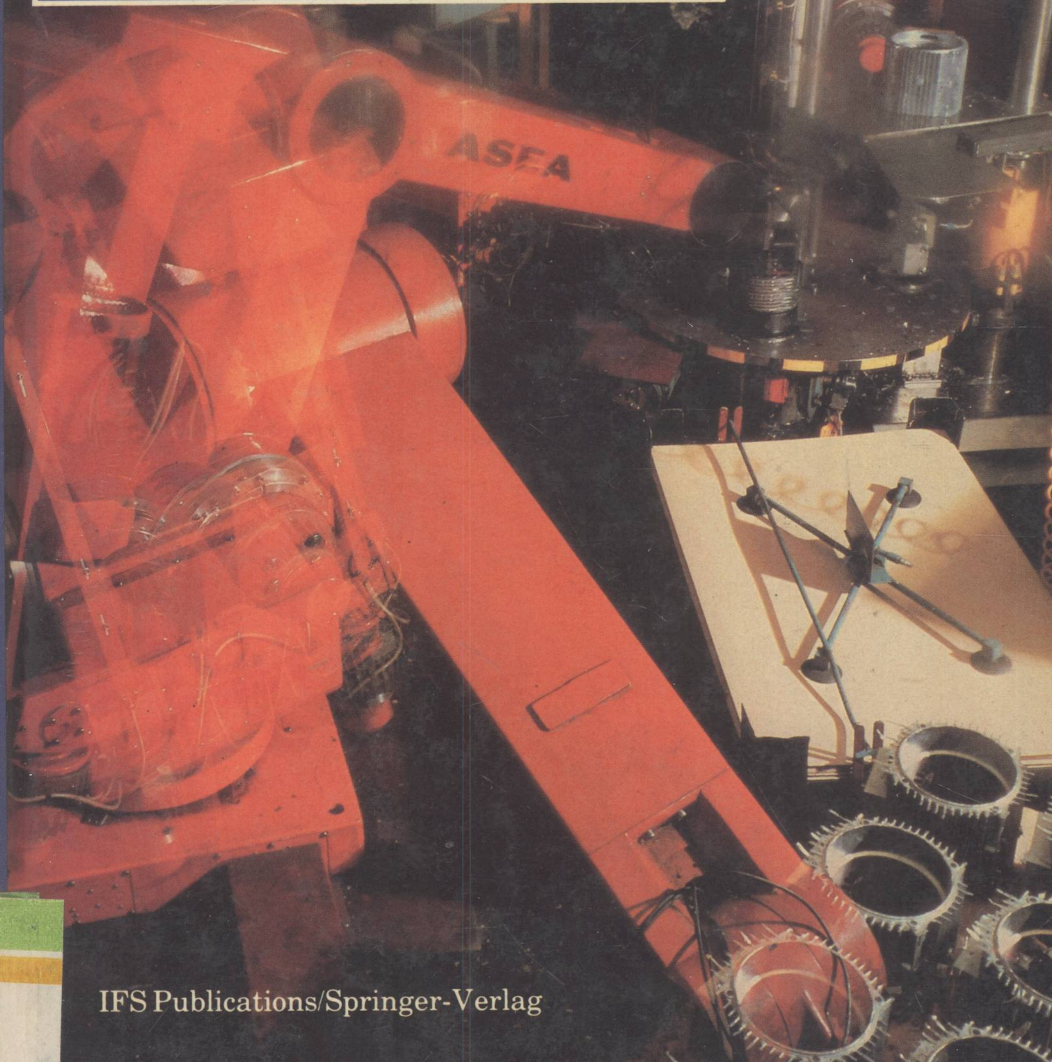
M. Svensson



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The authors

Gösta Martins is on the staff of ASEA Production Development, a company that is part of the Swedish ASEA group concerned with production engineering and shop-floor equipment, which has been responsible for most robot applications in ASEA's own workshops. He has been involved in this work since the first installation went into service in 1970, and has also been a popular speaker at courses in robot applications.

Morgan Svensson runs his own consultancy firm specialising in the project management and supply of robot applications. He is a former employee of ASEA, where he worked on the purchasing and commissioning of NC machines, and on the project engineering side of robot applications.

Preface

Production equipment must meet two demands: it must do the job, and it must be profitable. An installation that is badly engineered will never be a financial success, even if the preliminary costings showed that it would be profitable. The ability to engineer an installation is therefore a prerequisite for good profitability.

Correctly used, industrial robots offer great potential for flexible and profitable automation of production and for providing interesting work for the personnel whose job it is to look after them. The equipment must be profitable for the user, but it must also provide a reasonable profit for the supplier and for the firm that engineered and installed it.

The thinking outlined above is reflected in the structure of this book. Its aim is to help project engineers at users', consultants' and robot manufacturers' establishments to design industrial robot applications into production systems that are profitable to the company, by exploiting the potential for rationalisation that is offered by the use of flexible industrial robots, by carrying out preliminary studies and estimating profitability, by carrying out project engineering and installation, and by adapting products to suit flexible automatic handling equipment.

I hope that those who wish to learn about the potential of robot technology to increase the efficiency of industrial production, particularly in the manufacture of small batches, will benefit from the book, and I also hope that it will be used in technical colleges and similar establishments.

Morgan Svensson contributed Chapter Five ("Carrying out the Project"), and the last two examples cited in Chapter Three. These sections of the book are based on his experience of engineering and delivering robot applications, with responsibility for their operation.

My own experience is in the project engineering and installation of robots at ASEA's workshops. The contents of my parts of the book largely consist of edited versions of lectures and courses which I have given over the twenty or so years in which I have been involved in workshop automation and industrial robots. Parts of the book were published in 1986 in Swedish, in the form of a book issued by Sveriges Mekanförbund (the Swedish Association of Metal-Transforming, Mechanical and Electromechanical Engineering Industries). This material has been added to and partially revised for publication in English.

Gösta Martins

Contents

Chapter One

Requirements for profitability

What makes an installation profitable? A profitable installation is characterised by:

- Well-chosen work.
- A good technical solution.
- Good potential.

These three features are reflected in the structure of this preliminary, summarising chapter. The message that this chapter is intended to convey could be said to be: simplicity works well. To create simplicity, there must be a clear objective that is understood in the same way by everyone involved in attaining it.

Well-chosen work

Start by considering first the company's needs, rather than the possibilities and limitations of particular equipment.

Defining a clear objective

The objective of an application is to create a profitable and reliably functioning installation. This is a common objective for both the user and the supplier. In order to be able to work towards this objective, the supplier must know in what way the installation contributes to increased profitability for the user and his or her company.

The reasons for considering it important to determine at an early stage the objectives of an installation are based on the following experience. The simpler the installation, the fewer the breakdowns. All automation is inherently complex, and each part must therefore be as simple as possible. Achieving simplicity requires a clear and unambiguous objective. If such an objective exists, inessentials that complicate the solution can be eliminated.

But it must be an objective that everyone involved in the creation of the profitable application understands in the same way. Supplier, planner and user must work towards the same objective.

Start from the prerequisites and needs of the user and break down the overall objectives into operational ones. When this has been done, you can begin to discuss the extent to which different systems are capable of meeting the objectives. The customer should not determine in detail what the system is to look like. That is the business of the supplier/planner. The customer should lay down the ultimate requirements and specify the preconditions.

It is important that automation should integrate well with the other activities of the company, and suit the workshop environment and the production flow. Planners must therefore get a clear idea of what happens before and after the operation that is to be performed with an industrial robot.

Analysis of revenue possibilities

Arriving at a clear objective by means of discussion takes time, and it is therefore wise to begin by quickly assessing whether the installation is worthwhile; in other words, whether there is sufficient rationalisation potential to justify the capital outlay.

If this rough assessment indicates that the rationalisation potential is too low, the first step is to see whether the preconditions can be modified to improve it. If you begin to cut back on the capital investment, you often end up with poorer equipment and lose the other rationalisation effects that can be achieved through flexible automation.

You should first investigate whether the workload can be increased. If the appropriate workload is available, it is the job of the production engineer to use his or her imagination and know-how, and the inherent flexibility of the industrial robot, to create an economic and reliable installation. The available production volume can be increased:

- By combining a succession of operations.
- By bringing together different objects in the same installation.

Production capacity can be raised:

- By reducing the cycle time.
- By making use of unmanned operation outside the normal shift.

Do not be afraid of variant production; today's technology can cope with it. An example in which all four of these methods for increasing the workload were used is the production of brake parts described in Chapter Three.

After this, other potential methods of increasing revenue should be investigated, in particular how to exploit the advantages of:

- High machine utilisation.
- Short throughput time.
- Rapid resetting.
- High flexibility – both in method and design changing, in resetting and variant production, and where the product is modified or new.
- Low direct cost relatively independent of volume.
- Rapid capacity change.
- Disengagement of man and machine.
- Scope for simpler and more compliant production control.
- Improved working environment.
- More consistent quality.

These possibilities are dealt with in greater detail in Chapter Two.

Choosing an application

If a choice has to be made between several different applications, those that you have experience of, or that will enable you to benefit in the future from a repetition effect, should be chosen. Such a choice brings many benefits. In the case of repeat orders, assessment and cost estimation become more reliable, installation is quicker and reliability higher. You know what the problems are and can avoid them. Weak points can be improved on. This benefits both customer and supplier.

A "spearhead" installation should be intended to be the first of several similar installations: if it becomes an isolated phenomenon, neither the customer nor the supplier benefit from the experience gained. A spearhead installation should only be permitted to achieve lower profitability than the target set within the company if it will make future installations cheaper, so that they *will* achieve the target. Sometimes new applications have to be introduced; this is how development advances. Here too, experience can be a great advantage: for example, the planner's experience of robot installations and of the manufacturing process in question, as well as the customer's experience of automation and of his or her own manufacturing process.

A good technical solution

To ensure that the installation is worthwhile, when the supplier and user are agreed on the main objectives, an ideas sketch of the installation can be made. A good technical solution can then be produced, based on the ideas sketch and the objectives that have been set up.

Principal features

An installation with a good technical solution is characterised by the following features:

- Disengagement of man and machine.
- High reliability.
- Safety.
- Short setting time.
- Realisation of the flexibility potential of the industrial robot.
- Proper interaction between man and machine.

Disengagement of man and machine. This means that an operator need not intervene in each cycle in order to produce a given number of workpieces. This facilitates the design of a production layout in which the area of responsibility of the operator is extended, for example to cover punctuality, quality, a certain amount of maintenance, scheduling under the operating plan, and so on. This creates a more flexible production system and makes the work more interesting for the personnel.

High reliability. The personnel must be able to leave the equipment without incurring the risk of a machine stoppage that causes a lot of additional work or, worse still, a machine breakdown. If they cannot do this, the personnel will switch off the machine before they leave it. However, if there is a risk of the machine stopping, but it is easy to restart, it can run unmanned. The equipment must then be secured against catastrophes.

High reliability is mainly achieved by a thorough solution which is based on simplicity and clear logic. A complicated solution makes the work of the personnel more difficult both in operation and in servicing.

Reliability also depends on the quality of the workpieces, for example their dimensional accuracy and freedom from burrs. The equipment is designed for a given workpiece quality. If this quality is not maintained in service, the risk of machine stoppages increases. The required quality must therefore be determined and understood in the same way by the planner and by the customer before the order is placed.

This is particularly important when planning for automatic assembly.

Personnel safety. The installation must be safe while in use, during programming and during servicing. It must be possible for preparatory work on tool changing, magazine filling, inspection measurements, etc., to be done outside the working area of the robot.

Short setting time. A short setting time is even more essential in a machine group served by an industrial robot than for a single machine, since the group cannot be started until all the machines have been reset. The smaller the batches, the greater the need for a short resetting time.

Realisation of the flexibility potential of the industrial robot. The industrial robot replaces operations that are often performed manually, but this does not mean that the robot has to simulate all the motion sequences the operator does in order to perform the task that is to be automated. Ergonomically, the human being and the industrial robot are entirely different, and it is essential to be aware of this if you are to make full use of the flexibility of the industrial robot.

Proper interaction between man and machine. Automation will not work without people capable of programming the equipment, intervening when problems arise and carrying out repair and servicing work. Proper interaction between man and machine means that the installation is designed in such a way that these functions are facilitated and the personnel have confidence in the equipment.

Preliminary study

The more often you have to carry out an installation in a particular field of application, the better you can design the technical solution. No preliminary study is needed for such repeat orders, but it is important to adapt the application to suit the local conditions; in other words, to discuss the objectives with the customer.

In the case of new applications, a good technical solution requires close cooperation between the customer's engineers and the installer throughout the entire process. Planning is a creative activity in which discussion must be open, or the necessary simple solutions will not be found. For applications in new fields, a step-by-step preliminary study comprising the following stages is therefore recommended:

1. Drawing up an ideas sketch, together with a definition of any technical problems and a rough financial calculation.
2. Carrying out experimental work to check that the installation is technically feasible. Establishing a solution in principle of the defined technical problems, and a more certain costing.
3. Working out a final proposal (or tender) which must answer the following questions:

- What will the installation look like?
- What will it cost?
- What will its profitability be?

Chapter Four deals in detail with the various steps of a preliminary study and with aspects of cooperation between customer and supplier. Chapter Five covers the actual planning, i.e. the work on the application from order to delivery.

Good potential

The potential of an installation is good if it is working at least as well one year after commissioning as it did when it first took over production. By this time the personnel should be familiar with the installation and should have dealt with any minor problems that the planner may have overlooked.

This does not mean supplying installations with incomplete solutions. Obviously the equipment must, when supplied, conform to what has been agreed, but its design and the training provided must be such that the personnel can then take over and use its potential to increase its profitability.

The principal characteristics

An installation with good potential means an application that can be developed and that provides a workplace that functions well. It is characterised by:

- Tested operation.
- Proper introduction.
- Good documentation.
- Completed installation.

For the supplier, *tested operation* means, among other things, testing as much as possible at his or her factory before delivery, as well as thinking through the restarting process and the routines to be followed when problems arise, and ensuring that these routines are simple.

A *proper introduction* means that the personnel who are to take over – both operating and maintenance personnel – understand how the installation is intended to work, can identify the cause of problems and take appropriate action and, not least, that they believe in the effectiveness of the installation.

Good documentation means documentation in which it is easy to find the required information.

For the planner, a *completed installation* means providing advice during commissioning, and not simply accepting a situation in which the objective is not completely achieved.