INDUSTRIAL ROBOTS FOR SMALLER FIRMS

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The use of industrial robots in a small or medium-sized manufacturing firm is the subject of this article. The big auto manufacturers are already using these machines to paint cars, weld seams, and perform many other tasks. But do they make sense economically for smaller firms?

Industrial robots are machines controlled by a small computer program that have mechanical arms capable of moving in three dimensions, usually attached to mechanical hands, grippers, or tools such as paint sprayers or welding guns.

They have a computer memory which can record the sequence of operations so that the robot limb can be programmed to do the same operations repeatedly. Sometimes a computer program can be written to control the memory instructions, but usually a person uses manual controls to operate the robot limb, recording the proper sequence. Industrial robots are desirable in some situations, such as lifting very heavy loads or working in a hostile environment.

In a typical job the operator loads the machine, selects the workpiece or raw material, picks it up, makes sure it is correctly oriented, and positions it on the machine. He then uses a series of controls to unload the workpiece and place it into a bin, onto a shelf, or onto a conveyor belt. He may also inspect the product [4].

Some cautionary notes for smaller firms that are considering investing in this new technology:

(1) An industrial robot is just a machine and should be evaluated in the same manner as other industrial equipment. In fact, some of the robots that do pick-and-place operations used to be called transfer machines.

(2) When investing in novel technology such as robots or laser cutters a firm should use easier financial justification standards for investing in one new machine, but *tougher* standards for two or more due to the learning factor. Since there will usually be engineers and production workers who are intensely eager to learn the new technology, they will be able to get the "bugs" out of *one* new machine. New applications may suggest themselves only after the machine is on hand, hence can't be factored into the normal financial justification calculations.

In contrast, buying two or more novel machines at once (even at a discount) may prove uneconomical because of the incremental cost of removing the "bugs".

(3) "Be not the first by whom the new is tried, nor yet the last to cast the old aside." This poetic advice, when penned by the poet Alexander Pope a few hundred years ago, originally had a satiric intent. But it's good advice for the smaller manufacturer investing in new machinery. Sure, technology will never progress if no one is first. Someone has to be first. But why you?

(4) Industrial robots are more economically justifiable when there is a two-shift or three-shift operation, where the savings in labor costs should be more than the costs of maintenance and initial "teething troubles".

Economic justification also depends on relative labor costs. Auto companies, forced to pay high union wages for semi-skilled jobs, can more readily justify robotization than can smaller firms paying lower wages. Japanese companies with high land costs come closer to the breakeven point with any advance that economizes on factory space.

(5) You may actually save less labor than you think. With just one robot, you'll still need a full-time operator to watch over it and do repair work. When it's working right, you can add other associated tasks to the operator's workload, or assign him to watch over two or more robots.

Although it may not be as labor-saving as you originally hoped, a lot of the benefits will come from the consistency, reproducibility and flexibility of results. With a paint-spray robot, for instance, the operator "walks through" the procedure by moving the robot arms and recording the results on computer storage. By repeating this procedure a dozen times, the very best paint-coverage result can be chosen. Different paint-spray routines for different models can also be done and changed over at the flick of a switch.

(6) Industrial robots are still surprisingly poor at doing some things that humans can do.

Computer vision is still at the frontier. The robots can use television cameras to pick out simple patterns, but have trouble finding one part in a jumble of other parts.

Computer voice recognition is also rudimentary. You can train the computer to recognize several dozen words spoken by one operator, but it may malfunction for a different operator, a different accent, or the same operator with a hoarse throat.

Robotic touch, smell, and taste are also way out on the research frontier. Many robots are in fact "blind," they may spray the same area whether or not there is a part there, be prompted by simple signals such as the interruption of light beams, or stop sensor knobs that turn off the power when the robot bumps into something.

(7) Often, there are simpler ways to solve a problem. Suppose we consider a very old example from Barnes [3]. The bolt and washer assembly was originally made in the following manner. Containers with the bolts, lock washers, steel washers, and rubber washers were arranged on top of a bench. The operator reached over to the container of bolts, picked up a bolt with her left hand, and brought it up to position in front of her. Then with the right hand she picked up a lock washer and placed it on the bolt, followed by a flat steel washer and a rubber washer. This completed the assembly, and with the left hand the operator disposed of it in the container to her left.

Current robots would be unable to pick up the bolt and washers from the containers. Moreover, Barnes has a better method that saves 35% of the time using a cheap workbench fixture with two countersunk holes into which the washers can be slid, enabling the worker to make two items at a time.

For large quantities, an expensive shake-and-shimmy conveyor belt can be purchased that rattles the bolts and washers into slots so that they are positioned properly for assembly. But for small quantities, the best method is the flexible human being.

Another example is a job where small rectangular items on a conveyor belt had to be turned over so they could be painted on the other side. One day, the foreman noticed that the man assigned to this dull job was standing completely motionless, apparently goofing off. Approaching closer, the foreman saw that the worker had his finger out so that every package hitting his finger flipped over and went on its way. So, they were able to replace this guy with a little wooden peg.

(8) Sometimes, there are simpler ways of designing a product. Value Analysis, an engineering technique of re-evaluating the design of an existing product, can often lead to substantial labor reduction through the use of fewer parts and easier manufacturing techniques. You obviously would want to investigate these possibilities before investing a lot of money in robotizing existing processes for existing products.

Economic Justification Analysis

Industrial robots can be analyzed basically like any other machine. Koren's approach [10, p. 273] is: Let R = robot cost, G = robot grippers, S = sensors, F = feeders, D = layout changes (initial costs), M = annual maintenance cost, L = labor saving ($/year), Q = quality improvement value, and I = production increase (values in $/year). Thus, total capital investment is $C = R + G + S + D + F$, total annual savings $A = L + Q + I$, and Payback period $P = C/(A - M)$. The labor savings (L) would of course be greater if a two-shift or three-shift operation could be assumed. The payback period can then be compared with the expected lifetime of the machinery.

More complex financial analysis would assume an interest rate i and machine life n years (a 5-year lifetime would be a reasonable conservative assumption). The ROI (return on investment) or the net present value could then be determined by standard financial analysis techniques.

As Koren points out, however, "The introduction of the first robot into a plant should not always be done on an economic basis alone. Considerations such as ease of installation, high confidence of success, introducing robots to employees, and education of maintenance people should play an important role in the decision process. With the first installation you are not only looking for success, but you are laying the groundwork for additional robot usage."[8, p. 276]

Strategic Analysis

Before such economic analysis is even attempted, however, some strategic analysis must be done to ascertain whether a small firm can afford the gamble. Suppose firm A has 50 employees, 3 of whom are engaged in spray-painting the products; while firm B has only 10 employees, one of whom does painting part-time. Not only would the labor savings be less for firm B, but a spray-paint robot would be more of a "bet-your-company" gamble.

There are also questions of product/market mix stability. If product design is very stable, investing in automation can be more readily justified. More often, small firms are competing in small market niches where success depends on the ability to "turn on a dime", and where the product is continually being modified and improved.

CONCLUSION

In conclusion, industrial robots should be carefully evaluated, except that an initial application should be subject to easier justification because of the technology learning factor. The job to be robotized should also be carefully studied to prevent automating a job that should be eliminated or combined.

An excellent explanatory book for those starting out is the one by Engelberger [4].

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