Will Robots Kill all the Remaining Manufacturing Jobs in the USA?

Introduction

A recent study by a group of students at MIT set out to find the extent to the which robots have replaced people on the factory floor in the USA. Instead of finding armies of robots twittering away to each other in Japanese and Chinese, they found:

- One manufacturing plant in Massachusetts purchased one robot
- One plant in Vermont had purchased two
- And one plant in the mid-west had purchased five - but that company was Japanese owned and operated.

Other than that, there was nary a robot to be seen.

So, what is going on here?

Is the US hopelessly backwards relative to the rest of the world?

The answer is a resounding NO!

The offshoring of the USA's manufacturing base started with the Japanese in the post Korean War era in the 1970's and expanded steadily to other Asian countries. Then once China became a member of the World Trade Organization in 2001, all remaining long-run manufacturing of standard products rapidly moved to China, where its lower wage rates and lax ecological standards resulted in significantly lower costs.

As a result, many manufacturing plants in the USA went out of business, because they could not compete. This resulted in the destruction of millions of high paying manufacturing jobs in the USA and the hollowing out of many of our once-great cities.

Manufacturers that did survive quickly became experts in short-run, quick-turn manufacturing as they learned to focus on products that were too heavy to economically air-freight from China and there was a need for delivery in less than the standard 6-week shipment time from China to the ports of LA or Portland.

By a weird irony of fate, these manufacturers have been helped by the Amazon effect, where everyone wants products that meet their specialized needs delivered next day (or at least in a few days). As a result, most mid-sized US based manufacturers use/make a standard set of intermediate materials from which they are able to produce and quickly deliver a wide-range of finished products on short notice.

One client of ours makes large roll-on/roll-off dumpsters out of ½" steel plate. They make these dumpsters in five different standard sizes, with primer paint, and without any attachments. Then

they use these intermediate products to rapidly deliver finished custom dumpsters, each weighing many tons, painted in the color of the customer's choice, with about 80 different combinations of lids, doors etc. available, all within about 48 hours. Try doing that from the Guangdong province in China.

Yes, this company does use "robots", but they are not humanoid robots wandering around the shop floor or robots with big articulated arms. Instead, they use CNC (computer numerically controlled) flame cutters and machine tools to make their parts. The reason for this is that they can use CAD (computer aided design) software to quickly design a custom part and then have the CAD software spit out a CNC program to automatically make the part.

We see the same pattern with many of our clients, whether they are machine shops or make components for architect designed curtain-wall windows in skyscrapers, custom fitted kitchen cabinets, or custom Corian countertops. They all start with a CAD design, and use CNC machines to make parts which are manually assembled, and then quickly shipped or delivered to customers.

Yes, if you want an iPhone or a plastic rubber ducky, the Chinese manufacturers are very good at this, and will reign supreme in long run manufacturing for the foreseeable future, unless Globalization collapses, as it has done periodically since 1700 BC (and probably before that).

The surviving manufacturers in the USA are very good at in-market, short-run, quick-turn manufacturing and, in fact, have a greater total dollar-value output than all the Chinese manufacturers combined, without the "benefit" of robots.

So why don't our Manufacturers use Robots?

The answer is that industrial robots, despite what our popular media think, are pretty dumb machines that have to be programmed in great detail for every aspect of the task they need to perform. This works well when you have robots spot welding standard car bodies. It works terribly in a make-to-order, rapid-delivery world where everything can change on a dime.

In one system that I worked on, we automated the cutting, wrapping, and labeling of bolts of cloth for Walmart. At the end of a line was a large yellow robot that stacked the bolts of cloth on different pallets depending on the needs of different Walmart stores.

All worked well until someone changed the products being made but neglected to "tell" the robot about the changes. As a result, I got a panic-struck call and rushed down to the plant to see a huge pile of product falling off the end of the conveyer belt while the robot was flailing its big yellow arm about, as it could not make up its mind as to what to do with all the new products coming down the line.

Despite great strides made by robot manufacturers, it still takes expensive engineers to maintain and program the robots, especially if the tasks it has to do change frequently.

Programming for most CNC machines, on the other hand, is generated automatically with most CAD software. As a result, they are very flexible and do not need people to spend any time generating the CNC program, once the customer has approved the design.

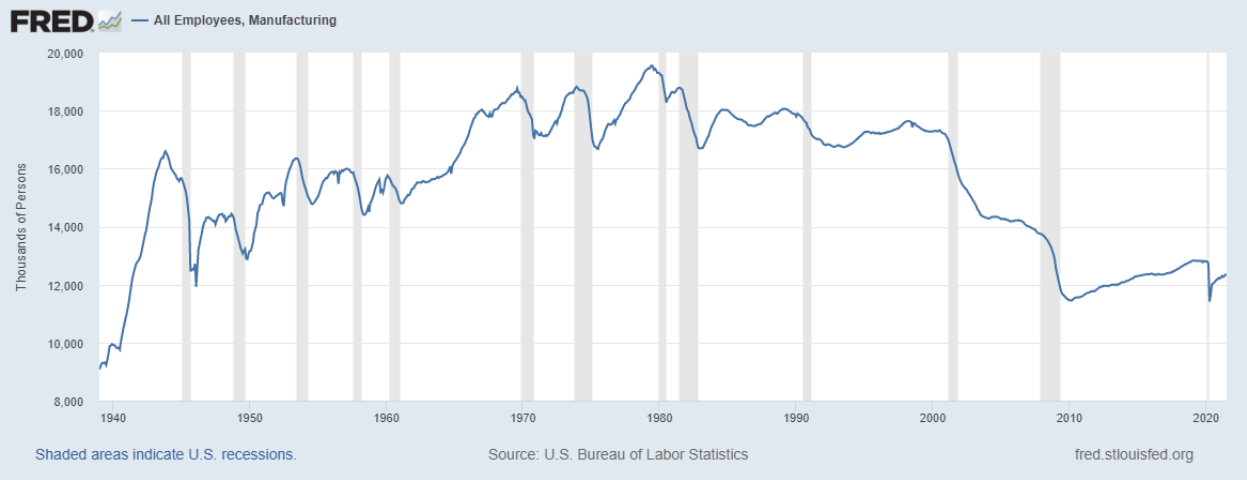
The big difference here is that robots are expected to do complete tasks, including automatically handling all possible situations that could arise, which can get very complex. The CNC machines, on the other hand, are there to assist to machine operator by automating the turning of knobs and feeding of stock and are not expected to handle a situation like a broken tool, which is why the operator is there.

As a result, CNC machines are simpler, typically less complex, less costly, and are often created by adding CNC controllers to older custom machines, which were once were manually operated. The same applies to PLC controlled process lines, which are also controlled by programs or data automatically generated and downloaded from some other software to control the actions of the process line.

By combining the skills of people with automated machinery, we arrive at a very flexible but efficient combination. By contrast robots, which are designed to work without human support, are not very flexible.

As a result, in the USA where we mostly do quick-turn, short-run manufacturing, there will be an increase in the number of skilled people needed to setup, maintain and operate these semi-automated systems. But there is unlikely to be a significant increase in the number of robots in use.

Where have all the Manufacturing Jobs Gone?



If jobs have not been displaced by robots, where have they gone?

According to the Federal Reserve, there are currently 12 million people employed in manufacturing in the USA, down from a high of nearly 20 Million in 1980. Much of this reduction has been due offshoring of long-run standard product manufacturing. But a significant part, in the remaining short run, quick-turn manufacturers has also been due to automation, mostly in the form of CNC machines

Using CAD programs in combination with specialized CNC machines typically results in far fewer jobs on the factory-floor. One long-term client of mine used to have 70 or 80 people operating machines on the shop floor. Last-time I went there, there were just 6 people running CNC machines and putting out twice as much product on a quick-turn, make-to-order basis as

the previous 70 or 80 people had. Yes, these 6 people are highly skilled and well paid but there are far fewer of them.

In another case, which I am very familiar with, an envelope manufacturing company used to have 300 people on the factory floor and now has a couple of dozen people running highly automated machines.

In a couple of cases, I have gone out on the factory floor, and seeing very few people, asked if they were on break or shutdown. No, they reassured me, they only need very few people to run the machines. In fact, in many cases, there were more material handlers bringing raw materials to the shop floor and taking away finished product, than there are machine operators.

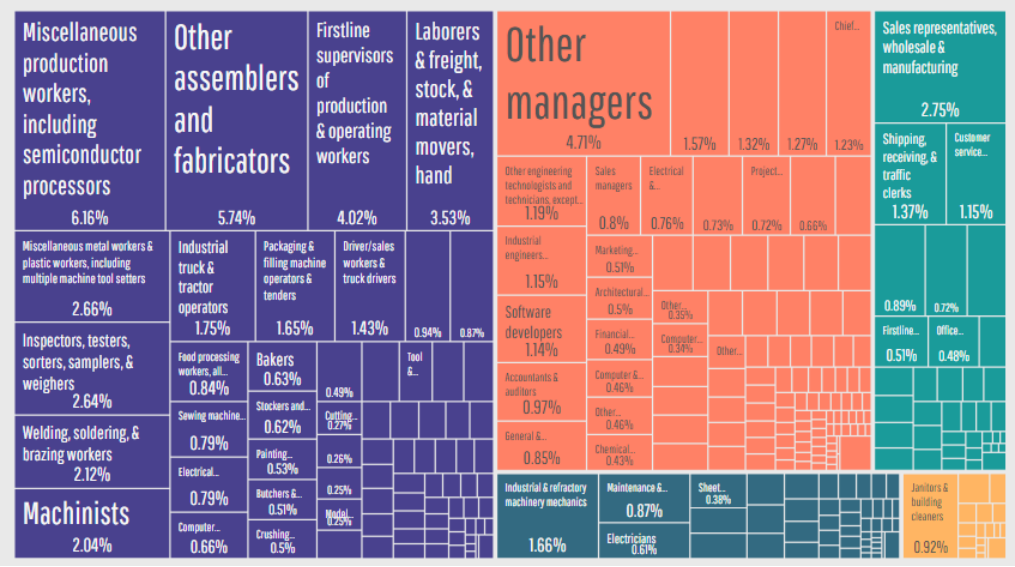
Where are the High-Paying Jobs are in Manufacturing?

There are about 3,500 large manufacturing plants in the USA (think GM or Tesla) which do long-lead-time, but still flexible, manufacturing using classical robots to assist people. These plants are highly automated, computer controlled, and run very efficiently, at least until something goes wrong. They are not a big source of manufacturing jobs any more.

Most people in manufacturing are employed by the 60,000 or so mid-sized plants in the USA, with have a throughput of between $10 Million to around $100 Million per year. These plants typically employ between 10 to 50 people each in making products to order.

There are also a couple of hundred-thousand smaller “job shops” which range from some 3D printers in someone’s basement to small machine shops that feed the larger plants. These small plants typically only have a handful of people making products.

But, as can be seen from the data shown below from the Census Bureau, the people who are actually making products on the shop floor only account for less than half of the people in manufacturing, even when we include materials handlers, quality control inspectors, and similar people who are not running machines or other equipment but are working in supporting roles.



The rest are high-paying “white collar” front-office jobs, some of which are becoming increasingly vulnerable to automation.

Will Automation Eliminate White Collar Jobs in Manufacturing?

Will automation have a significant impact on the over six million high-paying white-collar manufacturing jobs in the USA? The answer is undoubtedly yes, but these people will not be replaced by humanoid robots. Instead, better information technology, and especially decision support systems, will provide the information and advice that the managers need to do their jobs with fewer support people.

Some of the important "front office" roles in mid-sized manufacturing plants, which provide the bulk of the "white collar" jobs are:

1. Owner/President/Plant Manager
2. Chief Financial Officer/ Accountant/ Comptroller
3. Sales Manager, possibly managing a sales and marketing team
4. Production Manager – manages making products – may have multiple department managers as direct reports.
5. Materials Manager/Supply Chain Manager/Purchasing Manager
6. Warehouse Manager – typically responsible for receiving, picking, moving, and shipping raw, intermediate and finished goods.
7. Product Engineering – uses CAD software to generate CNC programs for customer orders.
8. Manufacturing engineering and facilities management – responsible for all production automation equipment and especially new equipment and production line deployment.
9. Human resources – to handle all the regulations and litigation relative to employees.
10. Information technology – mostly outsourced with a single in-plant manager.

As with the replacement of typists by people typing their own documents using a word-processor, so we are seeing a reduction in the number of support staff required in each of these roles due to information technology.

Some examples:

1. Displacement of many direct sales activities by E-Commerce
2. Reduction in needed production planning support staff with the use of automated real-time scheduling and planning software.
3. Replacement of expeditors, chasing down the status of customer orders, with the use of barcode tracking systems which provide the real-time information needed by customer support and sales people, as well as that needed by production managers to make sure that customer orders shipped on time.

4. Replacement of front-office staff manually entering production, inventory, and warehouse data into an ERP or accounting system from paper forms, with data from a real-time shop-floor operations tracking system.

5. Elimination of supervisors whose primary function is to "walk-the-floor" to spot when production problems are happening. Now this function is being replaced with automated monitoring systems that can send alerts to the production manager or other people when there are situations that need attention.

What we are seeing, as a result of this automation, is a reduction in layers of management and the elimination of support staff through the application of information technology. Again, this is not being done by robots but by the ever-increasing use of computers to provide the information needed by managers, when needed, to enable them to do their jobs very efficiently without an army of support staff.

Commentary

Immediately post World War II, the USA was the leading manufacturing country in the world, as the manufacturing plants of most other countries had been bombed out of existence. High paying jobs were plentiful and the US Manufacturers could command high prices for their products as they had little or no competition.

In 1968, relatives of mine were being paid $28/hour to work on the line at the Oldsmobile plant in Flint Michigan. According to the US Bureau of Labor Statistics this is equivalent to $218/Hour today. These blue-collar workers owned their own homes, had a cottage with a boat on a lake up on the Michigan peninsular, purchased two new cars every couple of years. They had a stay-at-home wife, worked 40 hours a week, and had full medical benefits.

Today, the same semi-skilled worker counts himself lucky to get $28/Hour and is seeing a landscape where there is little job security. He and his wife both have to work full-time to make ends meet, medical insurance is far less generous, and they both have to drive 12-year-old cars.

What we are seeing is manufacturing plants being transformed from the source of well-paying employment for masses of unskilled people back in the 1960's, through the wasteland era from 1970 through 2010, when many of these people were laid-off, to today where a small number of highly skilled people run manufacturing plants with a high-degree of assistance from information technology but little, if any, assistance from robots.

This is akin to the transformation that has taken place in agriculture, where the hundreds of serfs (my forebears) who would have toiled in the farmer's fields are now replaced by the farmer driving round his fields in the air-conditioned cab of his "tractor", trading farm produce futures, while the "tractor" automatically plows, sows, and then harvests the farmer's fields.

Manufacturers are currently short about one million skilled trades people needed to make products. This gap is expected to grow to about two million within two years as many "baby-boomers" retire. In order to attract new recruits, manufacturers are going to have to pay at least $70,000 a year and possibly over $100,000 a year for skilled trades people to run their machines.

To make this investment pay-off, manufacturers will have to make sure that these skilled trades-people operate very efficiently with extensive use of CNC equipment to make the products and

real-time information system to handle all the paperwork, record-keeping chores that can waste valuable (and very expensive) time.

The days of the $15/Hour machine operator are long gone. Now we are reaching the point where the skilled trades people that operate the CNC machines will be paid far more than their fellow white-collar workers, who went to college and now have large student debts.

Recent studies have shown that, in most cases, the way to a good middle-class life is through trade-school and not through going to College and incurring massive debt to get a fancy degree. Now all we have to do is to get our young people to hear this message if manufacturing is to survive and thrive in the USA.

Author

This white paper was written by Dr. Peter Green, who serves as the Technical Director of KnarrTek Inc. and Milramco LLC. Dr Green obtained his BSC (Hons) in Electrical Engineering and his Ph.D. Degrees in Electronics and Computer Science from Leeds University in England. Subsequently Dr. Green was a senior member of technical staff at Massachusetts Institute of Technology and a Professor of Computer Engineering at Worcester Polytechnic Institute. He has also been a member of the senior management team of eight high-technology start-ups or early-stage companies.

Dr Green is an expert in real-time materials tracking and operations management within industrial organizations. He is a systems architect and led the team which developed the BellHawk job and materials tracking software and MilramX decision support software. Over the past decade Dr Green has also led the implementation of over 100 systems, based on BellHawk and MilramX, to assist manufacturers and other industrial organizations to improve the efficiency of their operations and to increase sales through improved customer satisfaction.

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