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Study of an Industrial Robot

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Assignment No: 7

Study of an Industrial Robot

CASE STUDY ON INDUSTRIAL ROBOTS

INTRODUCTION:

Today's manufacturers in numerous industries are gaining rapid increases in productivity by taking advantage of automation technologies. One of these automation technologies, robotics, is a key factor leading the way in the twenty-first century. Firmly established as a critical manufacturing technology, robotics is gaining acceptance by the workforce, gaining praise for its reliability, and being utilized more extensively in medium and small companies.

As manufacturing assembly has grown increasingly complex, the need for new and expanded capabilities, particularly in automated assembly systems, has become evident. As components get smaller, as in micro-manufacturing, it is required that greater precision, more flexibility and higher throughput are achieved. Manual assembly no longer suffices for a great many of manufacturing's current requirements. Functions formerly performed by humans, especially difficult, dangerous, monotonous, or tedious tasks, are now often assumed by robots or other mechanical devices that can be operated by humans or computers. Robots can take the place of humans in extreme settings or life threatening situations involving nuclear contaminants, corrosive chemicals, or poisonous fumes.

While the automotive industry is the largest market for robot manufacturers, other industries are increasing their use of robotics. According to reports from the Robotics Industries Association, industries such as semiconductors and electronics, metals, plastics and rubber, food and consumer goods, life sciences and pharmaceuticals, and aerospace are all finding ways that their services can be enhanced and improved through robotics.

Some of these manufacturers are also improving the quality of their products by using robots with powerful machine-vision inspection equipment or by linking their robots to statistical process control systems. Robot fixtures can move quickly and fluidly without sacrificing accuracy. Servo-driven positioners can be programmed to handle more than one model on the same line, something especially important to lean organizations. This programmability also allows its users to set up the systems again and again for different applications. In most cases, converting robots from one application to another can be completed with minimal downtime, requiring only programming changes. Benefits include reduced capital expenses (you don't have to buy new fixtures for new applications), floor space requirements, lead-time, component expenses, and training investment.

A BRIEF HISTORY OF ROBOTICS:

George Charles Devol is often called the father of robotics. He invented the first industrial robot, the Unimate, in 1954. A few years later, Devol and Joseph F. Engelberger formed the first robot company, Unimation. In 1960, Unimation was purchased by Condec Corporation. General Motors installed the Unimate for die casting handling and spot welding in 1961.

Modern industrial robot arms continued to evolve in the 1960's and 70's. In 1963, the six-jointed Rancho Arm was created to assist handicapped. This was followed by the tentacle arm, designed by Marvin Minsky in 1968. It was able to lift a person and had 12 joints.

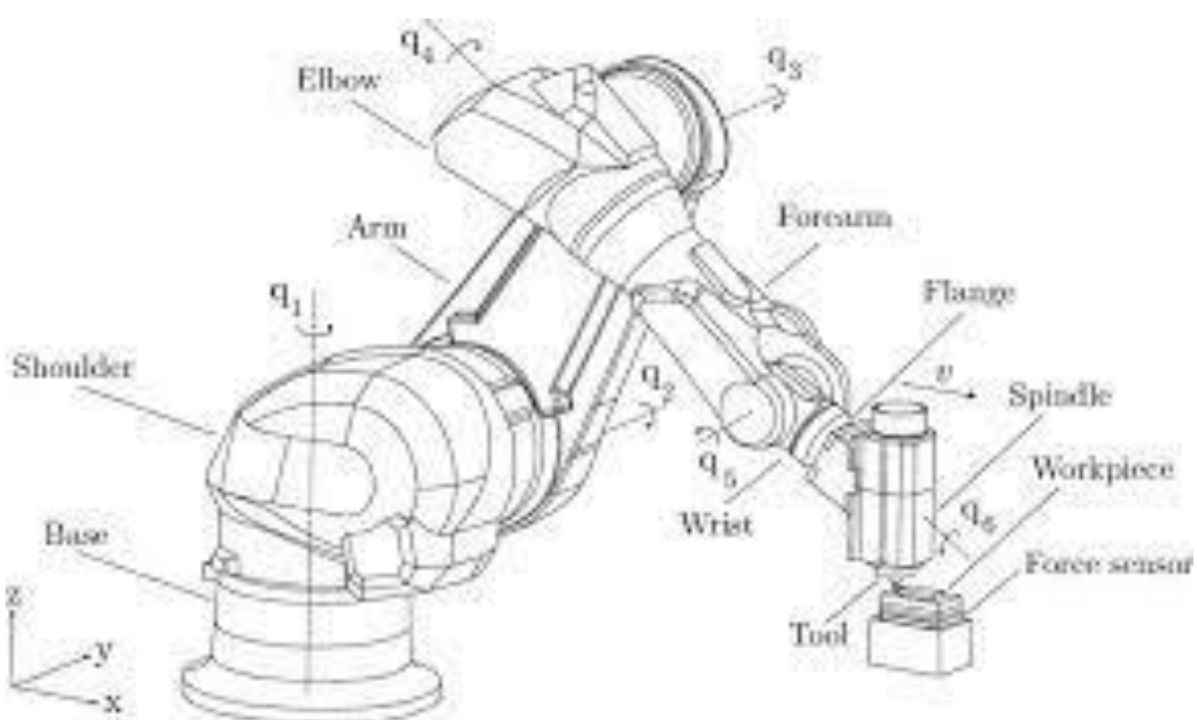
It was the 1969 Stanford Arm that eventually led to commercial arm production. The Stanford Arm was one of the first electronically powered, computer-controlled arms. By 1974, it reached a level of sophistication where it could assemble a Model T water pump.

The Stanford Arm was followed by the Silver Arm in 1974. The Silver Arm was created by MIT's David Silver to perform precise assembly using touch and pressure sensors and a microcomputer. These arms led to Victor Scheinman, the inventor of the Stanford Arm, to form Vicarm, Inc. in 1974 to manufacture industrial robotic arms. Scheinman was instrumental in the creation of the PUMA (programmable universal manipulator for assembly) for Unimation. In 1977, the European robot company ASEA, built two sizes of industrial robots.

Despite the fact that robotics technology was developed in the United States, Japan became the first nation to actually embrace robotics; many observers view this as a significant factor in Japan's emergence as a global manufacturing power. Today Japan is not only one of the major users of manufacturing robotics but it is also the dominant manufacturer of industrial robots.

In the early 1980s, 70 percent of robot orders were for use in the automotive industry. During this time, robot manufacturers simultaneously improved their reliability and performance and sought to lessen their dependence on the automotive industry by focusing on specific niche markets. By concentrating on applications other than spot welding, painting, and dispensing, the robotics industry was able to develop products that could successfully handle not only assembly, but also material handling and material removal. Spot welding, which for a long time was the major application of robotics, eventually was eclipsed by materials handling. This was a clear indication that the robotics industry was indeed becoming less dependent on the automotive industry, since materials handling is used in a wide and varied range of industries. Additionally, non-manufacturing applications started to become viable in such areas as security, health care, environmental cleanup, and space and undersea exploration.

Advances in robot control technology, simulation, and offline programming made robots easier to program, maintain, and use. Simulation use allowed for the discovery of potential problems before the robots were actually installed.



WORKING AND INSTALLATION :

Traditionally, the automotive industry has been the largest employer of robots. We look at a couple of robot applications in their spiritual home!

Jaguar Cars has transformed its traditional car body seam sealing, soundproofing and under-body sealing operations at its Castle Bromwich plant, by installing an automated six-axis ABB robot-based facility.

Installation of the robots began in February 2005 and the facility, which has a throughput of 43 vehicles per hour, has been in full operation since June 2005. It is fully automated, with no operator intervention required during normal operating conditions. Operation of the facility is split into three 'sealing' stations. It can process the complete range of Jaguar car bodies – including the XK sports car, the S Type and the XJ saloon, both standard and long wheel base.

The skid-mounted car bodies pass through three stations. At the first station, three seam sealing robots spray a PVC plastisol material at a temperature of 30°C within the interior and luggage compartment spaces of the body, to seal against water ingress and wind noise. Three IRB 4400 robots, with a 45kg payload, are designed with a long reach, allowing them to enter each car body to access body seams. The robots are mounted on linear track systems to further increase their flexibility. Two of them conduct sealing operations from either side of the rear passenger compartment, then track forward along the track and access the forward passenger compartment, while the third robot tracks across the rear of the body, sealing the luggage compartment. After seam sealing, the car bodies are transferred to the next station, where three more robots spray an epoxy-based, solvent-free material, at a temperature of 60°C, to reduce noise, vibration and harshness. Previous spraying methods at the facility involved the labour-intensive insertion of bitumen pads.

After seam sealing and sound insulation operations, the car bodies move on to an under-body sealing cell, incorporating two IRB 2400L robots with a 10kg payload. As the body moves through the station, the robots carry out a combined seam sealing and underbody coating operation, applying the same PVC plastisol used for internal seam sealing.

Once the under-body sealing application and curing is complete, the car bodies move on for the application of primer, base coat and clear coat. Here the robots are equipped with dispensing systems that incorporate both material conditioning and flow control. ABB SPA 400 (swivel pointer applicator) spray guns are used – each is equipped with three separate nozzle types that can be individually selected, depending on the area to be sprayed. A wide 'fan' configuration may be required for coating areas, while seams may need a very narrow, flat stream, so the robots are able to switch instantly from one nozzle to another, all co-ordinated by the ABB robot controller.

Positional accuracy :

Positional accuracy of each car body skid is ±15mm – not sufficiently precise for optimum quality. An integral vision system was, therefore, incorporated to locate the actual position of the car body in relation to its ideal datum position. This then sends data to the robot controller to offset the positioning of the robots by the required margin. Additionally, the under-body robots are equipped with 'conveyor tracking' software and encoder input, so that they can determine the exact positional accuracy of the carrier as it moves through the station. If the carrier moves faster, or slower, or stops, the robot will offset its program to track the movement.

From spot to arc :

When automotive component manufacturer, Wild Springs & Wireforms, won the contract to manufacture the frame supporting the rear seat cushion in the latest Astra saloon car, Vauxhall specified that the wire frame should be arcrather than spot-welded. Full-volume production quantities of over 4,000 per week for delivery to the foaming plant, which in turn supplies line-side to the OEM at Ellesmere Port, dictated the use of robotic welding for the operation.

The company turned to Motoman for the supply of a twin-robot MIG welding cell with powered turntable, with the assistance of system integrator, Bauromat UK. The Astra seat frame comprises 11 formed components made from round, mild steel wire of 5mm diameter, which are placed by an operator into a bespoke jig. During this time, 20 welds are deposited by the two robots to produce the previous frame. The turntable then swings through 180° to present the unwelded assembly to the robots and the welded frame to the operator for unloading, ensuring almost uninterrupted production. TAKT time is one minute – around 25 per cent less than for an equivalent spot welding cycle.

Much of Wild's experience of seat frame manufacture had involved spot welding in robot cells for a variety of automotive manufacturers, including Jaguar, Land Rover, Range Rover, Nissan, Honda, Toyota and for the BMW Mini convertible. It does, however, have long experience in large volume, robotic arc welding of automotive products from 0.5 to 13mm diameter wire, such as seat parts, exhaust hangers and various components requiring sub assembly. Other products produced at the Redditch factory include float rods, trim wires and springs for doors, throttles and thermostats.

Hence, Robots in Automotive Industry contribute not only to the company's growth but also to its nation. In Germany, The automotive industry's manufacturers, suppliers, and service providers represent Germany's largest industry in revenue terms (EUR 293 billion in 2007). Almost every second industrial robot can be found here. Thanks to numerous new vehicle programs there has been a significant number of new robot installations in the last three years. Moreover, there will continue to be a strong need for equipment in all areas; especially in the area of material-handling robots due to the extensive wear and tear inflicted on the equipment over prolonged periods of use in this industry.

USES OF INDUSTRIAL ROBOTS:

Though less dependent on the automotive industry than in the past, the robotics industry still finds its widest application in that market. However, driven by the need for increased manufacturing efficiency, the automakers and automotive-related industries are moving away from hard automation in favor of flexible automation. Analysts predict greater use of robots for assembly, paint systems, final trim, and parts transfer in the automotive industry. Realistic robot simulation is making an impact by integrating vehicle design and engineering into manufacturing.

One reason for increased practicality of robots is the availability to control machinery and systems through personal or laptop computers. According to Waurzyniak, some advances in computer-guided systems are robots with force sensing capabilities and 3-D and 2-D vision-guidance capabilities. NASA is using sophisticated computer-guided robot controllers for its Space Shuttle Endeavor and the Mars landing craft. Each of these systems utilize computer control of some sort, ranging from simple machine-specific tracking, to shop-wide data collection across a variety of machinery and instruments, to galactic monitoring and control in a unique, outer space environment.

The Robotic Industries Association reports that an estimated 144,000 industrial robots are in use in the United States in 2004, up from 82,000 in 1998. In 2004, North American manufacturers purchased 14, 838 robots, valued at nearly $1 billion, a 20 percent increase from 2003 and the industry's second best unit total ever. There has been a 152 percent increase in new robots ordered and a 78 percent increase in revenue in 2004 as well.

The key factors driving this growth in robotics are mass customization of electronic goods (specifically communications equipment), the miniaturization of electronic goods and their internal components, and the re-standardization of the semiconductor industry. The food and beverage industry is also in the midst of an equipment-spending boom in an effort to improve operating efficiencies. Robot installations for such tasks as packaging, palletizing, and filling are expected to see continued growth. In addition, increases are anticipated in the aerospace, appliance, and non-manufacturing markets.

ADVANTAGES:

When we think of robots we think of the androids in Hollywood movies and on television. But in reality most robots don't look like C3PO or the Terminator. Most of the robots created today are just a series of mechanical arms or wheels with tools and sensors built in. They don't fit the usual stereotype image of robots that most people have. In the United States, 90 percent of the robots in existence are for use in the manufacturing field assembling and building products for consumers around the world. Of all of those robots more than half of them are being used in the automobile industry.

Over the past thirty-five years or so, robots have completely changed the automobile industry in many ways. Sadly, the use of these robots has also led to many people losing their jobs through cost effectiveness. But the robots have improved the industries with a job efficiency that just couldn't be duplicated by humans.

Robots have made assembly lines and factories safer by handling jobs that are too dangerous or too difficult for humans to perform without risk. Automation has dramatically altered factories throughout the globe. Modern industrial robots offer multiple advantages. They have single-handedly transformed products, facilities, and companies. Recent developments have made industrial robots more user-friendly, affordable, and intelligent than ever before.

Cost Effectiveness - The use of robots in the manufacturing area of the automobile industry has saved millions of dollars over the years. By replacing employees with robots, the automobile industry was able to double and triple their production times. In some ways it came down to simple money saving issues like robots not needing lunch breaks or bathroom breaks. Robots never call in sick or take vacations. Robots also don't require health insurance or request raises. A robot can work twenty-four hours a day without a break, and continuously perform the same mundane tasks over and over again virtually non-stop. Even with the expenses of maintenance and occasional breakdowns, robots just make more sense economically for the automobile industry.

Job Efficiency - By replacing human workers with robotic workers, the automotive industry was able to assure that certain jobs would be performed specifically to their expectations. Robots are not limited like humans when it comes to performing many assembly jobs like painting, finishing, welding, riveting, and installation. Robots also don't have restrictions with moving heavy objects or issues of fatigue. Barring any computer errors, robots will almost always get the job done quicker and more efficiently than a human possibly could. Robots are able to be programmed to perform precise intricate duties at much faster speeds than any human could be expected to.

Safety - One of the benefits of robots in the automobile industry is the elimination of humans needing to perform jobs that are dangerous or pose health risks. Because the robots are so efficient, there is no issue with human errors causing accidents or injuries to themselves and others around them. Robots are able to withstand exposure to extreme heat, chemicals in the air, and general physical contact with parts and structures. There are a lot of jobs that pose high risk to a human in the automotive industry that simply make more sense to have a robot perform. The use of robotics in crash-test dummies is also a job that a human would never be able to perform safely. Robots have simply made the work place a safer place by taking over these jobs.

Changing the Product - Robots perform applications with greater accuracy, precision and consistency. The product quality improves because of these increases

While it is a shame that many jobs that humans could perform are being taken by robots, it does make sense in a business environment to use robots to improve cost effectiveness, job efficiency, and safety. As technology continues to improve, so do the possibilities of more robots being used in the automobile industry.

Changing the Environment - Workers no longer have to endure dull, hazardous or taxing tasks. Robots handle toxic substances, repetitive and detail-driven jobs, and lift, carry and select products without tiring or stopping. Robots have prevented many accidents and waste - saving company money. The introduction of robots has led many workers to learn new tasks such as programming.

Changing the Company - The typical return on investment for an industrial robot is substantial and quick. Robots are tireless - leading to increased productivity and manufacturing cost cuts. Management control increases as well.

FUTURE OF ROBOTICS:

To some, the future of robotics has never looked brighter. Production of bipedal robots that mimic human movement are being created around the globe. Honda Motor Company's ASIMO (Advanced Step in Innovative Mobility) robot is considered the world's most advanced humanoid robot. It can climb stairs, kick, walk, talk, dance and even communicate and interact via its voice and facial recognition systems. Honda plans to one day market the robot as an assisted-living companion for the disabled or elderly.

Other robots that simulate human movement have been created at Cornell University, Massachusetts Institute of Technology (MIT), and Holland's Delft University of Technology. In a March 2005 article in *Machine Design,* the creators of the three robots describe the mechanics utilized in their designs and detail how their robots use less energy than ASIMO, although they do not have the range of capabilities of the ASIMO robot. These variations in mobility indicate promise and potential in a variety of robotic applications for the future.

Chip Walter's article, "You, robot", discusses renowned robotics researcher, Hans Moravec, Carnegie Mellon University scientist and cofounder of the university's Robotics Institute. Moravec is known for his longstanding prediction that super-robots that can perceive, intuit, adapt, think, and even simulate feelings, much like humans, will be practicable before the year 2050. His confidence in his predictions led him to open his own robotics firm in 2003, the Seegrid Corporation, to assist him in fulfilling his claims. His path toward that vision is to start simply—to create mobile carts with software and vision systems that can be 'taught' to follow paths and navigate independently. Moravec believes that machines will evolve in small steps, eventually reaching the levels of human intelligence and movement. His bedrock belief, on which he bases his technology, is "... if robots are going to succeed, the world cannot be adapted to them; they have to adapt to the world, just like the rest of us."

Stuart Brown reports that navigation technologies such as the global positioning system (GPS) are allowing industrial robots to move around in the world. GPS in conjunction with inertial navigation systems (INS) and the booming field of silicon micro-electromechanical systems (MEMS) are impacting robotics from simple automated lawn mowers to complex airplane control systems. Robotics are reaching the micro-level with the exploration of robotic water 'insects' equipped with biomechanical sensors that could be used as environmental monitors. The current prototype weighs less than a gram and draws power from ultra-thin electrical wires. An affordable and time-saving alternative to locating gas leaks has been developed in a pipe-inspecting robot crawler; equipped with multiple joints and video cameras, it easily navigates sharp turns and narrow pipes while projecting images of pipe integrity to a monitor. Plans for the future include a sensor that will detect corrosion and cracks in the pipes that do not appear in the video images.

In India, India’s 1st Robo Expo & 1st Robo Conference 2008 took place exclusively for the automotive sector at the 9th Auto Expo 2008.

India is fast emerging as a manufacturing hub with the automotive sector making remarkable contribution in last few years. Indian Automobile sector continues to grow in top gear and at present, USD 14 billion investments are underway in Auto sector in India. Robotics suggests a whole new world of automation with Robots taking on challenges in safety, productivity and quality. Robotics & automation are the need of this sector.

Cutting Edge technologies in Robotics will contribute to lead Indian Industry into the domain of innovation, setting them ahead in the race for safety, quality and efficiency. Robots can maximize productivity, quality, safety, reduce labor costs and overcome the increasing shortage of skilled labor in automobile manufacturing industries. To cater to this need of the automotive sector, CII – Innovation Mission organized the 1st Robo Expo 2008 concurrent with the 9th Auto Expo 2008 from 10th – 17th January 2008. The 1st Robo Conference was organized by Global Innovation and Technology Alliance (GITA) in close cooperation with Department of Science and Technology and CII on 14th – 15th January 2008 to tie in with the Robo Expo. With more than $14 billion in investments, India is fast-emerging as a leading manufacturing hub for the automotive sector.

Robots have come of age. While they were initially used for fairly simple tasks such as welding and spray-painting automobiles, these machines have increased tremendously in ability over the last decade, reaching further and broader than simple auto applications. Robotics will remain vital in the decades to come due to expanding scientific fields and increasing demand for more affordable and sophisticated methods of accomplishing common tasks.