

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

## A Survey on Role for Robotics - Sustainability in Manufacturing

Goparaju Atul

IV year B.E. Student, Department of Mechanical Engineering, MVSR Engineering College, Hyderabad, Telangana state, India

**ABSTRACT:** Sustainability has become something of a buzzword in modern manufacturing processes. Often requiring investment to bring about the changes needed, it presents something of a double-edged sword for companies seeking to enhance their reputation through sustainable practices whilst enhancing their competitiveness through reduced costs. There has been a recent push in robotics globally. This work makes an attempt at exploring the role of robotics in achieving sustainability in manufacturing. It describes the advancement made so far in applying robots to manufacturing- welding shot blasting, painting, and so forth, within the sustainability framework. This paper is an attempt at exploring the concepts for the role for robotics in sustainable development. Industrial robotics is often associated with an unsustainable economic model. However, robotics also provides qualitative benefits through its precision, strength, sensing capabilities and computing power.

**KEYWORDS :** Manufacturing robots, robot operation system, Sustainable development sustainable robotics, robot applications

### I. INTRODUCTION

Robots are changing the face of manufacturing. They are designed to move materials, as well as perform a variety of programmed tasks in manufacturing and production settings. They are often used to perform duties that are dangerous, or unsuitable for human workers, such as repetitious work that causes boredom and could lead to injuries because of the inattentiveness of the worker. Sustainability is the ability to develop and implement technologies/methodologies, which are self-sustaining without jeopardizing the potential for future generation to meet their needs [1]. Modern industrial robots application have contributed to the better management of production cost, performance and sustainability issues. Robotics for sustainable development remains an exciting challenge where research and industry in both developed and developing countries can both contribute and benefit [2]. The gains of sustainability using robots in manufacturing can help achieve, adaptability to a new task; automatically compensating for limited variability; meeting safety requirements and ability to be easily programmed by shop-floor workers [3].

The purpose of this paper is to highlight some of the achievement recorded with the use of industrial robots applications to manufacturing. Sustainability issues using robots as it applies to manufacturing will be addressed. Industrial robots are able to significantly improve product quality. Applications are performed with precision and superior repeatability on every job. This level of reliability can be difficult to accomplish any other way. Robots are regularly being upgraded, but some of the most precise robots used today have a repeatability of  $\pm 0.02$ mm. Robots also increase workplace safety. A lighter, mobile plug and play generation of robots is arriving on the production floor to work safely alongside human workers thanks to advances in sensor and vision technology, and computing power. Should an employee get in their way, the robot will stop, thereby avoiding an accident.

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

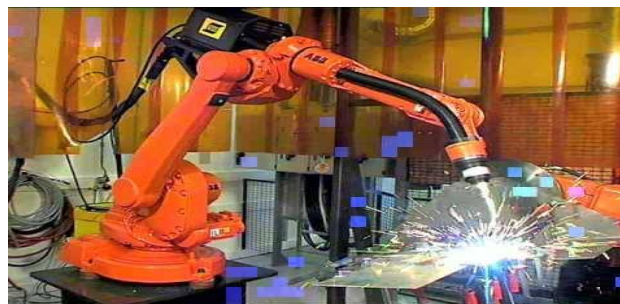
Vol. 7, Issue 5, May 2018



The FANUC M-710iC/70 Brings Fast Speeds and Reliability

The FANUC M-710iC series was engineered to bring users high speeds, maximum flexibility, and reliability that covers a wide range of applications. The series includes eight medium payload robots with a slim wrist, small footprint, and payloads ranging from 12 - 70 kg and reach up to 3.1 meters. It brings the heavy 70 kg lifting along with the high axis speeds and rigid arm. It can be mounted on the ceiling or at an angle and reach overhead and behind providing one of the largest work envelopes in its class. It has a wide motion envelope and enough wrist load capacity to handle a large panel.

The support for sustainability practices in manufacturing can be enhanced by implementing full robotic automation. As presented by Robotic [5], robotic handling operations (machine tending, palletizing and moulding) accounts for 38% manufacturing operations. Also, robotic welding, robotic assembly (press-fitting, inserting, and disassembling), robotic dispensing (painting, gluing, and spraying), robotic processing (laser and water jet cutting) accounts for 29%, 10%, 4% and 2% respectively. The cost of welding robots is going down, making it easier to automate a welding process. The robot may be directed by a predetermined program, be guided by machine vision, or follow a combination of the two methods. The benefits of robotic welding have demonstrated to make it a technology that helps many manufacturers increase precision, repeatability, and output.



Robotic processing laser and water jet cutting

Many manufacturers finish their products through grinding, cutting, deburring, sanding, polishing or routing. Material removal robots can refine product surfaces, using harsh, abrasive methods to smooth out steel to precise spot removal for small parts like jewelry. Robot material removal can not only perfect a company's product, but it will increase cycle times and production rates, which will save money. By automating material removal processes, manufacturers increase the safety level in their shops by protecting workers from harmful dust and fumes caused by material removal applications.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018



Robots deburring a diesel engine block.  
(Courtesy of Midwest Engineering Systems Inc.)

## II. ROBOTIC METHODOLOGIES AS A SOLUTION TO ACHIEVING SUSTAINABILITY IN MANUFACTURING

Advancement in welding technologies has led to the improvement in Seam tracking design. One of the factors limiting the productivity of all robotic welding projects is the quality of the weld preparations [7]. Kim, Son [8] researched on a robotic seam tracking system that utilizes a structured light based vision sensing techniques so as to achieve robustness in the presence of disturbances. The syntactic analysis used was improved by using extraction reliability of the joint features which was now used to extract the 3-dimensional information of the weld joint, thus leading to robot path correction. Wang, Zhang [9] proposed a seam tracking system according to a pre-planned welding track using a variable parameter PID control trajectory; which adapts to the changing welding line form and the working condition. Visual inspection sensors for robotic tailored blank welding that ensures a reduction in material wastage and weight has been employed by [10]. The use of fast development soft and graphics systems have been useful in creating a computer-generated design so as to visualize the possibility of achieving sustainability. Software platforms such as Adams, Autolev, DynaMechs, Open-Dynamics, SD Fast, SimMechanics, Webot, VRS, and so forth, have been developed to provide dynamic simulation capabilities for industrial robots [11]. The use of Robotic CAD platforms such as Delmia, Kuka Sim Pro, ABB robot studio and CATIA tools allows one to design and simulate 3D process; including robot models [12]. Some of the benefit of using CAD simulation models to achieve sustainability includes but limited to:

- Increase programming potential
- Improved control over job programming since higher control capabilities leads to seamlessly finished parts
- Removes the guesswork since most CAD packages provides the automation required to maximize efficiency
- Makes accessibility by clients easier since manufacturers can design faster, manage projects, test and simulate as well as machine faster than ever.
- Eliminates costly mistakes and waste by allowing the designer to visualize, inspect the manufacturing process so as to check for collision before they occur.

The use of Robotic Operating System ROS for industrial robots is proposed to address this shortcoming. ROS provided various features like message passing, distributed computing, code reusing, and so forth. Robotic companies are now porting their software to ROS; which also have viability with industrial robotics because the company is switching from branded robotic application to ROS [13].

The advantages of using ROS as reported by [13, 14] are numerous. First, they have built-in, ready-made compatibility packages, for example, MoveIt package for motion planning of manipulators, Simultaneous Local and Mapping (SLAM) and Adaptive Monte Carlo Localization (AMCL) packages in ROS can be used in autonomous navigation in a mobile robot. Second, it has RViz and Gazebo tools for debugging, visualizing, and performing the simulation. Third, it is loaded with lots of drivers and interface packages of various sensors (Velodyne-LIDAR, Laser scanners, Kinect, and so forth) and actuators (such as Dynamixel servos). Fourth, ROS message allows communication between nodes which can be programmed in any language that has ROS client

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

libraries.

Fifth, in ROS, the different node is written for each process, and if one node crashes, the system can still work; this is unlike other standalone robotic applications. Sixth, it is possible to access devices using ROS topics from ROS drivers, hence reducing the complexity of the computation and debug-ability of the system. Finally, ROS is equipped with an active support community because of its steady growth of developers worldwide.

### III. MISCONCEPTIONS ABOUT SUSTAINABILITY OF MANUFACTURING SYSTEMS USING ROBOTIC METHODOLOGIES

#### Controversy about energy consumption

Robot energy consumption is a relevant topic in achieving sustainability. There is a popular notion that industrial robot is responsible for a net increase in energy consumption [15]. This impression may not necessary is the case because; first, a lot of lightning energy is saved since robots do not need to work in bright lighting; second, during winter months, substantial saving is achieved since heating is not required in factory floor with the use of robots, unlike human workforce. Energy consumption constraints is a key ingredient to achieving full sustainability of industrial robots. The selection of motion pattern has been used as the basis to predict power consumption by varying the velocity and acceleration of the robot before using a quadratic model of robot energy consumption to estimates its energy.

It has been proven that the slower motion of the manipulator, does not necessarily guarantee the most energy efficient; also, the best strategy for energy conversion depends on the robot model [16]. In other words, slower motion consumes more energy than a fast motion. A lot of energy consumption model has been proposed. Vergnano, Thorstensson [17] proposed a novel method for energy consumption optimization in a robotic manufacturing system. Their method employs a set of mathematical models of energy consumption into a scheduling of the entire systems by modeling and parameterizing the energy function as a function of the execution time.

In a related development, Ahmed Shaik of the Council for Scientific and Industrial Research (CSIR) South Africa, adopted a Hybrid Kinematics Machine (HKM) robotic design that offers an optimal solution which reduces robotic power consumption, as they perform similar task [18]. The replacement of a Serial Kinematic Machine (SKM) with HKM under the same operating condition, shows a significant decrease in the cost of energy over a long term. The Energy consumption of industrial manipulators is a function of the following factors [19]: the mass of the arm and its links, mass of the end effector and its associated load, links offsets, joint and Cartesian accelerations, the distance of link gravity centers and end effectors load from the base. Robot simulation can play a vital role in the analysis of energy consumption by validating and verifying the effects of mathematical models, control algorithms, and software tools. See Fig. for a proposed framework of Automation and Robotics for European Sustainable manufacturing AREUS approach to Eco-friendly manufacturing.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

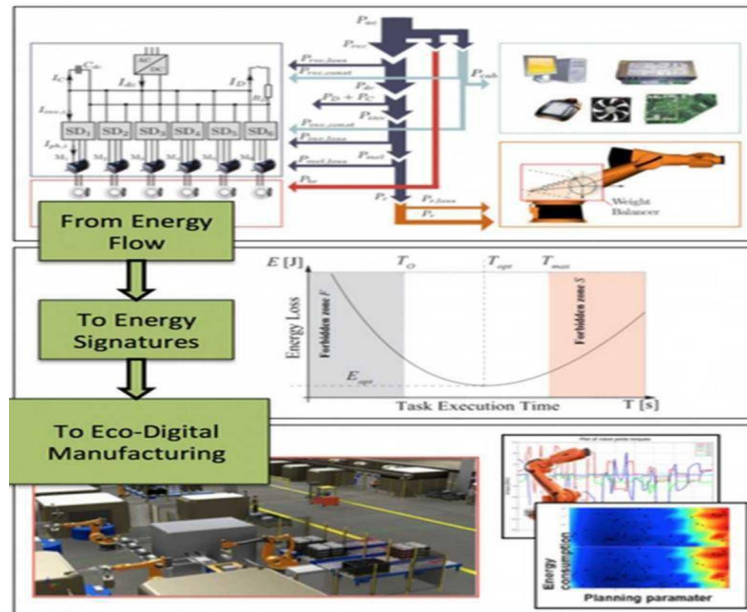


Fig. The framework of AREUS approach to Eco- friendly manufacturing[19].

## IV. CONTROVERSY SURROUNDING ROBOTS TAKING HUMAN JOBS, SKILL GAPS AND SKILL SHORTAGES

A summary of the research by IFR [20], reveals the following:

- 4-6 million direct jobs created in world manufacturing alone, through 2011, representing 3-5 jobs per robot in use.
- 8-10 million indirect jobs as a result of an increase in the use of robots.
- 1.9-3.5 million jobs are projected to be created in the next eight years.
- When manufacturing jobs are preserved, jobs throughout the community where the factories are located are also sustained.

The findings above proves that robots create employment rather than killing jobs. Although robotics automation may reduce certain jobs, the study highlights that subsequently many more jobs are created. Countries that have embraced the use of robots as a means of achieving sustainability in manufacturing have resulted in greater output and lower unemployment.

Furthermore, employments in robotics require a broad range of skills. This leads to pertinent questions that need answers: “is there a skill shortage/skill gap in robotics”? Skill gaps and skill shortages are exactly not the same, but both can be used to denote a situation where there are not enough skilled people to fill the requirements of a job. Robotic jobs require a broad range of skills. For example, when an existing workforce lacks the requisite skill to do a job, there exist a skill gap. However, skills shortage exists when the job cannot be filled as a result of dearth skilled applicants.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

## V. CONCLUSION

It is sacrosanct to preserve resources by minimizing the environmental impact of manufacturing activities. Industrial robot and automation can help play a leading role in increasing productivity and sustaining manufacturing systems. This work discussed issues relevant to the use of robots in achieving manufacturing system sustainability, especially as regards the use of energy. To achieve full manufacturing system sustainability with the use of industrial robots, new robotic approaches and solutions that guarantee eco-friendly manufacturing was discussed extensively in this paper. The use of ROS-Industrial will be the technological trends of the future, and it has the capability of contributing to sustainability in manufacturing. Also, issues that deal with skill gap and skill shortages, as a hindrance to achieving full sustainability have been addressed through the development of educational and training centers required for equipping the users of robots with the necessary skills for utilizing and maintaining the robots used in manufacturing industries.

## REFERENCES

- [1] Commission, B., *Our common future, Chapter 2: Towards sustainable development*. World Commission on Environment and Development (WCED). Geneva: United Nation, 1987.
- [2] Bugmann, G., M. Siegel, and R.Burcin. A role for robotics in sustainable development in Proceedings of the IEEE Africon. 2011.
- [3] Project, S., Sustainable and reliable robotics for part handling in manufacturing automation, in Stamina -Robot. 2013: Denmark.
- [4] Motoman, Y. Automation and Robotics A Sustainable Path to Profit. N/A [cited 2016 11-04-2016]; Available from: <http://www.motoman.com/about/robotics/>.
- [5] Robotic, in Robotics Industry News, Applications, and Trends, J.-P.Jobin, Editor. 2014, Robotic company.
- [6] IFR, Case Studies Of Industrial Robots, in International Federation of Robotics. 2013, IFR: Frankfurt Germany.
- [7] Hazel, B., et al. Robotic penstock welding. in Applied Robotics for the Power Industry (CARPI), 2010 1st International Conference on. 2010.
- [8] Kim, J.S., et al. A robust method for vision-based seam tracking in robotic arc welding. in Intelligent Control, 1995., Proceedings of the 1995 IEEE International Symposium on. 1995. IEEE.
- [9] Wang, K., et al. Research on control technology of trajectory tracking for robotic welding. In Computational Intelligence and Software Engineering (CiSE), 2010 International Conference on.2010. IEEE.
- [10] Zhang, L., and Y. Xie. Development of automatic visual inspection sensor in robotic tailored blank welding. in Intelligent Systems and Applications, 2009. ISA 2009. International Workshop on. 2009. IEEE.
- [11] Ogbemhe, J.,and K. Mpofu, Towards achieving a fully intelligent robotic arc welding: a review. Industrial Robot: An International Journal, 2015. 42(5): p. 475-484.
- [12] Dávila-Ríos, I., L.M. Torres-Trevino, and I. López-Juárez. On the Implementation of a robotic welding process using 3D simulation environment. In Electronics, Robotics, and Automotive Mechanics Conference, 2008.CERMA'08. 2008. IEEE.
- [13] Joseph, L., Mastering ROS for Robotics Programming. 2015.
- [14] Joseph, L., Learning robotics using Python. 2015.
- [15] Consultant, F., ROBOTICS IMPROVE SUSTAINABILITY IN FACTORIES. 2015, Factory Consultant: Livermore.
- [16] Chemnitz, M., G.Schreck, and J.Krüger. Analyzing energy consumption of industrial robots. in Emerging Technologies & Factory Automation (ETFA), 2011 IEEE 16thConference on. 2011. IEEE.
- [17] Vergnano, A., et al., Modeling and Optimization of Energy Consumption in Cooperative Multi-Robot Systems. IEEE Transactions on Automation Science and Engineering, 2012. 9(2): p. 423-428.
- [18] CSIR, News snippets from around the CSIR, in Info scope. 2012, Science scope: South Africa.
- [19] AREUS, Eco-efficient Design, and Simulation tools. 2014, Automation and Robotics for European Sustainable manufacturing: Modena Itali.
- [20] IFR, IFR: Robots Improve Manufacturing Success & Create Jobs, in The International Federation of Robotics (IFR). 2013: Frankfurt, Germany.
- [21] Deloitte, The skill gap in U.S. manufacturing 2015 and beyond, in Manufacturing Institute. 2015: USA.
- [22] ROBOTIQ, How to Benefits from Robotic Shortage, in Robotics Industry News, Applications, and Trends, A. Owen-Hill, Editor.2016, Robotic company: Canada.