# Sustainable and Smart Manufacturing through Distributed Manufacturing System and Robotics Methodology

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**Abstract:** *Now a days manufacturing companies are working on the sustainable and smart manufacturing systems. In this paper sustainable manufacturing initiatives is the creation of energy-efficient and manufacturing resources-saving systems. Distributed Decentralized networks of adaptable and flexible mini-factories are not only helpful to reduce emissions through reduction of transports, but also serve for the growth and development of regional economic cycles. This work also makes an attempt at exploring the role of robotics in achieving sustainability in manufacturing. Its describes the advancement made so far in applying robots to manufacturing-welding shot blasting, painting, and so forth, within the sustainability framework. The adoption of new technologies like Robotic Operating Systems (ROS), in the approaches to the design of industrial robots, could enhance sustainability in the use of robots in manufacturing at a reduced cost. This paper gives an overview of trends towards DMS as well as reasons and arguments why Distributed Manufacturing Systems and Robotics are appropriate concepts for more sustainable and smart manufacturing.*

**Keywords:** Distributed Manufacturing Systems (DMS), Robotic Operating Systems (ROS) and Robotics.



## 1. Introduction

When Sustainability is the ability to develop and implement technologies or methodologies, which are self-sustaining without jeopardizing the potential for future generation to meet their needs [1]. Modern industrial robots applications 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 highpoint some of the achievement recorded in manufacturing with the use of industrial robots. The paper also intends to create more awareness on how different complex manufacturing systems operations can be sustained through the use of improved robotic methodologies. Smart manufacturing depends on the ability to perform real-time analytics on large data gathered at various points in the value chain.

## 2. Distributed Manufacturing Systems (DMS)

Distributed manufacturing also known as distributed production ,cloud producing and local manufacturing is a form of decentralized manufacturing practiced by enterprises using a network of geographically dispersed manufacturing facilities that are coordinated using information technology .

### 2.1 DMS in the early era of globalization

The challenge to be coordinating and manufactures distributed systems due to the geographical circulation of the single production units; it was required to become accustomed the planning of manufacture process to changed situation [1, 5, 7]. The same requirement occurred for the development of the manufacture development [8, 9]. Furthermore, accustomed supply, planning and development model have to be assessed. This has been done based on multi-agent systems (MAS) that enhances decentralized decision-making [16].

### 2.2 Effects of information and communication technology

The progressing development of data and communication, innovation offers for DMS. The universal programming arrangement, demonstrating distinctive layers of an organization's divisions for an all inclusive data framework [14] and executing a calendar framework in a nearby worldwide degree [15]. Accurate going to what is the requirement of mix of modernization frameworks [16], [17], likewise with a functional approach that utilized business programming [06]. A make an effort was made to create generation execution frameworks on MAS [18], additionally for the specific instance of virtual undertakings [19].

### 2.3. Virtual DMS networks

The strategy of incorporating the single creation units into a general system has been an essential issue for DMS. Research works analyzed the impact of worldwide circulation, the development of little and medium undertakings [22]. The essential issue of choosing plants that are very autonomous from the chief firm has been tended to [23]. In light of MAS, the idea of a self-sorted out system that uses the organic instruments of stigmergy and swarm knowledge was created [24] for the coordination of generation systems.

### 2.4. Historic evolution of DMS and current trends

The previously themes of creation process, data and correspondence innovation, and generation systems are critical issues of DMS and thusly have been talked about consistently finished over the past two decades. In the Nineties, the theme globalization was a major issue and this is reflected additionally in the investigations of DMS [14, 21]. Another trend was production creation reproduction of DMS that, like globalization [4, 16, 17]. As opposed to that, the early use of DMS for the plan of action of diversifying [25] was reexamined as of late [27, 40] in mix with the idea of variability and mass customization. Similar records for the idea of virtual ventures [19, 28, 29]. The adaption of DMS concerning the store network administration has been talked about before [30, 31, 32] is still in light of a legitimate concern for analysts [20, 33, 34, 35]. Over the most recent couple of years the verbal confrontation about mass customization emerged and is exceptionally examined [11, 34, 27, 37]. Because of the novel specialized conceivable outcomes the subject of cloud producing emerged of late [30, 36] in blend with Distributed Manufacturing.

## 3. Sustainable Manufacturing through Distributed Manufacturing Systems

### 3.1 Dimensions of Sustainability in Manufacturing

The Sustainability is part of the optimization of the overall efficiency of enterprises, products and processes. Supportability customarily has three measurements: economy, biology and socials. Expenses of vitality or materials affect the financial adequacy. The lessening of assets is a commitment to the financial and ecologic adequacy. The social measurement is spoken to by work conditions, states of instruction, abilities and others [38]. This model could be extended presenting a fourth measurement, the political-institutional measurement [39] (Figure. 1)

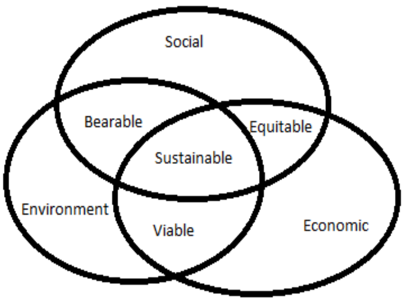



Figure 1. Dimensions of Sustainability in Manufacturing

### 3.2 Economic aspects of DMS

The main Distributed manufacturing empowers the creation of individual and redid items. It is definitely known ideas and strategies for mass customization it is conceivable to create likewise expansive amounts of altered items by methods for reconfigurable and variable assembling frameworks. This is particularly imperative in the field of sustenance industry, now and then because of social contrasts and in addition contrasts in fixings. An imperative monetary and showcasing perspective is the decrease in conveyance times and also in calculated cost through geologically scattered assembling frameworks.

### 3.3 Ecological aspects of DMS

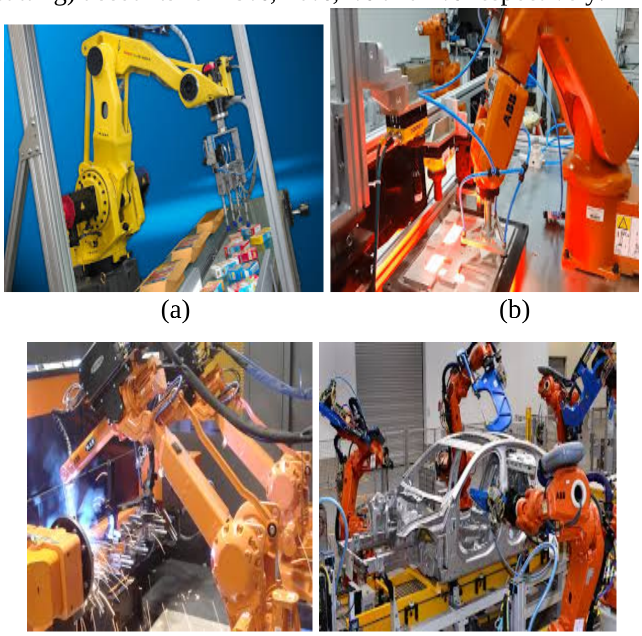
The reduction of transport volume results in a reduction of $CO_2$ emissions and therefore of environmental pollution. Thinking on the finite resources of fossil fuel and energy the reduction of transports helps protecting the environment. The integration of low-emission vehicles will be an interesting topic in designing solutions for the last mile logistics and capillary distribution in combination with DMS.

### 3.4 Social aspects of DMS

Changeable and flexible DMS make rising in local manufacturing which helps to achieve a higher employment rate due to the creation of new jobs in local manufacturing. Jobs in logistics companies will decline. It is therefore important in the future to work on models to allow a re-qualification for these people in the area of manufacturing.

## 4. Robots Application to Manufacturing

There are many applications of Industrial robots. (see Fig. 2). It also gives support to sustainability to improve manufacturing process. As presented by Robotic [40], robotics handling operations (machine tending, palletizing and molding) 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.



(a) (b) (c) (d)

Figure.2. (a) energy saver robot for high-speed packaging.; (b) ABB Robots environmental application to spraying, gluing and wiping; (c) The fourth generation advances welding system ; (d) FANUC M-1iA Robotics high-speed assembly robots.[6].

## 5. Robotic Methodologies as a solution to achieving sustainability in Manufacturing

One of the factors limiting the productivity of all robotic welding projects is the quality of the weld preparations [41]. Kim, Son [51] 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. Wang, Zhang [29] 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. The simulated result in MATLAB environment using trajectory tracking test signals (straight line, sine wave, triangular wave and square wave) and results proved that the welding line could be followed accurately under random noise. A visual inspection sensor for robotic tailored blank welding that ensures a reduction in material wastage and weight has been employed by [36]. 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, and Dynamic's, Open-Dynamics, SD Fast, Biomechanics, Webot, VRS, and so forth, have been developed to provide dynamic simulation capabilities for industrial robots [34]. 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 [46]. Some of the benefit of using CAD simulation models to achieve sustainability includes but limited to:

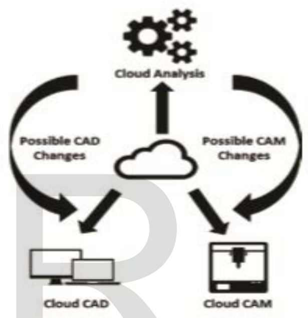
Increase programming potential, Improved control over job programming since higher control capabilities leads to seamlessly finished parts, Removes the guesswork since most CAD packages provides the automation required to maximize efficiency, Makes accessibility by clients easier since manufacturers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

## 6. Role of 3D Printing or Additive manufacturing to manufacturing smart and sustainable

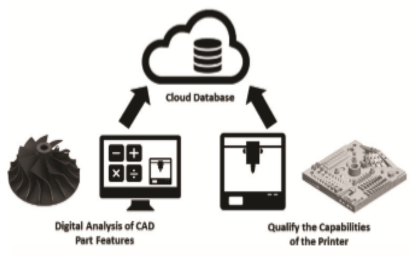
Recently popular 3D printing method involves direct making of products by layer by layer disposition of materials using digital data from a 3D model. It has been promoted as a zero waste manufacturing method as opposed to conventional subtraction ways of manufacturing which generate waste. It is particularly suitable for customized manufacturing of low volume products. Further efforts are necessary in terms of materials options, manufacturing speed, and engineering performance so that this method could be applied to high volume, engineering products.

## 7. Cloud-Based Smart Manufacturability Assistant and analysis

In this section of the paper will discuss a cloud based manufacturability collaborator can be acknowledged and recognize the specialized necessities such a framework would need to satisfy and realize To understand a cloud-based manufacturability aide, it is first important to incorporate cloud-based examination into the CBDM stage. This can either be down to an issue with the .STL work or on the other hand the planners are expecting to produce highlights which are outside the resistances and abilities of the machine. On the other hand, CAM input would give data with respect to the appropriateness of chose machine. For instance, it could recommend choosing a printer that has a higher print determination. A schematic of the cloud-based manufacturability device procedure is appeared in Figure 3.a and b. The product would need to comprehend confinements of all the 3D printers that it approaches. By assessing the CAD geometry it is conceivable to feature highlights which exist inside the advanced model that are outside the capacities of 3D printer.




(a)




(b)

Figure 3.(a). Example of feedback from a cloud -based analysis system and (b). Schematic of cloud- based manufacturability assistance

The main advantage of CBDM is less maintenance cost. A further advantage of increasing numbers of cloud-based CAD/CAM platforms is that the barrier to entry for entrepreneurs or hobbyist consumers within the extended maker communities and hence society as a whole decreases.

## 8. Conclusions

Industrial robot, DMS and automation can help and play an important role to make manufacturing smart and ecofriendlyss and increase productivity and also sustain manufacturing systems. The use of ROS-Industrial will be the technological trends of the future, and it has the capability of contributing to sustainability in manufacturing. In this paper some of the requirements that are necessary to create the next generation of cloud-based smart manufacturability tool have been described in short. Some of cloud based manufacturability tools have been also defined to overcome from some of some challenged in creating CAD parts. This tool aims to define the minimum feature sizes that exist within a CAD file and compare these to the minimum size features that can be manufactured by a given 3D-printer.

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