

# Collaborative Robotics Making a Difference in the Global Pandemic

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**Abstract**— In March 2020 the world as we know it was shaken to the core by the Covid-19 global pandemic. This crisis has had a significant impact on the EU27 economy and triggered unprecedented policy responses across Europe and the globe. Collaborative Robotics, or Cobots, have made a significant difference to many manufacturing plants by facilitating social distancing between workers, introducing flexibility on the factory floor and allowing the plants to manufacture high quality items for use in the medical field. California-based DCL Logistics, a third-party logistics company, decided to employ Cobots to manage a 30% increase in orders in the immediate aftermath of the outbreak and the Cobots have led to a 300% increase in productivity and a 60% jump in labor cost savings [1]. This paper will look at these flexible robots and discuss the benefits they brought to manufacturing in a time of global crisis.

**Keywords**— Global pandemic, Covid-19, Collaborative Robotics, Industry 4.0, Industry 5.0, Human Centred Systems.

## I. INTRODUCTION

As the global pandemic continues to engulf the world in waves, there has been an abrupt impact on the EU27 economy which will continue for the foreseeable future. According to De Vet et al Europe's economy has experienced a larger impact as compared to the global economy in 2020 and it is expected to have a slower recovery in 2021. They forecast that the real Gross Domestic Product (GDP) is expected only to reach pre Covid-19 crisis levels by mid-2022, in both the EU and the euro area. It is important to note that this adjustment is positive as compared to previous predictions, but a return of the economic activity to pre-crisis levels entails slow growth for the EU economy. [2]

The world is reacting to this global pandemic in a myriad of different ways, each national government putting emergency measures into place to try to protect the health and safety of their citizens, and, at the same time to try to keep their economies in as healthy state as possible. In Europe manufacturing is of critical importance and finding novel ways of keeping manufacturing plants operating as efficiently and effectively as possible often falls on the shoulders of the technical staff. Automation and digitisation during this global pandemic are being fast tracked and this will have a positive impact in the longer term.

## II. COVID-19 PANDEMIC AND THE MANUFACTURING INDUSTRY

Although all businesses were affected by the global pandemic manufacturing, according to De Vet et al the EU has had a significant negative impact. *"In the EU27 experienced a sharp decrease in March and April 2020 (respectively -11.1% and -20% change on the previous period), which coincided with the first wave of the spread of the coronavirus. It was then followed by a rebound in May and June 2020 (respectively 13% and 10.4% change on the previous period) and then by a small but increasing values in the period September-November 2020 that coincided with the resurgence of COVID-19 cases".* [2]

As reported by Reuters when a resurgence in Covid-19 cases in Texas brought many businesses to a halt, eight Cobots have kept the company All Axis Machining's metal fabrication facility in Dallas, USA, up and running. They state that the small, nimble Cobots perform multiple jobs, such as machine-tending, sanding, deburring, part inspection and laser marking, leaving the company far less dependent on manual labour. In fact when all the workers on one shift went into self-quarantine during the pandemic, they reported that it had no impact on the facility's productivity [1].

According to Grover and Karplus management practices in manufacturing strongly correlate with the company's ability to quickly change the product mix by adjusting operations, and in return, this may translate into better outcomes on sales and reduce factory closures. [3] This flexibility is directly related to the many factors, including the technology used to manufacture products. The affordability of automation can be a problem but the relatively low cost Cobot promises to payback the investment in months, making the changeover easier, even for small and medium-sized enterprises and several examples are outlined to demonstrate this. [1]

Mark Muro, a Senior Fellow and Policy Director at Washington-based the Brookings Institution, says *“the automation drive will result in a net reduction in the workforce as companies invest in technology not just for social distancing, but also to boost productivity and protect profits from the pandemic-induced recession.”* [1]

### III. COLLABORATIVE ROBOTS IN MANUFACTURING

Automation and robotics excel in the manufacture of standardised products using standard manufacturing processes in high volumes to an excellent quality standard. When creativity or customisation is expected, the human being is key. The solution is the collaboration of robots and the humans. Traditional robots cannot work side by side with humans but Cobots are designed to work in synchronisation with human employees and were first developed in 2012 in Denmark. [4]

A Cobot is not a replacement robot; it assists workers rather than replaces them. These robots are safe around humans by using force limiting sensors and rounder geometries than traditional robots. They are lightweight and thus are easily moved from task to task. In addition they are easy to implement and use without a specialised automation Engineer or Technician. In fact, an Operator with Cobot programming skills can deploy it. Another advantage mentioned previously is that Cobots are so affordable that it is a worthwhile investment for any company, regardless of the size of the company.

Cobots are extremely versatile and can be used for a wide variety of applications, examples of which include: Packaging and Palletizing, Machine Tending, Industrial Assembly, Pick and Place, Quality Inspection, Injection Molding, CNC Tending, Assembly, Polishing, Screw driving, Gluing, Dispensing and Welding. They can be easily changed over from one operation to another in a very short time. At the moment they are being used in the larger manufacturing companies but there is an opportunity to introduce this technology into small to medium size companies. [5] Figure 1 shows a family of Cobots from the company Universal Robots [6].

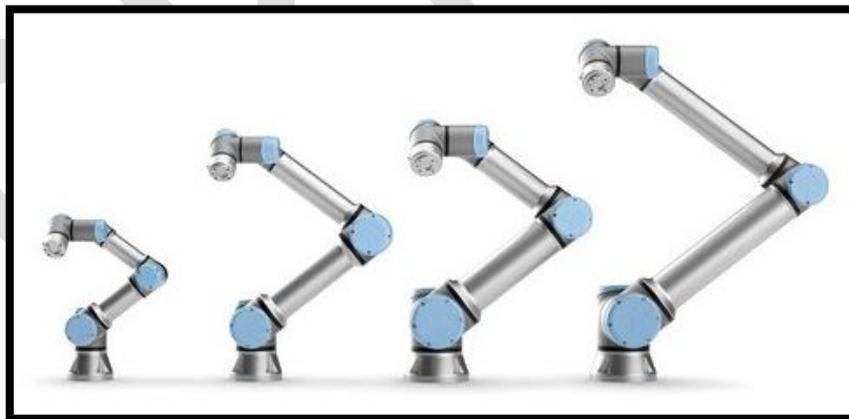


Figure 1 Cobot example from Universal Robots [5]

As detailed by the ISO10218 standard, robots can have four types of safety features. They are:

- ❖ Safety Monitored Stop
- ❖ Hand Guiding
- ❖ Speed and Separation Monitoring
- ❖ Power and Force Limiting

The safety monitored stop is implemented in environments where the robots operate mostly alone, with occasional human interference. The feature will cause the robot to pause (though not shutdown) when the safety zone is violated (i.e. a human enters its workspace). [7][8]

The speed and separation monitoring feature are an extension of safety monitored stop. Instead of adopting a single behaviour throughout the robot's entire workspace, the latter is gradated into several safety zones.

#### IV COLLABORATIVE ROBOTS IMPLEMENTATION WORLDWIDE

ABI Research state that *"various (industrial) robot manufacturers are bringing collaborative robots to the market. This market is expected to rise from \$100 million to \$1 to \$3 billion by 2020."* They undertook an assessment of Cobot manufacturers and ranked the leading 12 in a study in 2019. In this study they found that there are currently over 50 manufacturers worldwide, but most do not have a product that is available on a meaningful scale.

The *"Industrial Collaborative Robots Competitive Assessment"* concluded that Universal Robots (UR) were leading, particularly when focusing on the implementation volumes. The companies ranked in the assessment were:

- ❖ ABB
- ❖ Aubo Robotics
- ❖ Automata
- ❖ Doosan Robotics
- ❖ FANUC
- ❖ Franka Emika
- ❖ Kuka AG
- ❖ Precise Automation
- ❖ Productive Robotics
- ❖ Techman Robot
- ❖ Universal Robots
- ❖ Yaskawa Motoman

The criterion used were innovation and implementation. The *innovation criteria* included: payload, software, ergonomics and human-machine interaction experimentation and safety. The *implementation criteria* focused on: units and revenue, cost and return on investment, partnerships, value-added services and employee numbers. [8] [10]

#### V SOCIAL DISTANCING AND COLLABORATIVE ROBOTS

In 2020 the term *"social distancing"* became part of everyday vocabulary once the modes of transmission of the Covid-19 virus were established. The World Health Organisation describes the modes of transmission of the virus in their July 2020 document, explaining that social distancing was one of the most effective measures against transmission. [11] One of the difficulties in manufacturing plants is that workers need to stand in relatively close proximity on manufacturing lines. While job functions involving marketing, sales, management, finance, and research and development can work virtually, execution at the assembly line needs to be at specific physical locations. This resulted in disease outbreaks in several different industries. Bui et al comprehensively studied outbreaks in different sectors. They state that *"approximately 12% (1,389 of 11,448) of confirmed COVID-19 cases in Utah were associated with workplace outbreaks. Of the 210 workplace outbreaks occurred in 15 of 20 industry sectors; nearly one half of all workplace outbreaks occurred in three sectors: Manufacturing (43; 20%), Construction (32; 15%) and Wholesale Trade (29; 14%); 58% (806 of 1,389) of workplace outbreak-associated cases occurred in these three sectors."* [16]

As stated by Okorie et al *"manufacturing the COVID-19 disruption scope has been largely twofold; an endogenous disruption of manufacturing processes and systems as well as extreme shifts in demand and supply caused by exogenous supply chain disruption."* [17]

Cobots are designed to work with humans in several different modes. *"Human-industrial robot collaboration can range from a shared workspace with no direct human-robot contact or task synchronisation, to a robot that*

adjusts its motion in real-time to the motion of an individual human worker.” [8] [9] Figure 2 illustrates the various types of human-industrial robot collaboration possible, ranging from a completely separate set up on the left hand side, to a responsive collaboration on the right hand side.

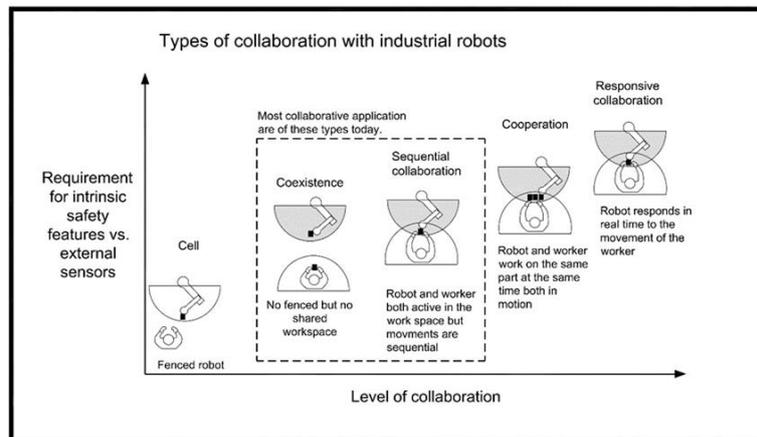


Figure 2 Adapted from Types of Human-Industrial Robot Collaboration [8] [9]

Cobots can be used to facilitate social distancing in a flexible timely manner due to their ability to be easily and fully integrated into manufacturing lines in a relatively short period of time.

In a study undertaken by Doyle-Kent in 2020 a qualitative analysis was undertaken in the area of Cobots and their applications in Irish manufacturing plants. It was the first trial to describe Cobots in an interdisciplinary manner including the technological, social, ethical, industrial, and educational aspects. Individual concepts can be found but the idea of gathering together these themes in a cohesive manner was the essence of this research. [8]

A number of Cobot Specialists were asked to describe the positive and negatives of introducing Cobots into manufacturing plants. Table I shows a summary after a comprehensive thematic analysis was undertaken by the Researcher to analyse the results.

TABLE I

THEMES RESULTING FROM THE QUALITATIVE STUDY. [8]

<p><b>THEME 1.</b> HEALTH AND SAFETY OF THE WORKFORCE IS ENHANCED BY INTRODUCING COLLABORATIVE ROBOTS.</p> <p><b>THEME 2.</b> THERE ARE UNCERTAINTIES ABOUT MEETING THE STATUARY HEALTH AND SAFETY REQUIREMENTS BY USING COLLABORATIVE ROBOTS UNGUARDED.</p> <p><b>THEME 3.</b> COLLABORATIVE ROBOTS ARE EASY TO INSTALL, TO USE AND TO MAINTAIN AND DO NOT REQUIRE A ROBOTICS EXPERT ON SITE.</p> <p><b>THEME 4.</b> THE VERSATILITY OF COLLABORATIVE ROBOTS MAKES THEM UNIQUELY APPLICABLE TO MOST ENVIRONMENTS.</p> <p><b>THEME 5.</b> THE RELATIVELY LOW COST OF A COLLABORATIVE ROBOT ENSURES IT IS WITHIN THE RANGE OF SMALL TO MEDIUM ENTERPRISES.</p> <p><b>THEME 6.</b> COLLABORATIVE ROBOTS MAY NOT BE FINANCIALLY VIABLE TO ALL BUSINESS.</p> <p><b>THEME 7.</b> COLLABORATIVE ROBOTS IMPROVE PRODUCTIVITY.</p> <p><b>THEME 8.</b> COLLABORATIVE ROBOTS CAN FILL THE SKILLS GAPS IN INDUSTRY AND OPERATORS WILL HAVE A MORE REWARDING &amp; INTERESTING WORK ENVIRONMENT DUE TO INCREASED SKILLS AND VARIED WORK PRACTICES.</p> <p><b>THEME 9.</b> MOST COLLABORATIVE ROBOTS ARE NOT WORKING TO THEIR FULL POTENTIAL IN IRISH INDUSTRY AND LARGER COMPANIES HAVE AN ADVANTAGE OVER SMALLER ONES.</p>
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It is obvious from this review that Cobots are seen by the Specialists as a very flexible, safe, affordable automation solution can be easily applied to many problems experienced by Irish companies, including a severe skills shortage in normal times. The detailed answers in this qualitative study also revealed that Cobot Operators, or Coboters,

reported feeling more fulfilled and safer in their work environment when working with Cobots. Work output from Cobots is of a very high quality, versatile and they can operate 24 hours a day. It was recommended that they were a viable option for social distancing, in a time when humans need to stay separated, due to the airborne transmission of a deadly virus.

In addition a comprehensive questionnaire was carried out as part of this research. 111 Respondents were asked 37 questions about robotics and automation in their plants. One of the questions asked was “*have you heard of collaborative robotics [Cobot]?*” Out of a total of 108 replies, 77 (71.3%) stated yes and 31 (28.7%) no. Also they were asked “*The current Covid-19-19 global pandemic makes physical distancing a requirement in the workplace, does this influence your opinion on using Cobots in manufacturing?*” Out of a total of 91 replies 39 (42.9%) stated yes and 52 (57.1%) no. An interpretation of these results is that Cobot Manufacturers need to be a lot more proactive in how they market their products to enable Engineering Professionals to have a clear understanding of how to use their products during a pandemic.

Whilst gathering information for the literature review a number of case studies of how Cobots were actually used in the pandemic were highlighted on the Universal Robot LinkedIn page, and a summary of these will be outlined in the next section.

## VI CASE STUDIES OF COLLABORATIVE ROBOTS DURING THE COVID-19-19 PANDEMIC

The following case studies illustrate that the Covid-19 pandemic has been positively assisted by automation and Cobots. The authors have just chosen a few examples out of many available online.

### **Case study 1:** *Endutec Maschinenbau Systemtechnik GMBH [8] [12]:*

This machine manufacturing company is also a certified systems integrator. The managing director explained that two years previously they had started to automate parts of their production with a UR10e Cobot. The reason was to “*achieve the fullest possible utilization of our machine capacity while also addressing the shortage of skilled workers. We are always desperately looking for qualified employees. Therefore, we planned to automate as many simple tasks as possible in order to be able to use our staff for higher-value tasks.*” He went on to say in spite of the global pandemic production ran as normal, the difference being some of the programmers worked from home and uploaded the programmes onto the company server whilst others worked on site. The only noticeable change, apart from mask wearing and hand sanitizing, was that shop floor production orders from the ERP system were distributed around the company in paper form. Now the employees receive the production order as PDF in an e-mail.

Automation and Cobots are an integral part of what they do and each task is analyzed to see if automation is possible. They state that skilled workforce shortage means that they use automation to make their facilities more competitive. Due to Covid-19 their customers are often working from home which means that they no longer have full and permanent access to their own data and this can cause delays in their orders but delivery must be on time. Nonetheless thanks to the Cobot they make the reduced delivery times as it runs through the night and also on weekends. “*For us, the crisis has shown that the time and money we invested in automation has more than paid off. I am convinced that other small and medium-sized companies will now also increasingly rely on robot technology to prepare themselves for the future.*”

This case study documents how the UR10e Cobot enabled Endutec to set up a two-shift operation, utilizing its machines to full capacity.

### **Case study 2:** *Conquer Manufacturing, India [8] [13].*

India has been severely affected by the global pandemic in 2021, but even before this Pradeep was explaining the importance of Cobots to India manufacturing. [13] He states that “*plant closures, partial layoffs, staggered shifts, labor shortages, stringent hygiene measures and restrictions on the number of people working together at the same time*” are some of the realities on the ground. He goes on to state that “*according to Business Insider, the seasonally adjusted IHS Markit India Manufacturing Purchasing Managers Index (PMI), a reflection of the health of the manufacturing economy, fell to 27.4 in April (2020), from 51.8 in March*” which is the sharpest deterioration in Indian business condition in the past 15 years. The government are cognisant of the urgent changes that need to be made so that the manufacturing plants can adapt and overcome.

Mandatory guidelines (social distancing, testing and tracing and limiting the number of workers in any location) in Indian manufacturing is a problem for this highly the manual workforce. Labour is often unskilled, this together with the lack of space on the shop floor are major barriers to the integration and operation of traditional automation. Cobots overcome these issues and the following points are key to the successful implementation of Cobots:

- ❖ Social distancing was enabled
- ❖ Partial automation was possible
- ❖ Quick deployment and flexible redeployment of the Cobots

Democratised automation was the result because of the fast payback of this relatively low cost technology and the fact that highly skilled automation experts were not required to deploy and maintain the Cobots.

### *Case study 3: Reliance Automation [14]*

Lacy in 2021 reported on the increase of automation due to the Covid-19 pandemic quoting the managing director of an automation company in Ireland, Reliance Automation. *“We have had two difficult years just as every other business; however, we continue to experience demand for automation resulting from the Covid-19 pandemic situation. Production lines of people who were tightly packed within one meter of each other suddenly needed to distance themselves 2m apart and there was also a huge increase in demand for Covid-19 related products such as testing and vaccines.”* He goes on to discuss that food companies, who are in particular usually slow to introduce automation, moved to rapidly incorporate automation due of significant increased demand. Finally Lacy states that The International Federation for Robotics (IFR) testified that automation has now been deployed 25 times faster than was expected pre-pandemic.

As outlined by Universal Robots, Cobots have been used to manufacture face shields, N95 masks and ventilator components. Cobots are also being used for mouth swabs, ultrasounds, and temperature checks. [8] [15]

## VII CONCLUSIONS AND LOOKING FORWARD

The features of Cobots that make them so versatile during a global pandemic will ensure their uptake post pandemic. Industry is in the midst of the fourth industrial revolution but is moving steadily into the fifth where personalisation and customisation are some of the key drivers. Cobots will play an important role in this person-centred manufacturing. [5]

Doyle-Kent offered a definition of Industry 5.0 – *“Industry 5.0 is the human-centred industrial revolution which consolidates the agile, data driven digital tools of Industry 4.0 and synchronises them with highly trained humans working with collaborative technology resulting in innovative, personalised, customised, high value, environmentally optimized, high quality products with a lot size one.”*[9]

Comprehensively educating Engineers on the benefits of Cobots and how to use them effectively will be key to their widespread use in manufacturing. However, this global pandemic has accelerated exposure to this technology, its possible applications, and the advantages it can bring to manufacturing plants on a global scale.

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