PRO-MAG

MADRAS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF PRODUCTION TECHNOLOGY
THE ASSOCIATION OF PRODUCTION ENGINEERS
BATCH: 2018-2019

FLYING TAXIS AND HYPERLOOP

Mobility will be drastically different and everything won’t be hi-tech either. As more of Gen-Z enter the workforce, health- and environment-conscious people will prefer to walk more or use bicycles. Public transport is likely to become more comfortable and reliable too. Also, people might use modes of transport that don’t exist today, such as on-demand flying taxis.

An experiment in the area of flying taxis—with the financial and technological heft needed to succeed - is being orchestrated by ride-sharing service provider uber technologies. As part of its Elevate programme, it plans to deploy uber. Air—electric aerial vehicles capable of vertical take-off and landing. The company has decided on Dallas and Los Angeles for its first trials and said last August that the third location would be either in India, Japan, Australia, Brazil or France.

Other surface-based long-haul transport options will include superfast Maglev (magnetic levitation) trains as well as hyper loop systems. One Maglev is operational in Shanghai, China, but runs only 30.5 km between the city’s international airport and Long yang Road station on its outskirts. The 286-km Chuo shin kansen in Japan is expected to be operational in 2027, cutting travel time between Tokyo and Nagoya by 30 to 40 minutes. At present, it takes 90 minutes.

The hyper loop is a system proposed by billionaire entrepreneur Elon Musk and at least three companies are competing to build its commercial version first. The system comprises pods moving rapidly through tubes from which air has been emptied out to near-vacuum levels, drastically reducing friction.

An underlying feature of all future transport modes will be their connected nature at multiple levels. Components of entire transport networks and even the roads and rails on which they will run will be connected, with large numbers of sensors. This will allow vehicles to communicate with each other and with their roads, rails and other infrastructure in real time.

NAME: ARULSELVAM A R

REG NO: 2019507003

LIFE IN THE FUTURE: TECH THAT WILL CHANGE THE WAY WE LIVE

Technology has the power to do many things, and changing the world is one of them. We're privileged to be living in a time where science and technology can assist us, make our lives easier and rethink the ways we go about our daily lives.

The technology we're already exposed and accustomed to has paved the way for us to innovate further, and this list of current and future technologies certainly have the potential to change our lives even more. Robots in space and in the workplace:

NASA is already sending robots of different shapes and sizes into space. As technology progresses, this makes sense. Robots don't need to worry about oxygen to breathe or food to eat and they can be packed full of sensors to send data back to Earth. The same applies in the workplace. Robots can take on the more difficult, dangerous and dull jobs to save mankind the trouble and risk.

Robot butlers

Chores, chores, chores. boring and unfortunately necessary. But what if robots could help save you the misery? We already have the beginnings with robot vacuum cleaners and smart home appliances. Larger, more useful robots are springing up too. We could easily be living in a future packed full of useful robots helping around the home as butlers, chefs or general dogsbodies. 48 real-life robots that will make you think the future is now.

NAME: ARUNKUMAR R

REG NO: 2019507004

INTERNET OF THINGS IN SMART HOME

A smart home is a residence that uses internet-connected devices to enable the remote monitoring and management of appliances and systems, such as lighting and heating. Smart home technology, also often referred to as home automation provides homeowners security, comfort, convenience and energy efficiency by allowing them to control smart devices, often by a smart home app on their smartphone or other networked device. A part of the internet of things (IOT), smart home systems and devices often operate together, sharing consumer usage data among themselves and automating actions based on the homeowners' preferences. Nearly every aspect of life where technology has entered the domestic space has seen the introduction of a smart home alternative.

Smart TVs connect to the internet to access content through applications, such as on-demand video and music. Some smart TVs also include voice or gesture recognition. In addition to being able to be controlled remotely and customized, smart lighting systems can detect when occupants are in the room and adjust lighting as needed. Using smart locks and garage-door openers, users can grant or deny access to visitors. Smart locks can also detect when residents are near and unlock the doors for them. With smart security cameras, residents can monitor their homes when they are away or on vacation. Smart motion sensors are also able to identify the difference between residents, visitors, pets and burglars, and can notify authorities if suspicious behavior is detected. Houseplants and lawns can be watered by way of connected timers. Kitchen appliances of all sorts are available, including smart coffee makers that can brew a fresh cup automatically at a programmed time. Smart refrigerators can keep track of expiration dates, make shopping lists or even create recipes.

IOT MODULE IN HOME

NAME: BALAJI N

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INDUSTRY 4.0

Industry 4.0 has been called the new buzzword of the manufacturing industry. Although the concept is not yet widespread, there is great potential that it will penetrate and improve many aspects of human life and today's manufacturing.. The objective of the present article is to give an overview of the underlying technologies, possible benefits and predicted challenges of Industry 4.0, in the context of the Information Society. The title 4.0 indicates that Industry 4.0 is considered the fourth industrial revolution, a logical continuation of the previous three industrial revolutions.

The Fourth Industrial Revolution:

The current, 4th revolution, started in the 2000s, takes automation even further and revolves around cyber-physical production systems. It overlaps largely with the technological advancements known as Smart Factories, the Industrial Internet of Things, **Smart Industry, or Advanced manufacturing.**

Industry 4.0 is a combination of several novel technological advancements: • information and communication technology, • cyber-physical systems, • network communications, • big data and cloud computing, • modelling, virtualization and simulation, • improved tools for human-computer interaction and cooperation.

Information and Communication Technology:

About 80% of the innovations in manufacturing are based on ICT. Digitization and the widespread application of ICT allows to integrate all systems throughout the supply and value chains and enables data aggregation on all levels. All information is digitized and the corresponding systems inside and across companies are integrated at all stages of both product creation and use lifecycles.

Cyber-Physical Systems:

Cyber-physical systems improve the capability of controlling and monitoring physical processes, with the help of sensors, intelligent robots, drones, 3D printing devices etc. In cyberphysical systems, physical components, such as 3D printers, drones and robots, and digital software components, such as data analytics and sensor technology, are aggregated into a network of interacting elements.

Network Communication:

Reliable high-quality communication networks are a crucial requirement Industry 4.0 and therefore it is important to expand the Broadband Internet infrastructure where needed. This high level of networking of interconnected components allows for a decentralized and self-organized operating of the cyber-physical systems.

Big Data and Cloud Computing:

These models are called digital twins, or device shadows. A digital twin is a computerized companion of a physical asset that enables real time monitoring, diagnostics and prognostics of the asset.

Modelling,Virtualization and Simulation:

They play the key role to lead the modern industries. They widely help in making things easy by visualising the outcome with effective softwares.

Improved Tools:

To control these processes, human workforce is supplied with state-of-the-art ICT tools that make use of advancements in augmented reality and intelligent robotics. The cyber-physical systems of Industry 4.0 have the primary aim of assisting humans in their everyday jobs.

These changes in manufacturing are said to result in a wide variety changes in manufacturing processes, products and business. Industry 4.0 has potential to positively affect meeting individual customer requirements, production flexibility, decision-making optimization, resource productivity and efficiency, value creation opportunities through new services, demographic changes in the workplace, human labor force work-life balance, and a competitive economy with high wages.

The forecasted scenarios of Industry 4.0 developments differ greatly. There are those who view Industry 4.0 as an answer to the current issues, and those who think that Industry 4.0 will only advance these issues. However, it is important to remember, that the course of Industry 4.0 has not been defined yet. The success or failure greatly depends on the course of actions taken today.

NAME : CHARULATHA K

REG NO: 2019507011

BIONIC PROSTHETICS - DISABLING DISABILITIES

Bionic prosthetics is one of the applications of mechatronics engineering in human biology. Bionic prosthetics is a game-changer in the field of medicine and amputee rehabilitation. Prosthetics have been evolving from hooks to artificial limbs that do things that a human hand can. Inspiration for bionic prosthetics is drawn from human body movements and mechanisms. They are made possible by synergetic integration of mechanical parts, electronics and software. The human body is a complex system with complex mechanism and mimicking it requires rigorous theoretical analysis and careful hardware implementation. The history of prosthetics dates back to more than 3000 years ago. Prosthetics took a technological leap after the American civil war. James Hanger, the first amputee in the war went on to design the 'Hanger Limb' which was the most advanced limb at that time and the company he founded is still a leader in the prosthetic industry. Now the bionic prosthetics have taken the baton and are much effective than how they were earlier. The sensors and actuators used in this prosthesis are of great importance.

A myoelectric prosthesis is extremely powerful and controlled by the electric signals generated by our muscles. This type of prosthesis uses the existing muscles in the residual limb to control its functions. The sensor transmits the data to a controller when the muscle contracts, it produces EMG (Electromyography signals which are similar to ECG of the heart) are interpreted and the controller commands the electric motor and moves the joint. Finger control in limbs is hard to achieve using EMG signals. Ultrasound technology along with machine learning can used to control more complex mechanisms. The unique muscle movements for individual fingers are fed into the controller and the algorithm controls the electric motor to move the fingers. There are even researches being done in brain implants that can amplify, filter and broadcast the signals. Brazilian scientist Miguel Nicolelis made a mind-controlled exoskeleton which operates on a brain human interface. Though brain human interface needs more clinical trials still it can be implanted in the future. More sensory feedbacks such as temperature sensing and pressure sensing can be introduced. The high cost of the bionic prosthetics is a concern, but the advent of 3D printing can be of big advantage in making affordable bionic prosthesis.

As far as the landscape of India is concerned, Bionics has high potential that is still untapped. A market so vast with the growing population, high demand of organ donor and rise in motor accidents leading to amputations. Fear of malfunction is a factor to overcome. Bionic prosthetics is the tool for building a future without disabilities.

Bionic Prosthetics

NAME: FAHAD K S

REG NO: 2019507015

SIEMENS ADVANCES DIGITAL TWIN TECHNOLOGY FOR MACHINING

Creating a tool chain for a more complete digital twin has been the goal for Siemens in recent years. Starting with its acquisition of the UGS NX PLM platform, the predecessor to the current Siemens Digital Industries Software division, it added through acquisition electronics simulation with Mentor Graphics and ease of use with the low-code developer Mendix. The new additional capability builds on Siemens Sinumerik One platform, which provides the tools for digital twinning CNC machinery and manufacturing processes.

With the release of its software version NCU-SW 6.14, Siemens is launching three technology packages exclusively for the CNC Sinumerik One: One Dynamics Operate, One Dynamics 3-axis milling and One Dynamics 5-axis milling.

The company noted that with a few exceptions, the functions of Sinumerik One Dynamics do not require any commissioning effort on the part of the machine builder. Once activated, they are available to the operator for immediate use on the machine. Since they are software functions of the CNC control, no intervention in the machine or machine mechanics is required. For users who have particularly challenging requirements in terms of machining quality and speed, the machine builder can add further optional CNC functions of Sinumerik that go beyond the Sinumerik One Dynamics packages.

The Sinumerik Edge Application Analyze My Machine /Condition, which the company presented last year at the EMO, uses high-frequency CNC data to create the mechanical fingerprint of a machine tool. In the application, users can capture and evaluate various parameters such as stiffness, friction, and backlash in the individual axes with the help of flexibly configurable measurement series. The measurement results can then be visualized and compared with reference data.

NAME: HARIGANESH T

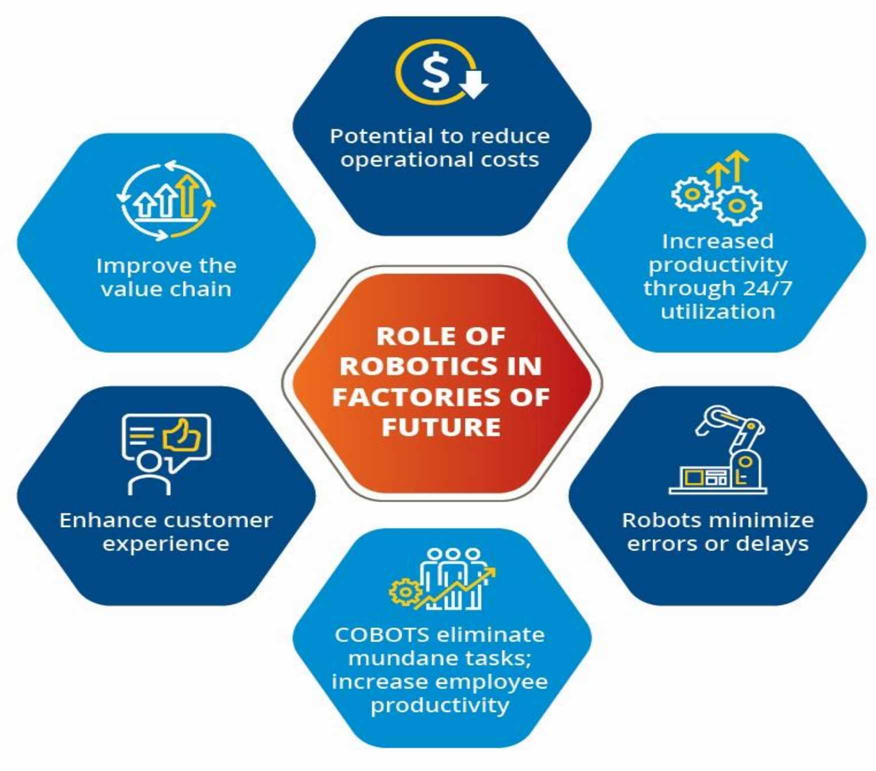
REG NO: 2019507018

<u>**AI AND ROBOT COMPANIONS**</u>

The field of artificial intelligence (AI) is over 60 years old, but it is only in recent years, with the advent of massive computational power and storage, that AI is extensively used in business strategies. Advances in related fields such as computer vision and the Internet-of-Things (IOT) have also helped accelerate the development of AI.

Experts feel there is no area that will be left untouched by AI, but the prominent ones that have captured people's imagination are self-driving cars, personalised medicine, new ways of teaching and the combination of AI and robotics.

One crucial study of how our lives will change due to AI is the One Hundred Year Study launched in 2014 at Stanford University. In its first report, in September 2016, the university says: "As cars become better drivers than people, city-dwellers will own fewer cars, live further from work, and spend time differently, leading to an entirely new urban organisation. In the typical North American city in 2030, physically embodied AI applications will not be limited to cars, but are likely to include trucks, flying vehicles and personal robots."



Future Robotics in Industries

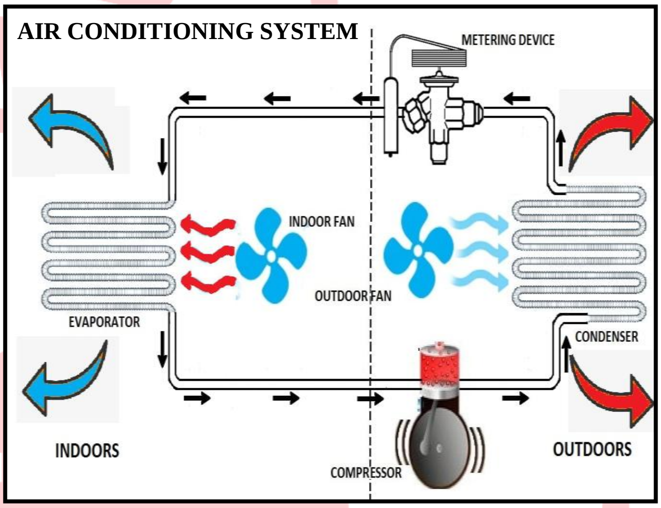
NAME: HARI HARAN V E

REG NO: 2019507019

AN AIR CONDITIONING SYSTEM

An air conditioning system uses principles of thermodynamics to cool a living space. In simple terms, it is a closed system that circulates a substance called a refrigerant, altering the pressure of the refrigerant at different points to promote the transfer of heat. Air conditioning is the process of cooling and dehumidifying indoor air to meet the requirements of thermal comfort or other purposes.

The cycle starting indoors, where the refrigerant is a cold, low-pressure mixture of liquid and vapor that enters the evaporator. The indoor fan blows hot air from the living space over the evaporator, which absorbs the heat, cooling the air blown back into the living space. The heat absorbed by the evaporator turns the refrigerant completely into vapor, and is carried outside as the refrigerant travels to the compressor.



The compressor dramatically increases the pressure and the temperature of the vaporized refrigerant and drives it to the condenser. The refrigerant is now hotter than the outside air, and as that air is blown by the outdoor fan over the condenser, the refrigerant cools and condenses into liquid form.

The liquefied refrigerant enters the metering device, which lowers the pressure and the temperature of the refrigerant and sends it back to the evaporator, as the cycle is repeated. Thus, the air conditioner works.

NAME: HARIPRIYA J

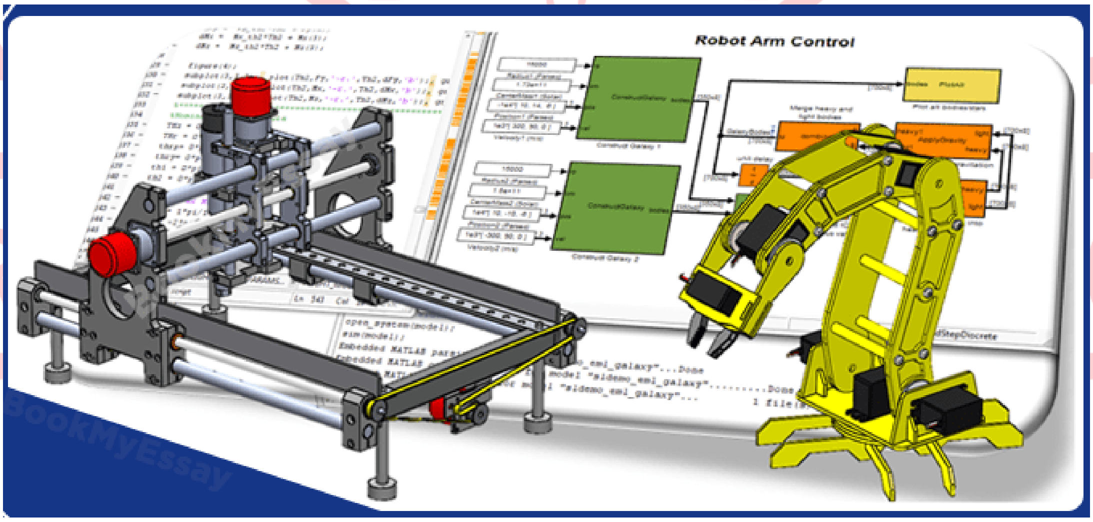
REG NO: 2019507020

AUTOMATION

In today's world what else is not automated? we are entering the age of automation unlike anything that came before. Our daily life has become incomplete and impossible without "automation". Things used to be simple but innovation makes the work much easier and rise productivity. In ancient times , people mostly did agriculture and other land works. After industrial revolution that shifted to production jobs. Automation spreaded widely all over the world. As a result of automation human most of human jobs became services and value for jobs increased.

Converting the manual process to automation is not easy as it looks. Before automating of the certain process we have to go through many things like researches , plans , designs and implements, production equipments, pneumatic components which includes mechanical applying knowledge of engineering principles and automation technologies. Where the machines are automated , there is a sure need for a production or a mechanical engineers to know the operations , troubleshooting, improvements, efficiency etc.

Though automation is based on software and codes, the mechanical and the production engineering is the heart beat of it. Starting from the process, its design, R&D, control analysis, manufacturing maintenance, output everything is under the production engineer. But this automation has some dislikes as human jobs are replaced by machines and human losing their jobs and their value for the job. However, the automation of a certain thing is not possible without the automation, mechanical or a production engineer. The future of mechanical and automation engineering offers a variety of opportunities for professionals entering the field. Stats saying that mechanical and the production engineers are less likely to be replaced by robots, as the job is ranked at 53 out of 702 all over the world. However , the people around the world strongly believe that robotics and automation should be advanced to assist humans in doing tasks which are considered to be difficult or dangerous to do manually ; not to replace humans.



Automation and Robotics

NAME: KALAI CHANDRAN M

REG NO: 2019507021

SIEMENS PRESENTS FIRST INDUSTRIAL 5G ROUTER

Siemens presents the first industrial 5G router for connecting local industrial applications to a public 5G network. Using the newly developed Scalance MUM856-1, industrial applications such as machines, control elements, and other devices can be accessed remotely via a public 5G network, providing a simple remote maintenance option for these applications using the high data rates offered by 5G.

In industry, in addition to the need for local wireless connectivity, there is increasing demand for remote access to machines and plants. In these cases, communication needs to bridge long distances. Public mobile networks can be used to access devices that are located at a considerable distance, for example in other countries. In addition, service technicians can connect to the machines they need to service via the mobile network while on the go.

Public 5G networks are therefore an important element of remote access and remote maintenance solutions. They can be used, for example, to provide users with very high bandwidths in urban areas with small radio cells and high frequencies. In rural areas, radio cells have to cover a large area, which is why lower frequencies are used. Particularly at the edges of radio cells, for example for LTE or UMTS, there are often significant losses in terms of both the bandwidth and stability of the communication connection. And it is exactly in these remote areas where stable bandwidth transmission is required for remote maintenance or video transmission, for example for water stations. With innovative 5G communications technologies, considerably more bandwidth with greater reliability is available at the edges of radio cells and the average data rate for users within a radio cell increases.

The new Scalance MUM856-1 also supports 4G so that operation is possible even if a 5G mobile network is not available. The device can also be integrated in private local 5G campus networks. Siemens is testing this use case in their own Automotive Test Center in a private standalone 5G test network, which is based on Siemens components.

NAME: KARTHIKEYAN B

REG NO: 2019507024

3D PRINTING TECHNOLOGY

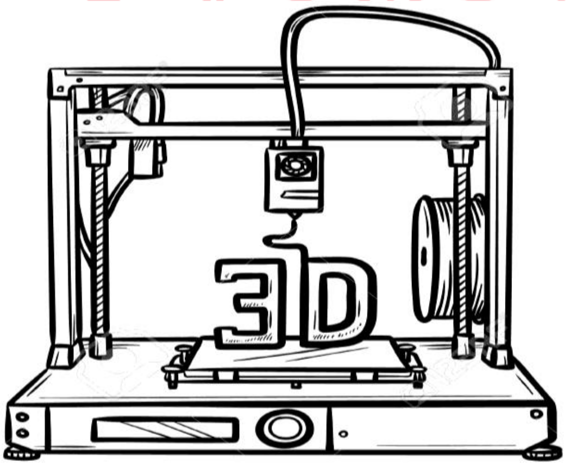
3D Printing technology is one of the growing technology in the world. 3D printing, or additive manufacturing, is the construction of a three-dimensional object from a CAD model or a digital 3D The term "3D printing" can refer to a variety of processes in which material is deposited, joined or solidified under computer control to create a three dimensional object, with material being added together (such as liquid molecules or powder grains being fused together), typically layer by layer.3D Printing is used in many fields like in construction, toys, household items, industries, clothes, food industry, medical and many more.

3D Printing is a simple process which involves first in designing the product or assets in any software, then materials which are needed for the printing the products are needed and the 3D printing machine is the important object needed for 3D printing. At last the assembling the parts to fully ready the product. It has been wondering for more than 50 years for this technology to come into existence that has become a dream come true moment for many of them. It has been wondering for more than 50 years for this technology to come into existence that has become a dream come true moment for many of them.

As far from now, there are many researchers have been going on this field and many projects have been succeeded in recent years. Actually we can also make a 3D product which comes into existence, first we have to model the product in software and then just load the soft copy of product then the 3D printer will print the object.

Some of the real life projects are:

- Rapid Prototyping done using Kuka Robotics with the help of 3D Printing Tech.
- Food Industries using additive manufacturing for making pizzas.
- Products from metals are changing to printable products, research is going on.
- 3D Printing the clothing fashion with the 3D Printing machine, etc.



3D Printer

NAME: KAUSHIK S

REG NO: 2019507025

SMART MANUFACTURING

Introduction:

Smart manufacturing is a broad category of manufacturing that employs computer integrated - manufacturing , high levels of adaptability and rapid design changes, digital information technology, and more flexible technical workforce training. Other goals sometimes include fast changes in production levels based on demand,optimization of the supply chain,efficient production and recyclability. In this concept, a smart factory has interoperable systems, multi-scale dynamic modelling and simulation, intelligent automation, strong cyber security, and networked sensors.

The broad definition of smart manufacturing covers many different technologies. Some of the key technologies in the smart manufacturing movement include big data processing capabilities, industrial connectivity devices and services, and advanced robotics.

Big Data Processing:

Smart manufacturing utilizes big data analytics, to refine complicated processes and manage supply chains. Big data analytics refers to a method for gathering and understanding large data sets in terms of what are known as the three V's, velocity, variety and volume. Velocity informs the frequency of data acquisition, which can be concurrent with the application of previous data. Variety describes the different types of data that may be handled. Volume represents the amount of data. Big data analytics allows an enterprise to use smart manufacturing to predict demand and the need for design changes rather than reacting to orders placed. Some products have embedded sensors, which produce large amounts of data that can be used to understand consumer behavior and improve future versions of the product.

Industrial Connectivity Devices and Services:

Leveraging the capabilities of the Internet, manufacturers are able to increase integration and data storage. Employing cloud software allows companies access to highly configurable computing resources. This allows for servers, networks and other storage applications to be created and released at a rapid pace. Enterprise integration platforms allow the manufacturer to collect data broadcast from its machines, which can track metrics such as work flow and machine history. Open communication between manufacturing devices and networks can also be achieved through Internet connectivity. This encompasses everything from tablets to machine automation sensors and allows for machines to adjust their processes based on input from external devices.

Advanced Robotics:

Advanced industrial robots , also known as smart machines operate autonomously and can communicate directly with manufacturing systems. In some advanced manufacturing contexts, they can work with humans for co-assembly tasks. By evaluating sensory input and distinguishing between different product configurations, these machines are able to solve problems and make decisions independent of people. These robots are able to complete work beyond what they were initially programmed to do and have artificial intelligence that allows them to learn from experience. These machines have the flexibility to be reconfigured and re-purposed. This gives them the ability to respond rapidly to design changes and innovation, which is a competitive advantage over more traditional manufacturing processes. An area of concern surrounding advanced robotics is the safety and well-being of the human workers who interact with robotic systems. Traditionally, measures have been taken to segregate robots from the human workforce, but advances in robotic cognitive ability have opened up opportunities, such as cobots, for robots to work collaboratively with people.

3D Printing:

As of 2019, 3D printing is mainly used in rapid prototyping, design iteration, and small-scale production. Improvements in speed, quality, and materials could make it useful in mass production and mass customization.

Eliminating Workplace Inefficiencies and Hazards:

Smart manufacturing can also be attributed to surveying workplace inefficiencies and assisting in worker safety. Efficiency optimization is a huge focus for adopters of "smart" systems, which is done through data research and intelligent learning automation. For instance operators can be given personal access cards with inbuilt Wi-Fi and Bluetooth, which can connect to the machines and a Cloud platform to determine which operator is working on which machine in real time. An intelligent, interconnected 'smart' system can be established to set a performance target, determine if the target is obtainable, and identify inefficiencies through failed or delayed performance targets. In general, automation may alleviate inefficiencies due to human error. And in general, evolving AI eliminates the inefficiencies of its predecessors.

Worker safety can be augmented by safe, innovative design and increasing integrated networks of automation. This is under the notion that Technicians are exposed less to hazardous environments as automation matures. If successful, less human supervision and user instruction for automation will devitalize workplace safety concerns.

Statistics:

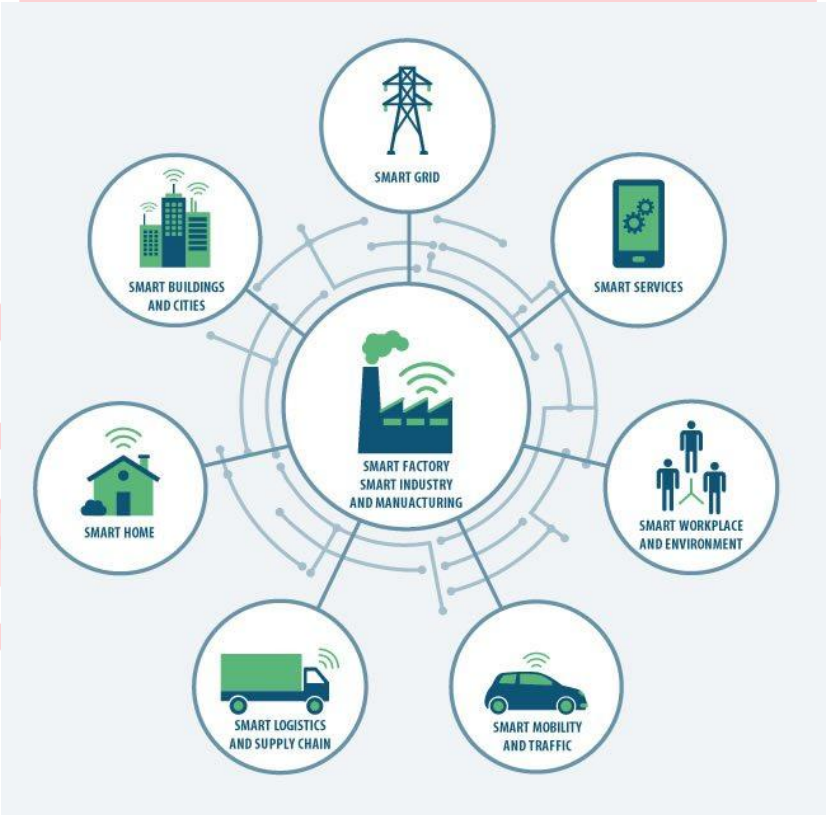
The Ministry of Economics,Trade and Industry in South Korea announced on 10 March 2016 that it had aided the construction of smart factories in 1,240 small medium enterprises, which it said resulted in an average 27.6% decrease in defective products, 7.1% faster production of prototypes, and 29.2% lower cost.

Action and Effects:

There are three core elements to this evolution:

Manufacturing execution: Manufacturing execution will play an even more important role. The degree of connectivity between the automation level and the manufacturing execution system (MES) will increase significantly, also across the borders of companies and locations. The integration of Enterprise Resource Planning (ERP) and MES levels will also advance to achieve complete transparency as well as connectivity to business data. That means that all necessary information is available in real time.

The merging of the product and production life cycle: The second core element is the merging of product and production life cycle based on a common data model. This will allow manufacturers to meet the challenges that result through ever-shorter product life cycles, both technically and in business.



Smart Manufacturing and Smart Industry

Cyber-physical systems: Cyber physical systems are a basis for the increase in manufacturing flexibility that results in shorter time to market. These production units can be flexibly integrated into existing production processes. Cyber physical systems combine communications, IT, data, and physical elements using core technologies, including sensor networks; Internet communication infrastructure; intelligent, real-time processing and event management; big data and data provisioning; embedded software for logic; and automated operations and management of systemic activities across enterprises.

Conclusion:

By smart manufacturing, productivity increases which leads to an increase in the economy. This also helps to maintain a healthy relationship between the manufacturer and the consumer. This is a gate to future manufacturing and production of products.

NAME: KEERTHANA S

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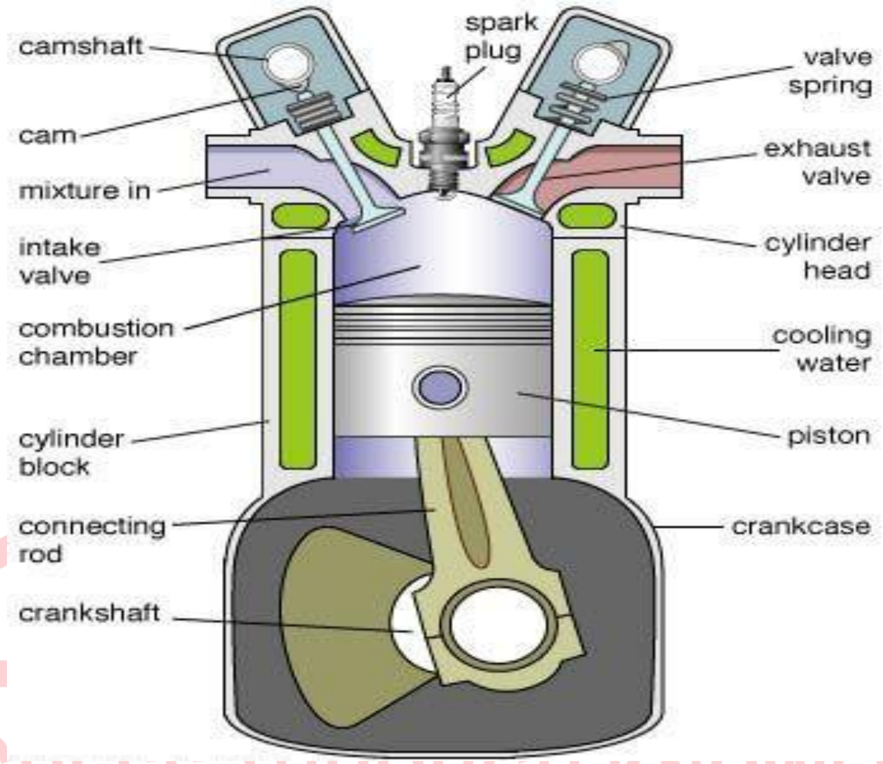
INTERNAL COMBUSTION ENGINE

In an internal combustion engine (ICE), the ignition and combustion of the fuel occurs within the engine itself. The engine then partially converts the energy from the combustion to work. There are two kinds of internal combustion engines currently in production: the spark ignition gasoline engine and the compression ignition diesel engine. Most of these are four-stroke cycle engines, meaning four piston strokes are needed to complete a cycle. The cycle includes four distinct processes: intake, compression, combustion and power (expansion), and exhaust.

Spark ignition gasoline and compression ignition diesel engines differ in how they supply and ignite the fuel. In a spark ignition engine, the fuel is mixed with air and then inducted into the cylinder during the intake process. After the piston compresses the fuel-air mixture, the spark ignites it at constant volume process causing combustion. The expansion of the combustion gases pushes the piston during the power stroke. In a diesel engine, only air is inducted into the engine and then compressed. Diesel engines then spray the fuel into the hot compressed air causing it to ignite during constant pressure process.



Parts of an IC Engine

The problem in using IC engine is that they need fuel for combustion and when these fuels are burnt there is liberation of large amount of pollutants which is very harmful to the environment. But day by day there is reduction in fossil fuels. To overcome this drawbacks, direct injection technology has been introduced. In that case fuel and air should be sprayed directly on cylinder so that the consumption rate of fuel is reduced considerably. This technology is also adapted in modern diesel and turbo-diesel engines, sometimes called 'TDI' (turbo direct injection). Turbo charging technology is also used nowadays.

It is improving efficiency, lowering fuel consumption and reducing emissions. There is no zero emission IC engines. So that the ideology of Hybrid Electric vehicles technology arises. This technology uses IC engine coupled with electric machines.

The result has proven that using this new ideology, fuel consumption and emission of pollutants are highly reduced. But the invention of Electric car fulfills all the requirements of ecofriendly vehicle. Many automobile industries have been concentrating on this eco-friendly concept. In future, IC engine can be used in fewer rate by using alternate renewable fuels and biofuels.

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REG NO: 2019507028

HYDRAULIC BRAKES

Hydraulic brakes transfer energy to stop an object, normally a rotating axle. In a very simple brake system, with just two cylinders and a disc brake, the cylinders could be connected via tubes, with a piston inside the cylinders. The cylinders and tubes are filled with incompressible oil. The two cylinders have the same volume, but different diameters, and thus different cross-section areas. The cylinder that the operator uses is called the master cylinder. The spinning disc brake will be adjacent to the piston with the larger cross-section. Suppose the diameter of the master cylinder is half the diameter of the slave cylinder, so the master cylinder has a cross-section four times smaller. Now, if the piston in the master cylinder is pushed down 40 mm, the slave piston will move 10 mm. If 10 (N) of force are applied to the master piston, the slave piston will press with a force of 40 N.

This force can be further increased by inserting a lever connected between the master piston, a pedal, and a pivot point. If the distance from the pedal to the pivot is three times the distance from the pivot to the connected piston, then it multiplies the pedal force by a factor of 3, when pushing down on the pedal, so that 10 N becomes 30 N on the master piston and 120 N on the brake pad. Conversely, the pedal must move three times as far as the master piston. If we push the pedal 120 mm down, the master piston will move 40 mm and the slave piston will move the brake pad by 10 mm.

NAME: KOUSHIK NARENDAR M

REG NO: 2019507029

COBOT: MANUFACTURING HAND

The Automation Timeline: The Drive Toward 4.0 Connectivity in Packaging and Processing report states that there are opportunities for OEMs and suppliers to offer automation technologies to companies of all sizes, across all sectors and along the entire production line. This comes as most manufacturers recognize an urgent need to broaden their use of automation. Breaking it down further, the report also states that leading Consumer Packaged Goods (CPGs) manufacturing lines are approximately 64 per cent automated, while small and medium enterprises (SMEs) are just behind with 56 per cent automation on their lines.

Today's automated packaging is supported by several advancements that include motion-control devices, 3D technology and sensors. These technologies can equip packaging machines to understand and interact with their surroundings through artificial intelligence (AI). For example, PWR Pack, a provider of robots for food packaging processes, has adopted 3D technology and sensors in its own packaging line as a way to improve overall efficiency. The use of 3D technology in the line's intelligent vision systems and sensors allows for precise product supervision and correct label placement, which is augmented further by PWR Pack's quality management.

Model of COBOT

iClick implemented an ABB dual-arm collaborative robot, also known as cobot, to maximize the capacity of the bagging machine and move its employees to higher-skilled jobs. Cobots are single or double-armed robots that can be trained to learn the repetitive motions of human workers and can learn to improve upon their initial movements over time, increasing the speed and efficiency of that specific task. This is an example of how automated systems can reduce stress on a production line and combine two manual tasks into one automated process. iClick has also been able to use the system to work on different orders, simultaneously. Through input/output (I/O) communications between the system and worker, the robot can indicate which of several dedicated conveyors to route the bagged PopGrips.

NAME: LEELA VENKATESH V

REG NO: 2019507030

CNC MACHINING

Introduction:

The term CNC stands for 'computer numerical control', and the CNC machining definition is that it is a subtractive manufacturing process which typically employs computerized controls and machine tools to remove layers of material from a stock piece known as the blank or workpiece and produces a custom-designed part. This process is suitable for a wide range of materials, including metals, plastics, wood, glass, foam, and composites, and finds application in a variety of industries, such as large CNC machining and CNC machining aerospace parts. When speaking in terms of the machine itself, the CNC machine definition is that it represents the actual programmable machine that is capable of autonomously performing the operations of CNC machining.

Subtractive manufacturing processes, such as CNC machining, are often presented in contrast to additive manufacturing processes, such as 3D printing, or formative manufacturing processes, such as liquid injection molding. While subtractive processes remove layers of material from the workpiece to produce custom shapes and designs, additive processes assemble layers of material to produce the desired form and formative processes deform and displace stock material into the desired shape. The automated nature of CNC machining enables the production of high precision and high accuracy, simple parts and the cost-effectiveness when fulfilling one-off and medium-volume production runs. However, while CNC machining demonstrates certain advantages over other manufacturing processes, the degree of complexity and intricacy attainable for part design and the cost-effectiveness of producing complex parts is limited.

Overview of CNC Machining Process:

Evolving from the numerical control (NC) machining process which utilized punched tape cards, CNC machining is a manufacturing process which utilizes computerized controls to operate and manipulate machine and cutting tools to shape stock material—e.g., metal, plastic, wood, foam, composite, etc.—into custom parts and designs. While the CNC machining process offers various capabilities and operations, the fundamental principles of the process remain largely the same throughout all of them. The basic CNC machining process includes the following stages:

- Designing the CAD mode
- Converting the CAD file to a CNC program
- Preparing the CNC machine
- Executing the machining operation

CAD Model Design:

The CNC machining process begins with the creation of a 2D vector or 3D solid part CAD design either in-house or by a CAD/CAM design service company. Computer aided design (CAD) software allows designers and manufacturers to produce a model or rendering of their parts and products along with the necessary technical specifications, such as dimensions and geometries, for producing the part or product.

Designs for CNC machined parts are restricted by the capabilities (or inabilities) of the CNC machine and tooling. For example, most CNC machine tooling is cylindrical therefore the part geometries possible via the CNC machining process are limited as the tooling creates curved corner sections. Additionally, the properties of the material being machined, tooling design, and workholding capabilities of the machine further restrict the design possibilities, such as the minimum part thicknesses, maximum part size, and inclusion and complexity of internal cavities and features. Once the CAD design is completed the designer exports it to a CNC compatible file format such as STEP or IGES.

CAD File Conversion:

The formatted CAD design file runs through a program, typically computer-aided manufacturing (CAM) software, to extract the part geometry and generates the digital programming code which will control the CNC machine and manipulate the tooling to produce the custom-designed part.

CNC machines used several programming languages, including the G-code and M-code. The most well-known of the CNC programming languages, general or geometric code, referred to as G-code, controls when, where, and how the machine tools move e.g., when to turn on or off, how fast to travel to a particular location, what paths to take, etc. across the workpiece. Miscellaneous function code, referred to as M-code, controls the auxiliary functions of the machine, such as automating the removal and replacement of the machine cover at the start and end of production, respectively.

Machine Setup:

Before the operator runs the CNC program, they must prepare the CNC machine for operation. These preparations include affixing the workpiece directly into the machine, onto machinery spindles, or into machine vises or similar workholding devices, and attaching the required tooling, such as drill bits and end mills, to the proper machine components. Once the machine is fully set up, the operator can run the CNC program.

Machining Operation Execution:

The CNC program acts as instructions for the CNC machine; it submits machine commands dictating the tooling's actions and movements to the machine's integrated computer, which operates and manipulates the machine tooling. Initiating the program prompts the CNC machine to begin the CNC machining process, and the program guides the machine throughout the process as it executes the necessary machine operations to produce a custom-designed part or product.CNC machining processes can be performed in-house if the company invests in obtaining and maintaining their own CNC equipment or out sourced to dedicated CNC machining service providers

Types of CNC Machining Operations:

CNC machining is a manufacturing process suitable for a wide variety of industries, including automotive, aerospace, construction, and agriculture, and able to produce a range of products, such as automobile frames, surgical equipment, airplane engines, and hand and garden tools. The process encompasses several different computer-controlled machining operations including mechanical, chemical, electrical, and thermal processes which remove the necessary material from the workpiece to produce a custom-designed part or product. While chemical, electrical, and thermal machining processes are covered in a later section, this section explores some of the most common mechanical CNC machining operations including:

- Drilling
- Milling
- Turning

CNC Drilling:

CNC Drilling Machine

Drilling is a machining process which employs multi-point drill bits to produce cylindrical holes in the workpiece. In CNC drilling, typically the CNC machine feeds the rotating drill bit perpendicularly to the plane of the workpiece's surface, which produces vertically-aligned holes with diameters equal to the diameter of the drill bit employed for the drilling operation. However, angular drilling operations can also be performed through the use of specialized machine configurations and work holding devices. Operational capabilities of the drilling process include counter boring, countersinking, reaming, and tapping.

CNC Milling:

CNC Drilling

Milling is a machining process which employs rotating multi-point cutting tools to remove material from the work piece. In CNC milling, the CNC machine typically feeds the work piece to the cutting tool in the same direction as the cutting tool's rotation, whereas in manual milling the machine feeds the workpiece in the opposite direction to the cutting tool's rotation. Operational capabilities of the milling process include face milling cutting shallow, flat surfaces and flat-bottomed cavities into the workpiece and peripheral milling cutting deep cavities, such as slots and threads, into the workpiece.

CNC Turning:

CNC Turning

Turning is a machining process which employs single-point cutting tools to remove material from the rotating work piece. In CNC turning the CNC machine typically a lathe or turning machine feeds the cutting tool in a linear motion along the surface of the rotating workpiece, removing material around the circumference until the desired diameter is achieved, to produce cylindrical parts with external and internal features, such as slots, tapers, and threads. Operational capabilities of the turning process include boring, facing, grooving, and thread cutting.

Types of CNC Machining Support Software:

The CNC machining process employs software applications to ensure the optimization, precision, and accuracy of the custom-designed part or product. Software applications used include:

- CAD
- CAM
- CAE

CAD:

Computer-Aided Design (CAD) software are programs used to draft and produce 2D vector or 3D solid part and surface renderings, as well as the necessary technical documentation and specifications associated with the part. The designs and models generated in a CAD program are typically used by a CAM program to create the necessary machine program to produce the part via a CNC machining method. CAD software can also be used to determine and define optimal part properties, evaluate and verify part designs, simulate products without a prototype, and provide design data to manufacturers and job shops.

CAM:

Computer-Aided Manufacturing (CAM) software are programs used extract the technical information from the CAD model and generate machine program necessary to run the CNC machine and manipulate the tooling to produce the custom-designed part. CAM software enables the CNC machine to run without operator assistance and can help automate finished product evaluation.

CAE:

Computer-aided engineering (CAE) software are programs used by engineers during the pre-processing, analysis, and post-processing phases of the development process. CAE software is used as assistive support tools in engineering analysis applications, such as design, simulation, planning, manufacturing, diagnosis, and repair, to help with evaluating and modifying product design. Types of CAE software available include finite element analysis (FEA), computational fluid dynamics (CFD), and multibody dynamics (MDB) software.

Summary:

Operations and their required equipment, and some of the considerations that may be taken into account by manufacturers and machine shops when deciding whether CNC machining is the most optimal solution for their particular manufacturing application

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NX SIEMENS SOFTWARE

NX, formerly known as "Unigraphics", is an advanced high-end CAD/CAM/CAE, which has been owned since 2007 by Siemens PLM Software. In 2000, Unigraphics purchased SDRC I-DEAS and began an effort to integrate aspects of both software packages into a single product which became Unigraphics NX or NX. Siemens NX software is a flexible and powerful integrated solution that helps us deliver better products faster and more efficiently. NX delivers the next generation of design, simulation, and manufacturing solutions that enable companies to realize the value of the digital twin…Supporting every aspect of product development, from concept design through engineering and manufacturing, NX gives you an integrated toolset that coordinates disciplines, preserves data integrity and design intent, and streamlines the entire process. It is used, among other tasks, for Design (parametric and direct solid/surface modelling), Engineering analysis (static; dynamic; electro-magnetic; thermal, using the finite element method and fluid, using the finite volume method). Manufacturing finished design by using included machining modules.

While, we are seeing about the supported operating systems and platforms of NX software, it runs on Linux, Microsoft Windows and Mac OS. Starting with version 1847, support for Windows versionsprior to Windows 10 as well as for macOS was completely removed, and the GUI was removed from the Linux version. While speaking about the architecture of NX software, it uses Parasolid for its Geometric modeling kernel andD-Cubed as Associative engine for sketcher and assembly constraints for lightweight data and Multi-CAD. NX is a direct competitor to CIATIA, Creo, Autodesk Inventor, and SolidWorks. The main key functions of NX basic software are listed following:Computer-aided design (CAD) for Design, Computer-aided engineering (CAE) for Simulation,Computer-aided manufacturing (CAM) for Manufacturing. Sothese are main features and characteristics of NX Siemens Software.

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ROBOTICS AND AUTOMATION

When we think about the future, the first thing that crosses most of our minds is robots. Now many industries use huge robots to carry out important tasks. The recent technological developments have enabled the automation of industries by advancing in robotics. This helps us to navigate the digital transformation taking place. In recent times, robots have proven to be highly efficient,

Smart manufacturers are seeing the potential of the emerging robots. In the third quarter of 2019, 23,894 robotic units were ordered whose value totals to $1.3 billion. This trend is mainly due to the fact that collaborative robots have evolved. The collaborative robots [cobots] allow manufacturers to automate one process at a time thereby increasing the investment. Cobots are easier to digest, faster to deploy and generates returns quicker.

According to Joe Campbell, Universal Robot's senior manager of strategic marketing and applications, there has been a noticeable raise in the number of small and medium sized manufacturing companies embracing collaborative robots. "The difference is that in many cases the programming is taking place by the line operator. The business impact in these companies is significant because is struggling to hire, which hits these companies even harder" he says. The cost of collaborative robots is below the annual cost of an average manufacturing worker. This makes cobots more appealing.

Industry focused companies are building products to easily integrate with robots in a way that eliminates the time, cost and risks associated with robots. Vectics Automation developed a full welding kit including a software process layer geared for a welder rather than an engineer to put the robot into action. This removes the need for a skilled robot engineer for every application.

The highly noticeable trend in automation is the convergence of IT and OT technology. It is causing organizations to take advantage of the integration. This paved the way for digital transformation which is taking place by automation. The involvement of these technologies has increased the productivity with an increased amount of data driven software.

As automation makes its way into new spaces, the efficient use of data is proving to be significant. Blake Moret, CEO of Rockwell Automation, says, "To be able to have scalable solutions that process just enough data could be right at the edge or in the cloud. Your workforce needs to be comfortable interacting with the system making simplification important. We need to drive the complexity out".

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<u>HUMAN RELATIONS AT WORK</u>

Human relations at work is one of the basic needs for a person in his profession. It is a relation between you and another person or between you and people in your workspace. Learning about human relations will help you to manage and overcome problems or difficulties at your workspace.

Maintaining a good human relation may reduce amount of conflict between the workers and the company. There are some important skills one must gain to maintain proper human relation at work. Some of the skills are good communication and interactions between co-workers to create better relationship, avoiding confrontation and resolve conflict, and one of the wise skills that I recommend is, not take any important decision while you are in stress or not in a clear mindset to make a decision.

Sometimes people in higher position at workplace need to be more careful with their activities and interactions. They must have enough courage to face the critical circumstances. Here are few suggestions to avoid such situation: Before any critical battle arise, prepare yourself for that battle. Imagine yourself in that situation and sketch a plan, how to tackle or dodge such situation. These were some ideas that should be followed by oneself to reach a higher position or as a fine worker.

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THE HYPERLOOP

The **Hyperloop** is a proposed mode of passenger and freight transportation,first used to describe an open-source vactrain design released by a joint team from Tesla and spaceX. Hyperloop is a sealed tube or system of tubes with low air pressure through which a pod may travel substantially free of air resistance or friction.The Hyperloop could convey people or objects at airline or hypersonic speeds while being very energy efficient. This would drastically reduce travel times versus trains as well as planes over distances of under approximately 1,500 kilometres (930 miles).

Elon Musk first publicly mentioned the Hyperloop in 2012. His initial concept incorporated reduced-pressure tubes in which pressurised capsules ride on air bearings driven by linear induction motors and axial compressors.

The Hyperloop Alpha concept was first published in August 2013, proposing and examining a route running from the Los Angeles region to the San Francisco Bay area, roughly following the interstate 5 corridor. The Hyperloop Genesis paper conceived of a hyperloop system that would propel passengers along the 350-mile (560 km) route at a speed of 760 mph (1,200 km/h), allowing for a travel time of 35 minutes, which is considerably faster than current rail or air travel times. The Hyperloop concept has been explicitly "open-sourced" by Musk and SpaceX, and others have been encouraged to take the ideas and further develop them. Virgin Hyperloop conducted the first human trial with Virgin Hyperloop executives Josh Giegel, its Chief Technology Officer, and Sara Luchian, Director of Passenger Experience as the first passengers at a speed of 172 km/h (107 mph) at the Virgin Hyperloop’s DevLoop test site in Las Vegas, Nevada on November 8 2020. The first hyperloop passengers just took a short but important ride. In a test on Sunday in Nevada, two people hit a speed of 107 mph. On Sunday, November 8, two people sat in a pod in a tube in Nevada and were quickly whisked a distance of about 1,300 feet.

“Maharashtra will create the first hyperloop transportation system in the world and a global hyperloop supply chain starting from Pune,” announced Chief Minister Fadnavis recently. “Maharashtra and India are at the forefront of hyperloop infrastructure building now and this is a moment of pride for our people.

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WATER SOLUBLE 3D PRINTING MATERIAL

Infinite Material Solutions LLC., a material design innovator focused on additive manufacturing, announces the official launch of a water-soluble 3D printing support material called AquaSys 180.

Built for exceptional temperature stability, this new product thrives in printing conditions that no existing water-soluble support material can withstand . This makes it uniquely compatible with industry-favored thermoplastics such as Polyetheretherketone (PEEK) and Polyetherimide (PEI), and significantly reduces the cost and time of downstream processing.

The step-forward that AquaSys 180 represents will be apparent to businesses that uses Fused Filament Fabrication (FFF) to print parts made from these high-temperature thermoplastics. Until now, doing so has required that each part be printed with support structures made from materials that either need to be removed manually, or dissolved with harmful solvents.

With AquaSys 180, users can now dissolve support structures with warm tap water, leaving behind a finished part with minimal residue, according to the company.

Bringing AquaSys 180 to market

“We are extremely excited to launch our AquaSys 180 product,” said Cernohous. “AquaSys 180 can be printed at chamber temperatures up to 180°C and has been engineered to function with high-temperature engineering thermoplastics like PEEK, PEKK, PEI and PPSU, providing unprecedented design freedom to our customers as a result. I am extremely proud of my team for their efforts to create this disruptive product.”

Infinite Material Solutions said this product announcement builds on previous efforts to "create a disruptive product in the field of 3D printing support materials." The company’s previous endeavor, AquaSys 120, was introduced in 2018 as what it calls the first water-soluble support compatible with popular build materials such as ABS.

"With AquaSys 180, the AquaSys offering is poised to attract a larger audience, especially within industries like aerospace and automotive, in which end-use parts made from PEI or PEEK would be particularly advantageous.

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AUGMENTED REALITY IN PRODUCTION ENGINEERING

Augmented reality (AR) refers to the combination of real and virtual worlds (computer-generated). A real image is captured on video, while that real-world image is “augmented” with layers of digital information. Augmented reality superimposes a computer generated (CGI) video onto a camera captured video, giving the impression that the CGI objects appear to have a fixed location in the real world. A camera streams real-world images to the display. A computer is given a reference on where to place the virtual objects. There can be a marker-based reference which uses a marker to achieve an augmentation, such as physical objects of the real world. These augmentations enhance the object or the image applying digitally enhanced images.

In manufacturing, the technology can be used to measure a variety of changes, identify unsafe working conditions, or even envision a finished product.Safety is always an issue in the manufacturing environment. With the right AR applications, inexperienced employees can be informed, trained, and protected at all times without wasting supplementary resources. Technical training and education can be expensive when working with large, complex machinery or dangerous equipment.AR can be used for factory planning.

Although the concept of augmented reality has been around for some time, the technology is still in its early stages but is growing very quickly. Augmented reality glasses are forecasted to achieve sales around 19.1 million units by next year. As augmented realty is expanded in manufacturing, we will certainly see some scenarios that we never thought possible or even imagined.

Augmented reality

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STATISTICS FOR PRODUCTION MANAGEMENT

Manufacturing has emerged as one of the highest growth sectors in terms of market size, investments and coverage. It comprises of apparel, chemical, automobiles, electronics, aeronautical, electrical, textile, food, etc.

Statistics, we heard a lot about it right! In this data-centric world, the importance of statistics is well known in all the areas. It holds a key position in general manufacturing, healthcare, finance, pharmaceutical, automotive and so forth. With the expertise of modern Statistical Data Analytics Software, we can do statistical data computations in seconds.

By applying statistics, we can present data in a simpler form and make a data-driven decision. There are many business benefits of statistics, such as process efficiency & productivity, better decision support systems, quality excellence, predict your business outcomes, and many more. Moreover, statistics is the base level knowledge required in all the Data Science disciplines (Business Analytics, Predictive Analytics, Machine Learning).

A few of the popular statistical methods used in the Manufacturing Industry are:

- Hypothesis Testing
- Measurement System Analysis (MSA)
- Statistical Process Control (SPC)
- Design of Experiment (DOE)

Hypothesis Testing:

We often do Sampling in a process, now you must be thinking "How sampling is related to hypothesis testing?" To draw inference or conclusion about the sample data with respect to the population as a whole, we use hypothesis testing. There are different methods used in hypothesis testing based on sample, such as one-sample t-test, two-sample t-test, ANOVA, etc.

Measurement System Analysis (MSA):

We collect data for analysis and draw some conclusion from it. Now the question is "How much we are sure that the data we collected is reliable enough for analysis?" MSA helps us to find variation in the data we collected from a measurement system and guide us to improve the system for measurement. Measurement System Analysis has different methods based on the types of data, for continuous data – Gage R&R Analysis and for attribute data – Attribute Agreement Analysis.

Statistical Process Control (SPC):

We want to know whether our process is statistically under control or out of control. And further, we want to evaluate whether our process is capable to meet our client requirement or not. How to examine it? Here, Statistical Process Control (SPC) comes into play which is a tool through which we can control, monitor and improve the process. It is used to track variation and eliminate it from a process. It is widely used in almost all manufacturing processes for process stability and continuous improvements.

Design of Experiment (DOE):

The terms like robustness and optimization are at peak in manufacturing processes. How to achieve it? Simple, by conducting the design of experiment or popularly known as DOE. It provides a quick and effective method for optimizing products or processes. It plays a major role in new product design & formulation, process development and improvement.

We have discussed a few of the statistical methods which are popularly used in the manufacturing industry. This small article can't cover all the statistical methods used in the industry. But at least, we got a glimpse of it. Statistics has emerged as one of the basic foundational skill needed in data science and applications. Most of the advanced statistical methods are used for quality improvement and organisational excellence.

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INTERNET OF THINGS

The Internet of things (IoT) describes the network of physical objects“things”—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of things. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", including devices and appliances (such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances).

Short-range wireless

Bluetooth mesh networking – Specification providing a mesh networking variant to Bluetooth low energy (BLE) with increased number of nodes and standardized application layer (Models).

Wi-Fi – Technology for local area networking based on the IEEE 802.11 standard, where devices may communicate through a shared access point or directly between individual devices.

ZigBee – Communication protocols for personal area networking based on the IEEE 802.15.4 standard, providing low power consumption, low data rate, low cost, and high throughput.

Long-range wireless

Low-power wide-area networking (LPWAN) – Wireless networks designed to allow long-range communication at a low data rate, reducing power and cost for transmission. Available LPWAN technologies.

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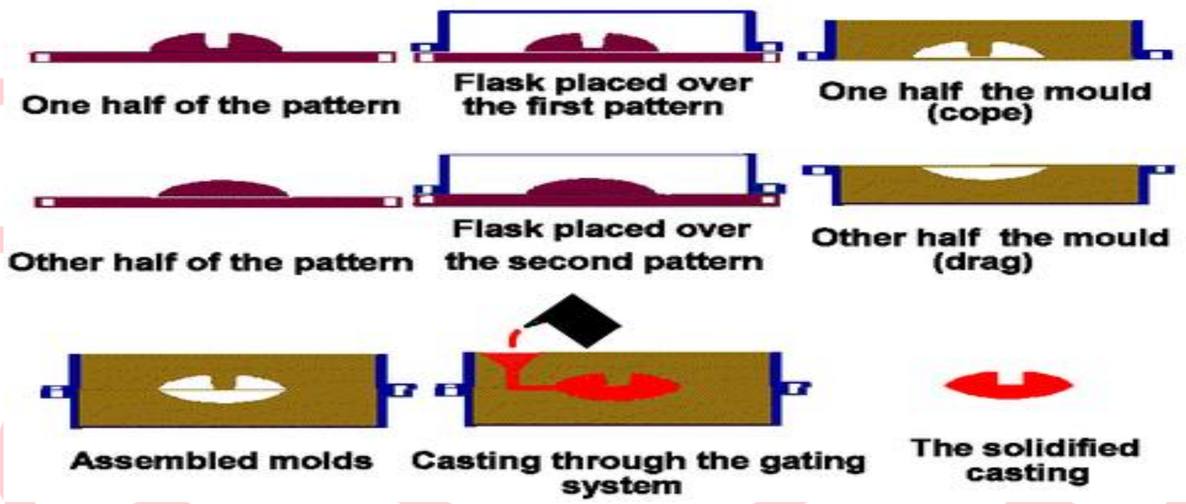
SAND CASTING

Sand casting,also known as sand molded casting,is a metal casting process characterized by using as the mold material. It is relatively cheap and sufficient refractory even for steel foundary use. A suitable bonding agent(usually clay)is mixed or occurs with the sand.The mixture is moistened with water to develop strength and plasticity of the clay and to make the agregate suitable for molding.The term"sand casting"can also refer to a casting produced via the sand casting process.Sand castings are produced in specialized factories called foundries.Over 70% of all metal castings are produced via a sand casting process.

Basic processes:

- Place a pattern in sand to create a mold.
- Incorporate the pattern and sand in agating system.
- Remove the pattern.
- Fill the mold cavity with molten metal.
- Allow the metal to cool.
- Break away the sand mold and remove the casting.



Steps involved in Sand Casting

Sand casting can be readily produced in nearly any ferrous or non-ferrous alloys.

- **Good design flexibility**
- **High complexity shapes**
- **Wider material choices.**

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REFRIFERATOR SYSTEM , WORKING AND USES :

A refrigerator (colloquially **fridge**) consists of a thermally insulated compartment and a heat pump (mechanical, electronic or chemical) that transfers heat from its inside to its external environment so that its inside is cooled to a temperature below the room temperature. Refrigeration is an essential food storage technique in developed countries. The lower temperature lowers the reproduction rate of bacteria, so the refrigerator reduces the rate of spoilage. A refrigerator maintains a temperature a few degrees above the freezing point of water. Optimum temperature range for perishable food storage is 3 to 5 °C (37 to 41 °F).[1] A similar device that maintains a temperature below the freezing point of water is called a **freezer**. The refrigerator replaced the icebox, which had been a common household appliance for almost a century and a half.

The first cooling systems for food involved ice. Artificial refrigeration began in the mid-1750s, and developed in the early 1800s. In 1834, the first working vapor-compression refrigeration system was built. The first commercial ice-making machine was invented in 1854. In 1913, refrigerators for home use were invented. In 1923 Frigidaire introduced the first self-contained unit. The introduction of Freon in the 1920s expanded the refrigerator market during the 1930s. Home freezers as separate compartments (larger than necessary just for ice cubes) were introduced in 1940. Frozen foods, previously a luxury item, became commonplace.

Freezer units are used in households as well as in industry and commerce. Commercial refrigerator and freezer units were in use for almost 40 years prior to the common home models. The freezer-over-refrigerator style had been the basic style since the 1940s, until modern, side-by-side refrigerators broke the trend. A vapor compression cycle is used in most household refrigerators, refrigerator–freezers and freezers. Newer refrigerators may include automatic defrosting, chilled water, and ice from a dispenser in the door.

Domestic refrigerators and freezers for food storage are made in a range of sizes. Among the smallest are Peltier-type refrigerators designed to chill beverages. A large domestic refrigerator stands as tall as a person and may be about 1 m wide with a capacity of 600 L. Refrigerators and freezers may be free-standing, or built into a kitchen. The refrigerator allows the modern household to keep food fresh for longer than before. Freezers allow people to buy food in bulk and eat it at leisure, and bulk purchases save money.

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