Fr. C. Rodrigues Institute of Technology

Department of Mechanical Engineering

Mechanical Engineering Students' Association

PRESENTS

# URJA (2016-17)

# ADVANCEMENT IN MANUFACTURING TECHNOLOGY

**Fr. C. Rodrigues Institute of Technology, Vashi**

**Department of Mechanical Engineering**

**Mechanical Engineering Students' Association**

Presents

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(2016-2017)

# Advancement in Manufacturing Technology

# PRINCIPAL'S MESSAGE

I intently believe that you should have an all-round development of your personality, having ambitions and aims untrammeled and hard work, enthusiasm, resilience laced with knowledge and intellect will take you to any extent you desire. Make it a habit to read newspapers daily and ensure the optimum use of library. In today's world professional approach towards things is necessary. Understanding the basics, relating them to real world situations and then building them into bigger things will help you to become a better engineer. Time management is another asset in the fervent stride for success. Endeavour to be better human being while foraying in the competitive life, realizing your dream's honesty and integrity should be your second names. The college life provides the opportunity to develop one's personality to the fullest extent. The college magazine harnesses the skills in writing of the students but also inculcates in them the habit of pleasure of reading.

**- Dr. S.M.Khot**

# HOD'S MESSAGE

Department of Mechanical Engineering is striving hard towards the goal of providing innovative and quality education with high standards to achieve academic excellence. We always intend to impart knowledge through a closed knit family of highly competent faculty. The very motto of our department is to provide quality education. The process of learning is extremely important in life. What you learn, how you learn and where you learn play a crucial role in developing ones intellectual capability, besides career. Reading is something which everyone should take seriously. Reading is important because it develops the mind and develop creative side of people. Reading is important because words-spoken and written are building blocks of life. And then building them into bigger things will help you to become a better engineer. Time management is another asset towards success. When you practice good time management, you have more time to breathe; this allows you determine which choices are the best to make. Try to be a better human being in this competitive world. Realize your dreams. Honesty and integrity should be your second name. The college life provide sample opportunity to develop ones personality. The college magazine harnesses the skills in writing of the students but also inculcates in them the habit of reading.

- **Prof. T. Mathewlal**

# CORDINATOR'S MESSAGE

MESA is a collegiate organization which stands for Mechanical Engineering Students Association. The objective of MESA is to create opportunities for students to enhance their knowledge about the latest developments in the technological world, by organizing various events. The MESA council of FCRIT, Vashi has ensured a continuous flow of ideas and knowledge by conducting seminars every year. These seminars give the students a sneak peak in the outside world. SYNERGY and MESH are the two events conducted every year under the aegis of MESA. In SYNERGY, one industry is identified during the year and is invited to the campus for interaction. The aim is to bridge the gap between industry and institute and provide an opportunity for staff and students to directly interact with them. During MESH, a seminar lecture series is organized in which expert speakers from industry and academia such as BARC, IIT etc. are invited to deliver lecture in their area of expertise. A project poster presentation is also organized wherein the final year students display their projects and present posters of their respective projects. Students display their projects and present posters of their respective projects. Students of lower semesters get an opportunity to have a glimpse of the type of project being carried by final year students. Apart from these activities, MESA also publishes an annual magazine on various technological topics. The published articles are related to researches and inventions that many are unaware of and might be interested in.

MESA continuously works for the overall development of the personality of the student other than their academic responsibilities. MESA provides wings and sky to the mind which are planning to fly high and believe in wellness in work.

**MESA Coordinators**

# ABOUT MESA

MESA is not a professional society, but works on the same ground. The objective of MESA is to create opportunities for the students to enhance their knowledge about the latest developments in the technological world, by organizing various events. Synergy and MESH are two conducted every year as a part of activities under MESA. MESH is conducted during the second half of academic year and synergy during the second half. Both these seminars look forward to provide a broader vision to the students regarding the various technologies and happening in the professional field outside the college classrooms. SYNERGY is organized with the aim of bridging the gap between the industry and the institute and facilitates industry institute interaction. One industry is identified during the year and invited to the campus. Professionals from industry develop lecture on 'Emerging Technologies and Methodologies' employed by their organization. The event provides an opportunity for the staff and students to directly interact with the professional of the industry. The industry, in turn, gets to know the institute closely, thereby providing an opportunity to identify the value addition required to create high class professional from the institute. MESH aims to introduce the recent trends in research and development, where in, research scholars /academicians from IITS and reputed institutes are invited to deliver lectures to students. Industry veterans are also invited to share their knowledge and experience with the students every year.

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# TECHNOLOGICAL TRANSFORMATION

**Akash Nemlekar (Mech - VI)**

Given today's leading-edge capabilities, it's reasonable to envision and prepare for a data-driven factory of the future, where all internal and external activities are connected through the same information platform. Customers, designers, and operators will share information on everything from initial concepts, to installation, to performance feedback throughout the life cycle of the product. Operators will access materials on demand, collaborate with robots to use them safely and ergonomically, and rely on virtual work instructions presented at the point of use. Assembly lines will output highly personalized products, sometimes in a lot size of one, that contain zero defects. But what breakthrough equipment, ideas, and processes will have the greatest impact on factory environments? The following four technology categories are already driving much of the change.

## INTERNET OF THINGS (IoT)

The connected factory is an idea that has been evolving for the past few years. Increasingly, it means expanding the power of the Web to link machines, sensors, computers, and humans in order to enable new levels of information monitoring, collection, processing, and analysis. These devices provide more precision and can translate collected data into insights that, for example, help to determine the amount of voltage used to produce a product or to better understand how temperature, pressure, and humidity impact performance. Stanley Black & Decker has adapted the Internet of Things in a plant in Mexico to monitor the status of production lines in real time via mobile devices and Wi-Fi RFID tags. As a result, overall equipment effectiveness has increased by 24 percent, labor utilization by 10 percent, and throughput by 10 percent.

But for industrial manufacturing companies, the next generation of IoT technology should go well beyond real-time monitoring to connected information platforms that leverage data and advanced analytics to deliver higher-quality, more durable, and more reliable products. A hint of this can be seen in wind turbines manufactured by General Electric (GE). This equipment contains some 20,000 sensors that produce 400 data points per second. Immediate, ongoing analysis of this data allows GE and its customers to optimize turbine performance and proactively make decisions about maintenance and parts replacement.

Before investing in IoT, however, industrial manufacturing companies must determine precisely what data is most valuable to collect, as well as gauge the efficacy of the analytical structures that will be used to assess the data. In addition, next-generation equipment will require a next-generation mix of workers, which should include employees who can design and build IoT products as well as data scientists who can analyze output.

## ROBOTICS

Over the last decade, China emerged as an automated manufacturing powerhouse, as increased labor costs and booming industrial demand drove tremendous growth in industrial robotics. Since 2013, the number of shipments of multipurpose industrial robots in China roughly doubled to an estimated 75,000 in 2015, with that number forecast to double yet again to 150,000 by 2018, according to the International Federation of Robotics. Yet although a Chinese company recently broke ground on the world's first fully automated factory in Dongguan, the widespread use of robotics and unmanned control technologies may not address all productivity concerns. Indeed, some manufacturers believe that greater automation is harmful, resulting in less innovation because only people can develop ideas to improve processes and products. Consequently, robotic implementation is evolving on a different path in the U.S. and other mature economies. In many cases, robots are employed to complement rather than replace workers. This concept, known as "Cobotics," teams operators and machines in order to make complex parts of the assembly process faster, easier, and safer.

Cobotics is rapidly gaining momentum, and successful implementations to date have focused largely on specific ergonomically challenging tasks within the aerospace and automotive industries. But these applications will expand as automation developers introduce more sophisticated sensors and more adaptable, highly functional robotic equipment that will let humans and machines interact deftly on the factory floor.

## AUGMENTED REALITY

Recent advances in computer vision, computer science, information technology, and engineering have enabled manufacturers to deliver real-time information and guidance at the point of use. Users simply follow the text, graphics, audio, and other virtual enhancements superimposed onto goggles or real assemblies as they perform complex tasks on the factory floor. These tools can simultaneously assess the accuracy and timing of these tasks, and notify the operator of quality risks.

Some industrial manufacturing companies are using this technology to provide hands-free training, enable faster responses to maintenance requests, track inventory, increase safety, and provide a real-time view of manufacturing operations. In more than a few instances, these added services could be sold as add-ons to the equipment itself, creating a new revenue stream for industrial manufacturing firms. Among the possible applications is an assembly-line instructional feature in which video clips or text instructions walk workers through complex processes step-by-step. Mistakes resulting from fatigue or on-the-job pressure are eliminated. Another possibility involves using data and physical evidence retrieved by augmented reality on the factory floor to design new equipment that addresses the shortcomings of present-day devices on the assembly line.

## 3D PRINTING

Also known as additive manufacturing, 3D printing technology produces solid objects from digital designs by building up multiple layers of plastic, resin, or other materials in a precisely determined shape. Early adopters among industrial manufacturing companies are using 3D printing to manufacture parts in small lots for product prototypes, to reduce design-to-manufacturing cycle times, and to dramatically alter the economics of production. For example, BAE Systems turned to 3D printing when it could no longer secure a critical injection-molded plastic part for a regional jetliner. The company saved more than 60 percent on the cost of the part, avoided retooling costs, and shrank production lead times by two months.

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# ROBOTS CHANGE HEAVY FABRICATION

**Poorva Khare (Mech - IV)**

The new generation of automation helps to keep workers safe and boosts production efficiency in heavy-duty fabrication shops.

Robots have had a long time presence in precision sheet metal fabrication shops, but not so much in companies that worked with structural steel or heavy plate. That's changing, however, because today's automation holds great potential to change the dynamic of heavy work.

**Figure 1: Automated Press Brake**

Heavy fabricators, particularly those that work with large-part, large-plate, and foundry applications, have been undergoing a technological evolution with the increasing use of robotic automation. Traditionally, heavy fabricators have relied on people power, hoists, cranes, and manipulators to maneuver large and weighty pieces through the process. However, robots have become less expensive and easier to use than ever before, which has opened the door for manufacturers and job fabrication shops to take a serious look at the benefits and return on investment (ROI) of robotic automation.

## STREAMLINING LARGE-PART FABRICATION

Manufacturers of large parts, such as castings and frames for trucks, off-road vehicles, and equipment for agricultural, construction, mining, and defense applications, are limited by their ability to make and move those parts quickly, consistently, and safely. Parts can weigh up to 1,000 lbs. and be as long as 12 ft. Some fabricating activities, such as making bends, call for the giant part to be laboriously moved several times at a press brake.

To improve throughput and quality, large-part manufacturers are turning to robots for machine loading/unloading, part handling, welding, painting, and assembly.

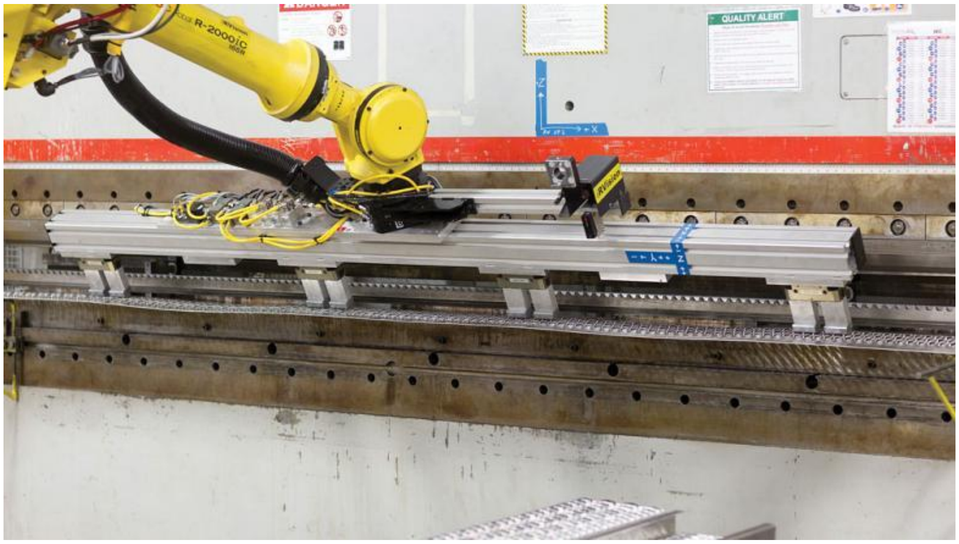


**Figure 2: Robot Gripper**

Robots stand to make a large impact in these types of applications. As an example, let's look at the process of forming tube from large plate.

To fabricate trapezoid-shaped tubes from flat laser-cut plate, the manufacturer's biggest challenge is presenting enormous pieces of plate metal, sometimes up to 72 in. long and 0.375 in. thick, to the press brake. First, two operators or a hoist add 90-degree bends with approximately 1-in. flanges on both long edges. Next, a 5-in. radius is formed to close the flanges against the upper die. Then the formed part is slid off the upper die after forming. Production requirements for an operation like this can be up to 400 tubes per day.

In this instance, seeing the opportunity for safer and more efficient operations with large plate, the tube fabricator upgraded to a robotic system, which doubled throughput. Much like the story of the tortoise and the hare, a robot moves plate material consistently and repeatedly. A human worker may move plate quickly for short intervals, but ultimately needs breaks and gets fatigued over time.

**OFFLINE PROGRAMMING**

Today’s robotic systems have offline programming capabilities, which remove many of the manual steps in setup and changeover. By working through an entire heavy process in a virtual environment, operators don’t even need to touch a piece of metal. Instead of workers handling heavy plate unnecessarily and creating scrap during process refinements, the entire line is established before turning on the machines.

In addition, offline programming minimizes downtime while a cell is configured for a new product. With more simple, intuitive robotic programming available today, most technicians can learn program touch-up after just a few hours of training.

Handling large parts and plates is cumbersome, difficult, painstaking, and back-breaking. As heavy fabricators continue to use robots, they will have better control over their businesses and be more competitive. Greater capacity, more projects, and bigger profits will lead to more job creation and new skill sets for workers in North America.

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# MICROMANUFACTURING

**Suraj Kumar Suntha (Mech- VI)**

Nowadays, meso (1-10 mm) and micro (1-1000 μm) manufacturing are emerging as an important technology specially in the areas where miniaturization yields economic and technical benefits, namely, aerospace, automotive, optical, biomedical and similar other areas. With the advent of numerical control (NC) in machine tools, accuracy, uniformity and repeatability of the machined parts have improved and manufacturing has gained the flexibility. With time, the miniaturization of the machines and devices is leading to the demand of parts with dimensions of the order of a few micrometers to a few hundred micrometers. It is quite safe to say that there is a need to have the manufacturing processes, which are capable of dealing with atomic and molecular dimensions. Hence, such processes come under the category of μ-manufacturing.

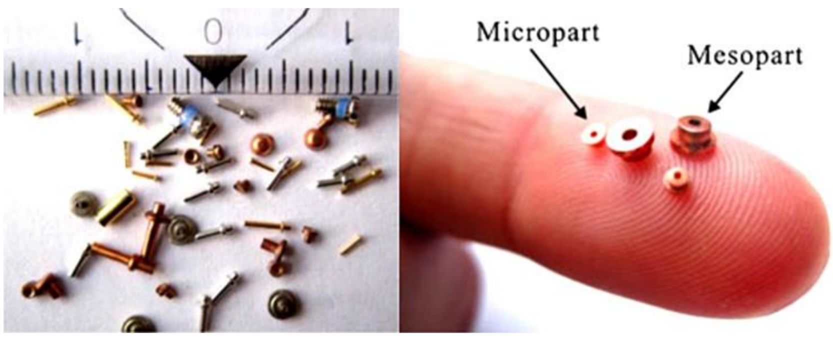


**Figure 1: Examples of Microparts**

Some of the examples of the products that require μ-manufacturing are micro holes in fiber optics, micro nozzles for high temperature jets, micro molds etc. Conventional methods (turning, drilling, etc.) with modified versions have been employed for μ- machining of various types of materials.

## MICROECM TECHNOLOGY

Electrochemical micromachining is a process in which metal is removed from metallic work pieces by controlled dissolution of surface atoms without direct contact between the tool and the work piece material. Material removal follows Faraday's law of electrolysis, that is, the amount of material removed is proportional to the time and intensity of an electrical current flow between tool and work piece. The work piece is not exposed to mechanical or thermal stress; hence there is no change in the physical or chemical properties of the material.

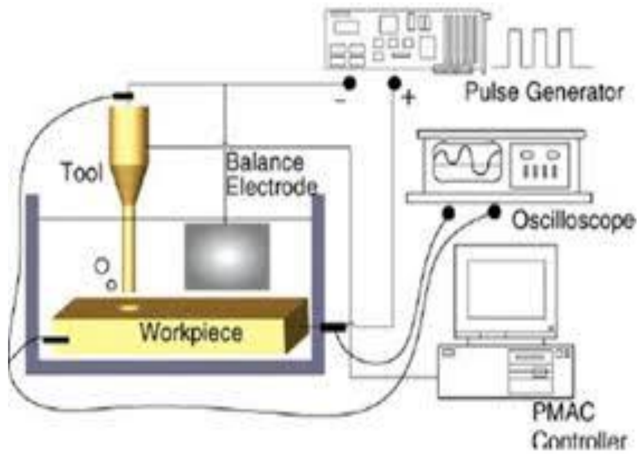


**Figure 2: Schematic setup of pulsed micro-ECM**

The microECM process can produce internal features a few microns deep by 10s to 100s of microns wide or external features as small as a few microns in some applications. In general, the process is limited by the ability to produce the cathode tool required to machine the desired features.

A significant advantage of the microECM technology is the ability to machine features in bores. The ability of the process to meet requirements for full-form, high-volume machining, with no consumed tooling, is very attractive to manufacturing. These microECM production systems have demonstrated unique capabilities with respect to micromachining.

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# LASER BASED ADDITIVE MANUFACTURING (LBAM)

**Najid Tisekar (Mech-VI)**

You might be knowing what is manufacturing which is nothing but to "make things on a large scale" as simple & short for even a layman to understand. Moving on to Advancements in manufacturing technology is to use our innovations in practical application i.e. innovative technology to improve products or processes. This brings us to have a look at the Laser Based Additive Manufacturing (LBAM) which is hailed by some as the 'third industrial revolution & one of the most sought by manufacturers of metal parts. LASER is the term applied for amplification of light by stimulated radiation emission. It is the key element in additive manufacturing or LBAM.

In the case of additive production, components are produced only from powder and laser light. Based on a 3D model, the laser builds it layer by layer. Thus, additive processes form a contrast to ablative and transforming processes which have so far prevailed in industrial manufacturing. The additive processes realize geometrically complex objects that would not be feasible with conventional methods - without tools. A great advantage here includes is the freedom of form in the design.

**Figure 1: LASER Metal Deposition**

The central element in additive manufacturing is a laser. It melts the metal powder and solidifies it to a high quality work piece. There are different possibilities for the additive production of metals: powder-based laser melting (laser metal fusion or LMF) and laser metal deposition (laser metal deposition or LMD). In the case of powder-based laser melting, the laser of powder creates layer-wise new work pieces. Until now, it has been able to exploit its advantages mainly in the production of prototypes, unicast and small batches. During laser application welding, the laser produces a molten bath on the component surface into which a metallic filler material in powder form is continuously introduced and melted. Thus, welded caterpillars are formed which result in structures on existing basic bodies or entire components. The method is also used for coating and repair.

## LASER LIGHTS THAT CAN BE USED

Nd: YAG (Solid laser), gaseous ($CO_2$ Laser) etc.

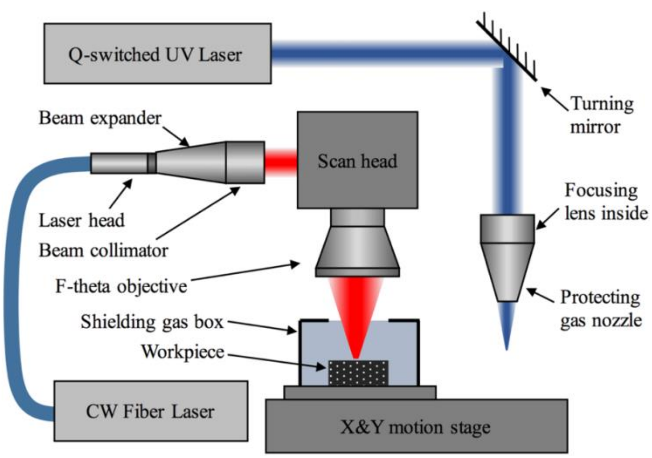


**Figure 2: Foil-based laser Additive Mfg. process**

One of the techniques used in LBAM is the Laminated Object Manufacturing (LOM). It is especially suited for producing parts from laminated paper, plastic, metals etcetera. A laser beam cuts the contour of part cross section. Several such sections when glued or welded, yield the prototype.

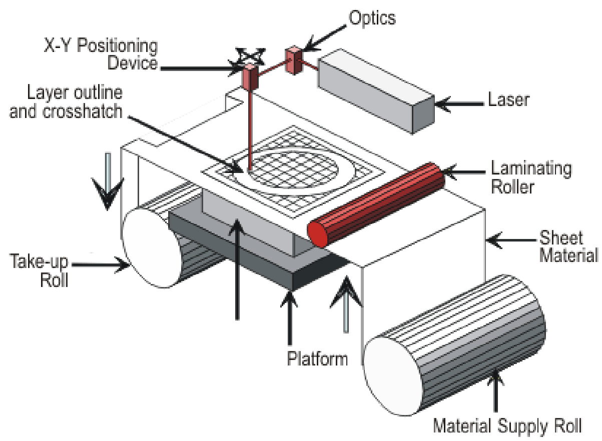


**Fig. 3: LOM setup**

## ADVANTAGES OF LBAM

Faster production rate, accuracy is high, saves a lot of time, Laser can be used for welding, No wastage as it is additive mfg. complex contour shapes production. Such advancement again is an essentiality because time changes; Change is at the heart of growth and enrichment. So I believe that manufacturers in industry must adapt to the statement by Steven Jobs as: "Let's go invent tomorrow instead of worrying about what happened yesterday."

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# THERMOACOUSTIC INSTABILITIES AND ITS CONTROL

**Divya Rao, Aditya Naikdhure, Aditya Nair (Mech – IV)**

**ABSTRACT**

Thermoacoustics is the study of a phenomenon that involves the concept of both thermodynamics and acoustics. In 1859, Rijke introduced this phenomenon by using a heated wire screen to induce strong oscillations in a tube which turns heat into sound by creating a self-amplifying standing wave. This is an excellent example of resonance. According to Lord Rayleigh, the vibration is encouraged if heat is given to the air at the moment of greatest condensation or taken from it at the moment of greatest refraction. The thermoacoustic instabilities arise from the coupling between pressure fluctuations and unsteady heat release in combustion and its detrimental consequences have been of serious concern in many practical applications. The characterization of thermoacoustic instability is very much essential for the design of the combustor. For example, in gas turbines, jet engines, etc. These instabilities depend on different parameters such as heat supplied, flow through the combustor, dimensions of the combustor and position of the heat supplied. There are many control techniques suggested and implemented by various researches in the past and are broadly classified as active control and passive control. Active control uses external energy. Passive control techniques include a certain change in design of combustion system. This study focuses on the basics of occurrence of thermo-acoustic instabilities and different effective ways to control it.

**EFFECTS OF THERMOACOUSTIC INSTABILITIES**

Thermoacoustic instabilities are often dangerous, since large fluctuations in pressure lead to excessive vibrations in the structure, raising fatigue concerns and mechanical failures .The occurrence of combustion instabilities produce large amplitude pressure and velocity oscillations that results in thrust oscillations, severe vibrations, and enhanced heat transfer to the combustor walls. It can result in premature component wear that could lead to costly shut down or mission failure.

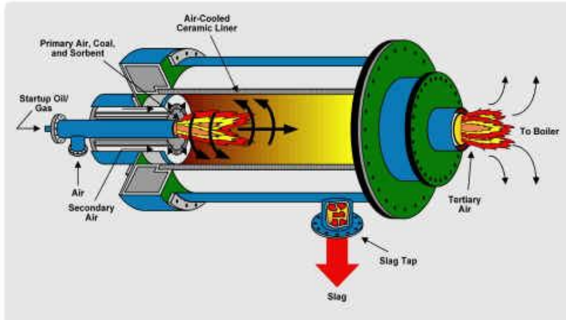


**Figure 1: Combustor**

First of all, there are several ways to explain why combustion chamber is susceptible to acoustic instabilities. First, the energy density associated with the combustion is quite large; therefore, a small fraction of this energy is sufficient to drive the oscillation. Second, combustion process involves time lags. That is, reactants entering the chamber are converted into the products in a finite time. Systems with delays are more readily unstable. Third, in most practical combustors, which have confined and weakly damped geometries, resonant interactions can readily occur. These factors all favor the establishment of unstable oscillations.

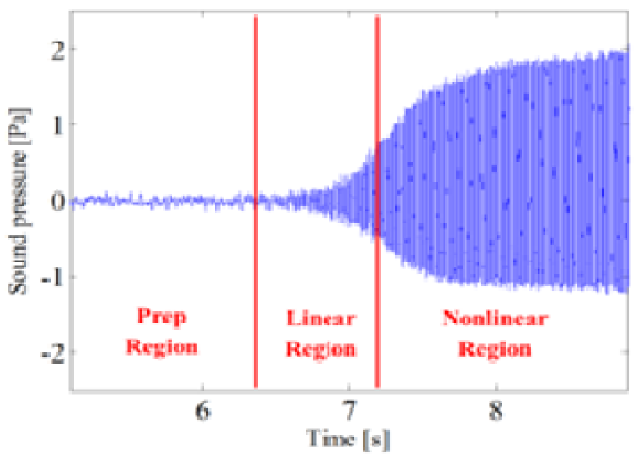


**Figure 2: Sound pressure vs Time Graph**

To meet the stringent emission norms, the development of lean combustion system is the necessity. But the lean combustors are more prone to combustion instabilities .The problem of thermoacoustic instabilities in low NOx combustors is the result of specific changes made to the diffusion flame combustor to accommodate premixing of air and fuel. In premixed combustors, most of the combustion air is sent through the fuel injector, eliminating the need for downstream combustion air holes that are present in diffusion flame combustors. These downstream air holes provide acoustic damping that reduces the likelihood of oscillations. Also, because of the distributed reaction zone in diffusion flames, it is unlikely that heat-release perturbations couple with the acoustic perturbations .Therefore thermoacoustic instabilities is not much of a concern in conventional combustors. On the other hand in premixed systems, the unsteady heat release is by the flame is an acoustic source and induces pressure waves in the combustor chamber. These acoustic travel downstream and after reflection from the boundaries return to the flame. This way the instabilities within the flame are enhanced and the flame fluctuates even stronger.

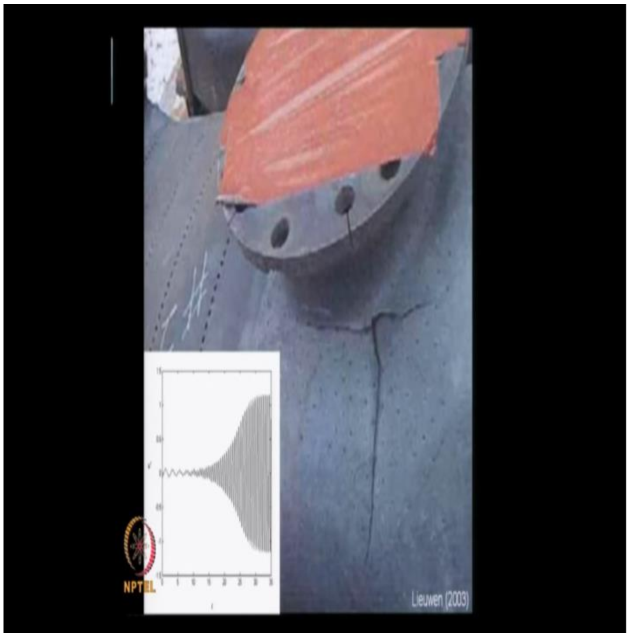


**Figure 3: Instability**

Mainly the problems that arise due to thermoacoustic instabilities are increased heat transfer at combustor walls, deteoration of combustion efficiency, increase in emission, and structural damage. Problem with this instability is that it is identified only in the later stages of program then it is very hard to fix it.

## CONTROL TECHNIQUES

In recent years, there has been considerable activity addressing the control of thermoacoustic instabilities. The research effort, throughout investigations carried out on lab scale experiments and the succeeding theoretical analysis, has shown the potential to damp or even to control combustion oscillations. In principle, two main categories of the control of thermoacoustic instabilities exist in gas turbine combustors. The passive control strategy is widely used in almost every industrial combustor compared to the active control techniques.

Since acoustic wave propagation is part of the feedback mechanism involved in thermoacoustic instabilities, passive control designs resort often to modify the resonant system of the combustor. Baffles, mufflers, Helmholtz resonators, acoustic liners and perforated plates were mounted at the combustor to change the boundary conditions and to damp acoustic attributes of the system.

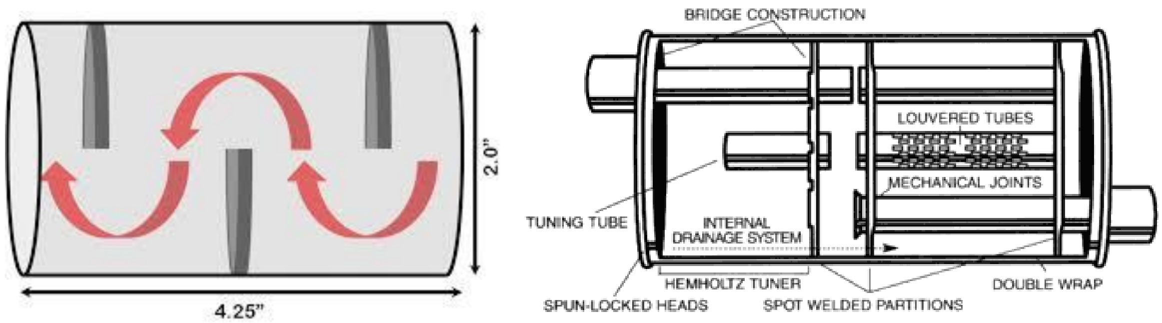


**Figure 4: Cross section view of muffler**

This design changes of the combustor result in a continuous combustion less prone to thermoacoustic instabilities. However, in general passive control does not provide a means for controlling these instabilities due to the multiple number of modes that may be excited within the combustor at different operating conditions.

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# ARTICLE ON PHOTOLITHOGRAPHY

**Jay M. Gite (MECH-VI)**

Photolithography also termed as optical lithography or UV lithography, is a process used in microfabrication to pattern parts of a thin film or bulk of a substrate. Photolithography basically uses light to transfer a geometric pattern from a photomask to a light sensitive chemical "photoresist" on the substrate. A series of chemical treatments that are then performed either engraves the exposure pattern into, or enables deposition of a new material in the desired pattern upon the material underneath the photo resist.

**<u>PROCEDURE UNDERSTANDING OF PHOTOLITHOGRAPHY.</u>**

STEPS INVOLVED IN PHOTOLITHOGRAPHY.

- **<u>CLEANING</u>**

In case if there is a presence of organic or inorganic contaminations on the wafer surface, they are usually removed by wet chemical treatment. Solutions made with trichloroethylene, acetone or methanol are used for cleaning process.

- **<u>PREPARATION</u>**

The wafer is initially heated to a temperature of around 1500C sufficient to remove off any moisture that may be present on the wafer surface. The wafer is covered with photoresist using spin coating. A viscous, liquid solution is dispensed onto the water and wafer is spun rapidly to produce a uniformly thick layer. The spin coating typically runs at 1200 to 4800 rpm for 30 to 60

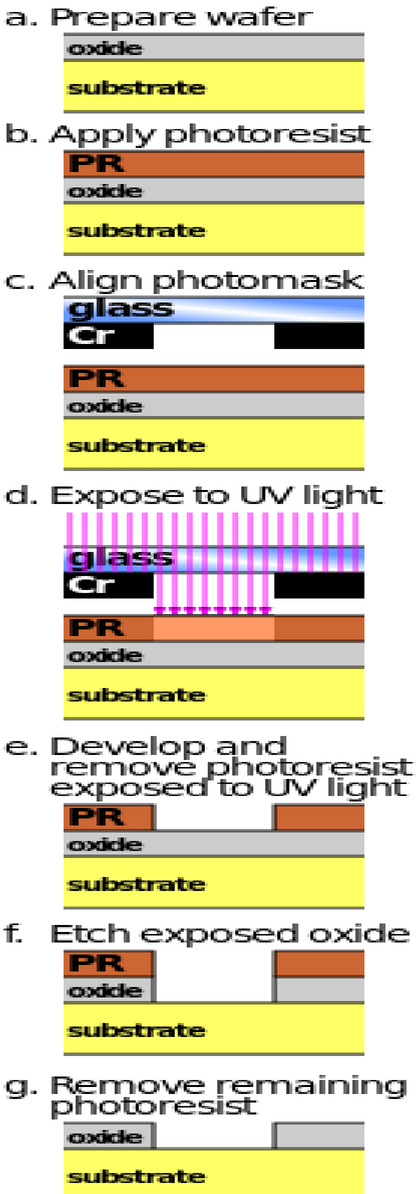


**Figure 1: Procedure**

seconds and it produces a layer between 0.5 to 2.5 micrometers thick. The uniformity obtained is in the range of 5 to 10 nanometers. The uniformity is on the account of viscous forces which bind the resist to wafer surface. The photoresist coated wafer is then prebaked to drive off any excess photoresist solvent, typically at 90 to 1000C for 30 to 60 seconds on a hotplate.

- **EXPOSURE AND DEVELOPING**

After prebaking, the photoresist is exposed to a pattern of intense light. The exposure to light causes a chemical change that allows some of the photoresist to remove by a special solution, called "developer" by analogy with photographic developer. In case of positive photo resist which is the commonly used version, the photoresist portion becomes soluble in the developer when exposed to light. In case of negative photo resist the region unexposed are soluble in the developer. A post exposure bake (PEB) is performed before developing with an intention typically to reduce the development of standing wave phenomenon caused by the destructive and constructive interference patterns of the incident light

- **ETCHING**

In etching either a wet or liquid chemical agent or a plasma (dry) chemical agent is used to remove the uppermost layer of the substrate in the areas that are not protected by photoresist. In semiconductor fabrication, dry etching techniques are generally used in order to avoid significant undercutting of the photoresist pattern. This becomes extremely essential when the width or size of the features to be developed is less than or equal to the thickness of the material being etched. The development of low-defectivity anisotropic dry-etch process has enabled the ever-smaller features defined photolithography. Wet etch process is isotropic in nature and is often indispensable.

- **PHOTORESIST REMOVAL**

After the process wherein photoresist is no longer a requirement it must be removed from the wafer surface or substrate. This process requires a resist stripper which chemically alters the resist so that it no longer adheres to the substrate. Alternative method uses a plasma containing oxygen which oxidizes it. This process is called ashing and is similar to dry etching.

**LIGHT SOURCE USED FOR PHOTOLITHOGRAPHY**

Historically, photolithography has used ultraviolet light from gas-discharge lamps using mercury or sometimes in combination with noble gases like xenon. These lamps produces light across a broad spectrum with several strong peaks in the ultraviolet range. A filtering process is carried out to select a single spectral line. Recent advancements has made led to the use of deep ultraviolet excimer lasers in lithography systems as krypton fluoride laser at 248 nanometers wavelength and the argon fluoride laser at 193 nanometers wavelength. Optical lithography has been extended to feature sizes below 50 nanometers using 193 nanometer argon fluoride excimer. Visible and infrared lasers were also applied for lithography. In such cases, photochemical reactions are initiated by multiphoton absorption. Usage of these light sources have a lot of advantages including possibilities to manufacture true 3-D objects and process non-photosensitized or pure glass like materials with superb optical resiliency.

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# 3-D PRINTING AND FUTURE PRODUCTION INDUSTRY

**Akash Kadam (MECH - IV)**

What is Innovation? “Getting a product into market and satisfying the human needs is called as Innovation". One of which is 3-D printing technology. 3-D printing, also known as Additive manufacturing (AM), refers to a process used to synthesize a three dimensional object in which successive layers of material are formed under computer control to create an object. Objects are of almost any complicated shapes and geometry.

Today this technology is changing the production industry by replacing the older method and techniques. Some experts feel that the technology is decades away from viability, but also believe that," The 3-D printing industry is expected to change nearly every industry it touches, completely disrupting the traditional manufacturing process ".Today most important factor in industry is saving of material cost and minimizing the wastage of materials.3-D printing technology has the potential to make the manufacturing options infinite and extremely precise. For example, today what's known as "subtractive process" if we want to make a part made out of an aluminum, a block is placed into CAD system & excess material is cut away to make the part. Using this process approximately 60 to 70 percent of aluminum block ends up as scrap depending upon the complexity of the shape required. By contrast 3-D printing is additive and manufacturers are able to use minimum material needed to fabricate the part .In this example eliminating the process of scrap melting ultimately driving down total material costs for manufacturers. For the manufacturing industry in general, this could significantly reduce capital tied up in the raw material and costs to reclaim scrap.

One more important factor in any industry is production time .In traditional assembly line process for engineered-to-order products for instance, the tools and material must be changed out for each individual job and reprogrammed for each customer and product .With 3-D printing the production time is given greater flexibility since assembly is a single operation and set up time is reduced nearly to zero .Due to flexibility in assembly line process industry would be able to push the orders through faster and in greater capacity. Additionally, the manufacturing process can be done at lower cost and every order can be made with shorter production time with great accuracy and precision.


**Figure 1: 3D Printing Machine**

The economics of manufacturing also changes. Manufacturing is less labor intensive uses less material produces less waste and can use new materials that are light and strong. Depending on material used products made with 3D printing technology can be up to 65% lighter but just as strong as traditionally manufactured products. Customization will become very easy triggering new product strategies and customer relationships collaboration with customers to create products. We can say that as 3D printing evolves, the new world of manufacturing looks like this:

## TIME TO MARKET FOR PRODUCTS SHRINKS

This will be due in part to faster design and prototyping cycles as a result of 3D printing, but also to the elimination of tooling and factory setup time for new products.

## PRODUCTS HAVE SUPERIOR CAPABILITIES

The barriers for manufacturing will be lowered .At the same time, products incorporating 3D printed components will exhibit superior features.

## CUSTOMIZATION IS THE NEW NORM

As innovative companies use 3D printing and other rapid techniques to offer customization at no additional cost. Consumers will come to expect customization as norm.

## THE ECONOMICS OF OFF-SHORE CHANGE

The cost advantage associated with mass production in low cost regions will be challenged by 3D printers providing just in time manufacturing near the point of sale or point of assembly.

## OPEN DESIGN IS HERE TO STAY

Communities of end users will be increasingly responsible for product designs, which will be available to anyone with necessary skills and tools who want to design and then manufacture .These open design products will be superior to proprietary products.

3D printing is increasing rapidly, with practical examples in numerous industries including defense, aerospace, automotive and healthcare. Although 3D printing has been applied mainly to low volume production, the products can be far superior (lighter, stronger, customized, already assembled) and cheaper than if created with traditional manufacturing processes. This is because 3D printing can control exactly how materials are deposited (built up), making it possible to create structures that cannot be produced using conventional means.

In a Nutshell 3D printing can be described as:

- **UNIQUE ADVANTAGES**
    - Affordable customization.
    - Allows manufacture of more efficient designs.
    - Lighter, stronger, less assembly required.
    - One machine, large scale production.
    - Very small objects.
    - Efficient use of raw materials(less waste)
    - Pay by weight.
    - Batches of one, created on demand.
    - New supply chain and retail opportunities.

- **<u>AREAS OF FURTHER DEVELOPMENT</u>**

  - Printing large volumes economically.
  - Expanding the range of printable materials.
  - Reducing the cost of printable materials.
  - Using multiple materials in the same printer including those for printing electronics.
  - Printing very large objects.
  - Improving durability and quality.

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# SELECTIVE LASER SINTERING

**Sanika Nanoti (MECH - VI)**

Selective laser sintering (SLS) is an additive manufacturing (AM) technique that uses a laser as the power source to sinter powdered material (typically metal), aiming the laser automatically at points in space defined by a 3D model, binding the material together to create a solid structure. It is similar to direct metal laser sintering (DMLS); the two are instantiations of the same concept but differ in technical details. Selective laser melting (SLM) uses a comparable concept, but in SLM the material is fully melted rather than sintered, allowing different properties (crystal structure, porosity, and so on). SLS (as well as the other mentioned AM techniques) is a relatively new technology that so far has mainly been used for rapid prototyping and for low-volume production of component parts. Production roles are expanding as the commercialization of AM technology improve.

## TECHNOLOGY

An additive manufacturing layer technology, SLS involves the use of a high power laser (for example, a carbon dioxide laser) to fuse small particles of plastic, metal, ceramic, or glass powders into a mass that has a desired three-dimensional shape. The laser selectively fuses powdered material by scanning cross-sections generated from a 3-D digital description of the part (for example from a CAD file or scan data) on the surface of a powder bed. After each cross-section is scanned, the powder bed is lowered by one layer thickness, a new layer of material is applied on top, and the process is repeated until the part is completed.

Because finished part density depends on peak laser power, rather than laser duration, a SLS machine typically uses a pulsed laser. The SLS machine preheats the bulk powder material in the powder bed somewhat below its melting point, to make it easier for the laser to raise the temperature of the selected regions the rest of the way to the melting point.

In contrast with some other additive manufacturing processes, such as stereo lithography (SLA) and fused deposition modelling (FDM), which most often require special support structures to fabricate overhanging designs, SLS does not need a separate feeder for support material because the part being constructed is surrounded by unsintered powder at all times, this allows for the construction of previously impossible geometries. Also, since the machine's chamber is always filled with powder material the fabrication of multiple parts has a far lower impact on the overall difficulty and price of the design because through a technique known as 'Nesting' multiple parts can be positioned to fit within the boundaries of the machine. One design aspect which should be observed however is that with SLS it is 'impossible' to fabricate a hollow but fully enclosed element. This is because the unsintered powder within the element can't be drained.

Since patents have started to expire, affordable home printers have become possible, but the heating process is still an obstacle, with a power consumption of up to 5 kW and temperatures having to be controlled within 2 °C for the three stages of preheating, melting and storing before removal.

## MATERIALS

- **POLYAMIDE (PA)**

Being a solid material, polyamide powder has the attractive feature of being self-supporting for the generated product sections. This makes support structure redundant. Polyamide allows the production of fully functional prototypes or end-use parts with high mechanical and thermal resistance.

- **POLYAMIDE ALUMINUM-FILLED (ALUMIDE)**

Alumide is a blend of aluminum powder and polyamide powder, which allows metallic-looking, non-porous components to be machined easily and is resistant to high temperatures (130°C).

- **CERAMICS**

SLS of ceramic materials can be either direct or indirect. Direct SLS of ceramics can be powder based or slurry based. In the powder-based method, the packing density of the powder layers is low, leading to a lower sintered density and also leading to cracks due to thermal stresses in the parts.

- **METALS**

Because metals possess excellent compressive strengths and also high fatigue resistance, porous metallic scaffolds such as titanium (Ti) and tantalum (Ta) and biocompatible alloys such as CoCr and nitinol have been proposed as bone replacement materials, but unlike bioactive ceramics or biocompatible polymeric scaffolds, biomolecules cannot be integrated into metallic scaffolds.

- **COMPOSITES**

Polymers are elastic and have low stiffness, whereas ceramics are rigid and brittle [69]. By mixing ceramics and polymers into composites, the mechanical properties are significantly improved because the problem of brittleness and the difficulty of shaping hard ceramics can be overcome

**APPLICATIONS**

- Prototypes with mechanical properties to rival those of injection-molded parts
- Series of small components as a cost-effective alternative to injection molding
- Large and complex functional parts up to 700 x 380 x 580 mm in one piece
- Personalized manufacturing, the economical production of unique, complex, designs built as one-off products or in small batches
- Lightweight designs using complex lattice structures

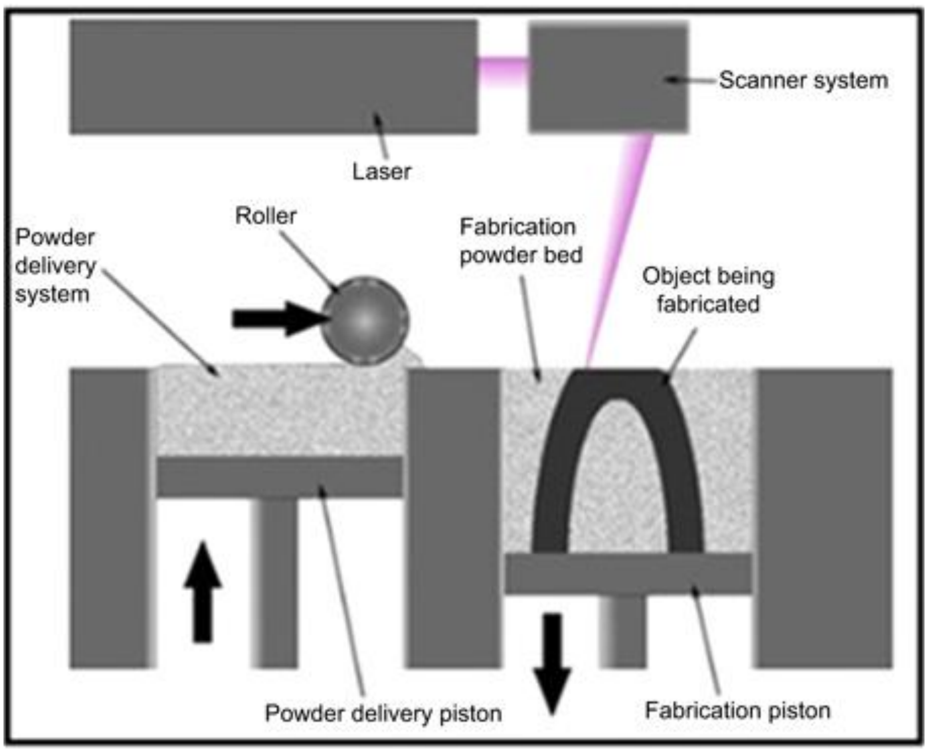


**Figure 1: Schematic of SLS from 3D CAD design to the laser sintering process.**

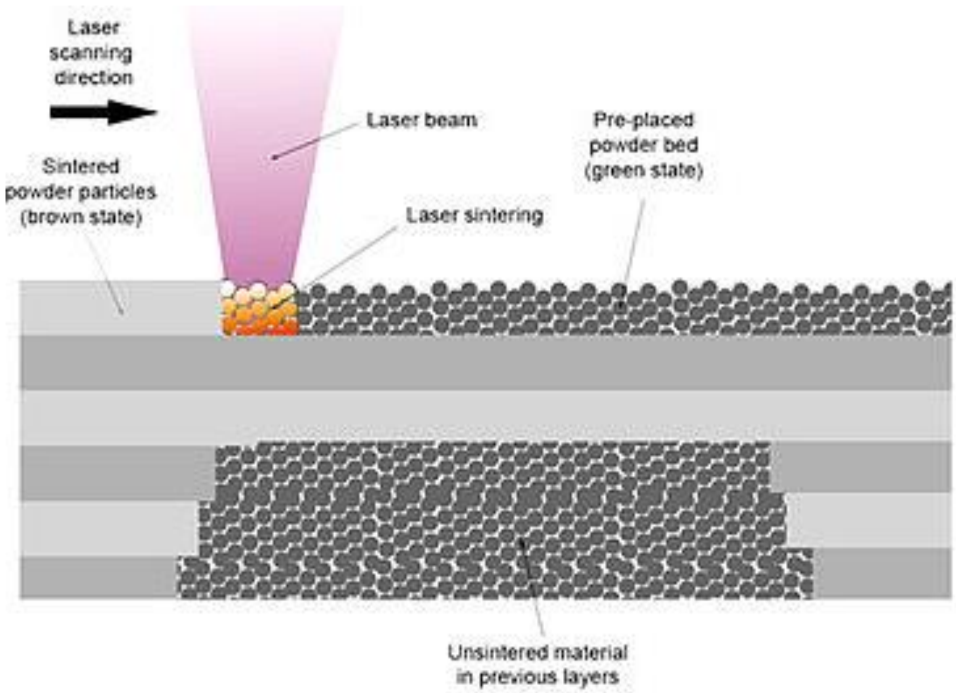


**Figure 2: Laser sintering process.**

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# FOOD'S NEXT FRONTIER

**Aditya Navneet Patil, Aishwarya Phalak (Mech – IV)**

3D Printing is an innovative manufacturing process whereby an object is built up layer by layer, from a 3D computer design using a variety of printing technologies. Converting a software-based design into distinct 2D layers or slices, which are "printed" and bounded to each other in order to create a 3D product is the primary method of operation of any 3D printer. These technologies were developed for the manufacturing industry and hence typically processes Plastics, Ceramics and Metals.

The idea of living with 3-D printed food is neither unthinkable nor new; designers and futurists have been looking to 3-D printing as food's next frontier. The premise of printing food seems, at first glance, a trivial endeavor. Many different techniques are used in the manufacture of food items, but they are mostly optimized for mass production. Thus, there is a natural gulf that exists between the two, where a person without the necessary training (and/or a steady hand), and not needing a large number of pieces, is left to ordering a custom product at high cost from a specialist. Bridging this gap is certainly within reason, using the food printing techniques.

## PRINCIPLES OF FOOD PRINTING

The main principle of 3D printing is stereo lithography, outlined by Charles Hull in a 1984 patent as "a system for generating three-dimensional objects by making a cross- sectional pattern of the object to be formed". This means that any 3D object generated using a 3D drawing software is first split into layers and these layers are then successively printed by the machine on top if one another. The food printer "Foodini" (Fig. 5) as it's called, is not too different from a regular 3D printer, but instead of printing with plastics, it deploys edible ingredients squeezed out of stainless steel capsules. Engineers and gourmands alike are dabbling with edible substances as raw materials for 3D printing. Among their hoped-for results: previously unachievable food shapes and textures, personalized grub, and varied menus on future long- term voyages to Mars.

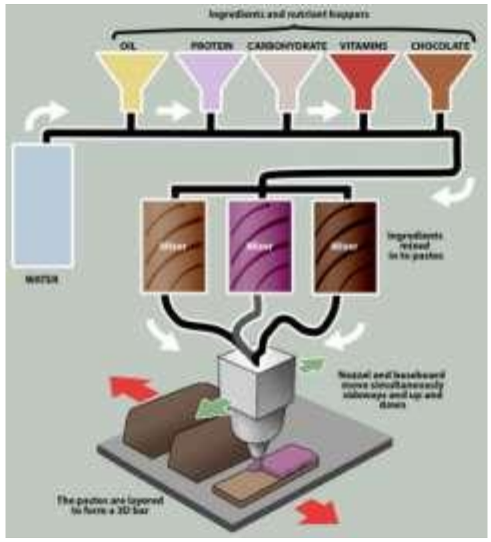


**Figure 1: Principle working of 3D Food Printing**

## CONFECTIONARIES AND DISHES

So far, any food items have been printed successfully. The 3D food printer Foodini from Natural Machines achieved milestone in printing intricate dishes, like chocolate snowflake. (E.g. Fig. 2)

**Figure 3: Pizza printed using Foodini printer by Natural Machines**

Kitchen counter, baking board, cake shop, bar top, and catering outfit. Cocktail decorations, architectural cake supports, interlocking candies, beautiful sugar sculptures. And there are everyone's favorite items such as Pizzas (e.g. Fig. 3) and Burgers (e.g. Fig. 4).

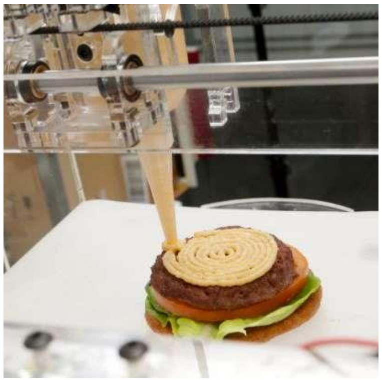

**Figure 4: Burger Printing**

## FOOD 3D PRINTERS

NASA has also jumped on the 3D printed food bandwagon and are said to be extensively funding research in this area in order to feed astronauts in space. In fact, we already can print chocolate confectioneries and desserts from a special printer invented recently called Chocedge. Hershey and 3D Systems have partnered to presumably create all kinds of printable food items. Should the company replace factory workers with 3D printers, it might be able to streamline the process of manufacturing.


**Figure 5: 3D Food Printers- Foodini printer**

ChefJet is the world's first kitchen-ready food 3D printer. Food is a vital part of how we celebrate, gather and relate. Now, our culinary traditions and the experiences that surround them get a little sweeter with the leading-edge ChefJet and ChefJet Pro, the world's first and only professionally certified, kitchen-ready 3D food printers. With the ChefJet, culinary artists of all kinds can create stunning and tasty decorations, edible sculptures and confections of all shapes and sizes.


**Figure 6: 3D Food Printers- MIT Food Printer (Left); TNO (Right)**

Combining the complete design freedom of 3D printing with edible materials, chefs can create imaginative food designs that were previously impossible to make. Full-color cocktail decorations, architectural cake supports, inter-locking candies, beautiful sugar sculptures: it's all possible with the ChefJet.

TNO started researching the shaping of food with 3d Printing technologies, resulting in successful collaboration with food designers and manufacturers. Now they are looking more and more into using 3D food printing technology for the creation of novel food structures. For these new structuring methods, traditional ingredients are generally used. However, they are also looking into the usage of alternative base materials like Algae or insects and this is becoming an increasingly important focal point for TNO (e.g. Fig. 6 (Right side))

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# IMPLEMENTING RAPID PROTOTYPING USING CNC MACHINING (CNC-RP) THROUGH A CAD/CAM INTERFACE

**Durgesh Dashrath Divate (MECH- IV)**

**ABSTRACT**

This paper presents the methodology and implementation of a rapid machining system using a CAD/CAM interface. Rapid Prototyping using CNC Machining (CNC-RP) is a method that has been developed which enables automatic generation of process plans for a machined component. The challenge with CNC-RP is not the technical problems of material removal, but with all of the required setup, fixture and toolpath planning, which has previously required a skilled machinist. Through the use of advanced geometric algorithms, we have implemented an interface with a CAD/CAM system that allows true automatic NC code generation directly from a CAD model with no human interaction; a capability necessary for a practical rapid prototyping system.

**INTRODUCTION**

Most commercial RP systems are based on additive processes whereby models are constructed by stacking 21/2-D cross sectional layers on top of one another. The additive RP systems are often limited in both geometric accuracy and material quality. Subtractive processes such as CNC machining have advantages over the limited choice of materials and the limited functionality of parts produced by additive processes. However, machining is not a completely automated method in either the process or fixture planning steps. There has been a need for a rapid machining system, but previous attempts to automate CNC machining have been approached from the perspective of traditional machining methods.

Traditional machining requires extensive planning by a specialized and experienced machining technician. Moreover, the challenge of machining complex and intricately shaped components is daunting even on the most advanced machines. In traditional machining, the focus is typically on simpler geometries (holes, slots, planes, etc), or, when the geometry is more complex, as in an airplane wing, the shape is defined by known geometric functions.

The CNC-RP process has been realized as a module in the MasterCAM package that automates virtually all of the process and setup planning tasks. Using several geometric algorithms and standardized tool and material libraries, this system can process a CAD model similar to the way an RP software interface processes an STL file. The interface computes setups, creates sacrificial support structures, generates toolpaths and outputs the required NC code and setup instructions. To process a part, the user simply loads the prescribed diameter and length stock material into the CNC machine and downloads the NC code for processing.

## IMPLEMENTING CNC-RP IN CAD/CAM

The process is initiated after the CAD model of the part is loaded in the CAD/CAM system. Next, a sequence of steps is initiated including 1) analyzing the part for an axis of rotation 2) establishing a work coordinate system 3) attaching sacrificial supports 4) determining setup orientations about the axis, 4) generating a roughing process to remove the bulk of material and 5) generating a finishing process to create the surface geometry. The flowchart's upper chain illustrates the steps in the CAD/CAM environment, while the lower chains represent the offline algorithms. Steps of the process and implementation are presented below.

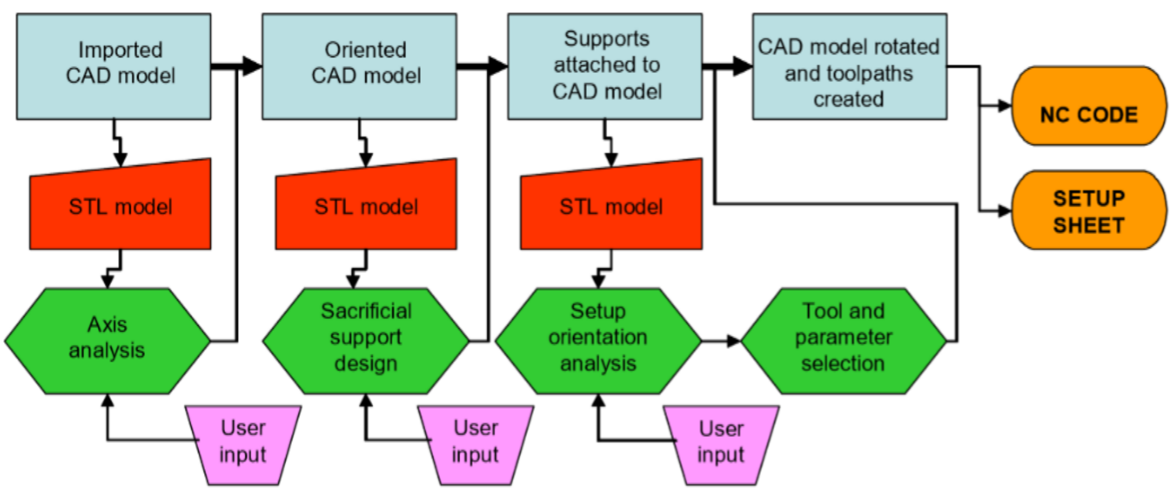


**Figure 1: System Flowchart in CAD/CAM system**

- **AXIS OF ROTATION PLANNING**

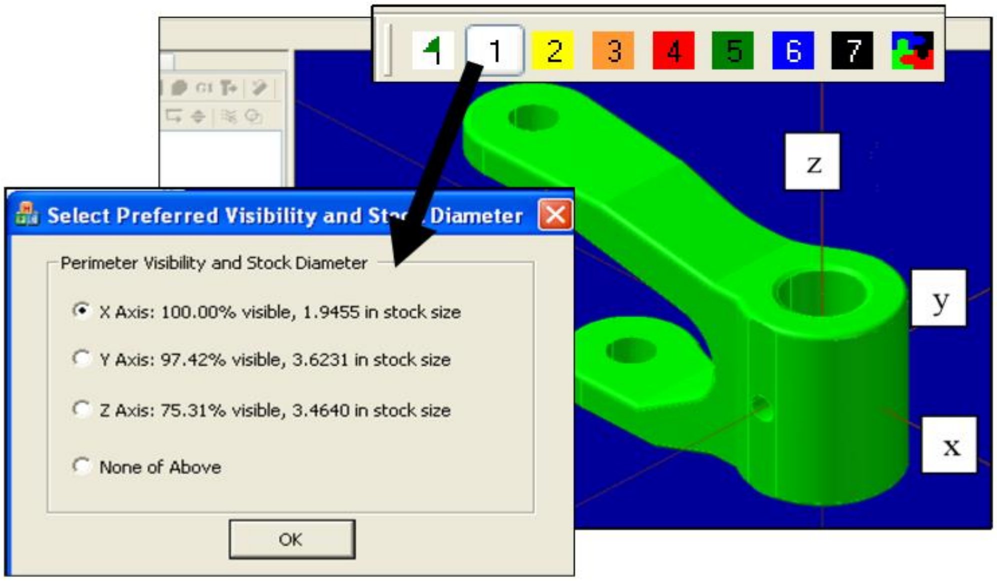


**Figure 2: Initial Visibility Analysis of Axes for Setup Orientation**

- **ESTABLISHING A COORDINATE SYSTEM**

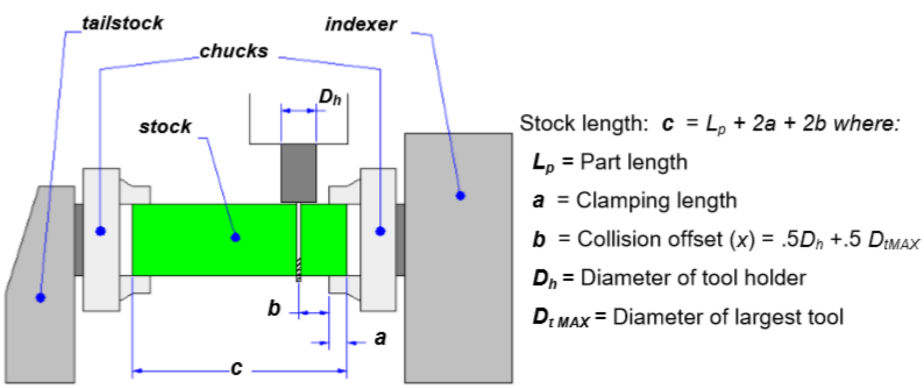


**Figure 3: Fixture setup and parameters for Coordinate system setting**

**EXAMPLE**

Step-by-step machining of a cast iron component from a 5" diameter bar stock. The machining time for this part was approximately 24 hours, however, the NC code was generated from a CAD model in under 5 minutes. In both the laboratory and an industrial sponsor installation, the CNC-RP process has been shown to effectively create a variety of parts using functional materials ranging from Plastic, Aluminum, Cast Iron and Steels.

## CONCLUSION

The implementation in a CAD/CAM environment enables CNC-RP as an effective rapid prototyping method for use on existing CNC machines. As such, the process can be used for short run production, custom manufacturing and prototyping for certain applications. In addition, the same CNC machine can also be free to create production parts in conventional applications. The impact is that there is no need for a specialized RP machine for these functional prototypes and parts. The system is currently being tested as a method for creating spare parts for legacy equipment in the agricultural industry. Of course, the process has limitations in both geometry and scale. Traditional additive RP processes are infinitely capable at creating complex shapes, as compared to CNC machining. In contrast, however, CNC-RP is generally more capable in surface finish, since layer depths can be controlled to very small values, as compared to additive RP processes. The greatest advantage however, is that CNC RP has exceedingly better capability in using a variety of materials to create truly functional parts.

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| **Mr. Sandeep Arote** | Lab Assistant |
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| **Mr. Rego Menezes** | Lab Attendant |
| **Mr. Sanjay Junonikar** | Lab Attendant |

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| SR NO | NAME OF THE STUDENT | COMPETITON/AWARD | DATE |
|---|---|---|---|
| 1 | RONALD JOSEPH<br>TEJASWINI RANE<br>SAJEET MATHEW JOHNSON | JAMBOREE(ISHRAE)<br>CONSOLATION PRICE | 07-01-2017 |
| 2 | AMEY PAWAR | BADMINTON (MUMBAI UNIVERSITY)<br>GOLD MEDAL | 2016 |

# COMPETITONS

| SR NO | NAME OF THE STUDENT | COMPETITON | DATE |
|---|---|---|---|
| 1 | ROSHAN GEORGE<br>JEFFY JACOB<br>TAYYABALI CHAUGULE<br>ANVAY JOSHI | SMART INDIA HACKATHON | 1-04-2017 |
| 2 | RONALD JOSEPH | SPECTRA SARDAR PATEL TECHNICAL FEST | 28-01-2017 |

# Placements 2016-17

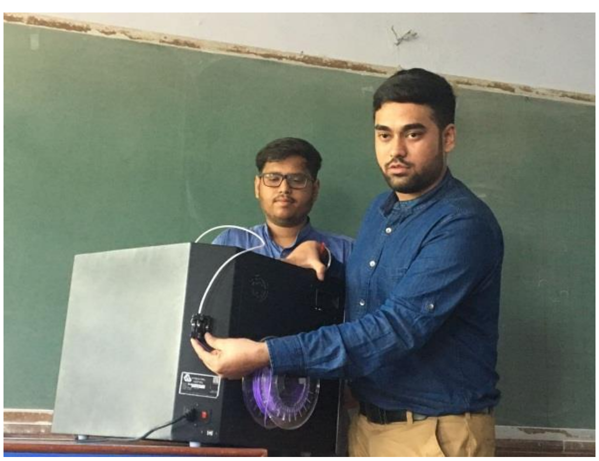
| Company Name | No . of Students | Package in Lakhs |
|---|---|---|
| Larsen & Tubro | 2 | 4.8 |
| TCS | 15 | 3.2 |
| NSEIT | 1 | 3 |
| Godrej | 9 | 5.5 |
| Selec Control | 2 | 3.15 |
| Freight Wings | 2 | 3.5 |
| Blue Star | 2 | 5 |
| Stellar Value Chain | 7 | 3.2 |
| Primetals | 1 | 4.25 |
| **Total Students Placed** | **39/60** | |

# Placement in Previous Years

| Academic year | No. of students placed | Students sitting for placement | Class strength | Average pay package |
|---|---|---|---|---|
| 2015 - 16 | 41 | 68 | 76 | 3.53 lakhs |
| 2014 - 15 | 44 | 70 | 82 | 4.1 lakhs |

# SYNERGY 2016

# MESH 2017



# MESA COMMITTEE

**SENIOR COUNCIL**

SANIKA NANOTI (PRESIDENT)
SHANAUK PHANSALKAR (SECRETARY)
SURAJKUMAR SUNTHA (JOINT SECRETARY)
NAJID TISEKAR (TREASURER)
SUMEET GARAD (P.R.O.)
MAGAZINE COMMITTEE:-
TAYYABALI REHMAN CHOUGULE
ANVAY JOSHI
SPONSORSHIP COMMIITEE:-
JAY GITE
AKASH NEMLEKAR

**JUNIOR COUNCIL**

POORVA KHARE (VICE PRESIDENT)
AKASH KADAM (VICE SECRETARY)
ADITYA PATIL (VICE JOINT SECRETARY)
JOEL D’SA (VICE P.R.O.)
MAGAZINE COMMITTEE:-
AISHWARYA PHALAK
SPONSORSHIP COMMIITEE:-
STEVEN PEIEREA
FRANKLIN FERNANDES

# ISHRAE COLLEGIATE CHAPTER

ISHRAE stands for Indian Society of Heating, Refrigeration and Air Conditioning Engineers. ISHRAE is an associate of ASHRAE, American society of Heating, Refrigeration and Air Conditioning Engineers. In order to develop interest of HVAC&R (Heating, Ventilation, Air Conditioning and Refrigeration), ISHRAE society started student chapters in engineering colleges having mechanical engineering branch. The ISHRAE student chapter of FCRIT started on 22nd September 2007. Prof. Nilesh Varkute is the college staff coordinator for ISHRAE.

# SAEINDIA

SAEINDIA is an affiliate society of SAE International registered in India as an Indian non-profit engineering and scientific society dedicated to the advancement of mobility industry in India. The Department has a SAE Collegiate Club of SAE, having 72 members. The Club is very active and is planning to organize events to promote its aims and objectives.

The founding principle of the SAE International is to unite scientific and technical staff to perform free academic discussions, to dedicate themselves to the cause of prospering the science and technology for automotive vehicles and to make contributions to speed up the modernization of automotive industry. SAEINDIA is a professional engineering society whose membership represents practically every engineering and scientific discipline. Its members combine their specialized abilities to further advance the research, development, design, manufacture and utilization of vehicles which operate on land, water, air and space. Prof. Girish Dalvi is the college staff coordinator for SAEINDIA

TORQUE - Intercollege event of Nitro Racing

SPARK - Seminar by speaker from automobile sector.

# MANSI JEWELLERS

Mansi Gold, Shilp Chowk Road, Kharghar, Navi Mumbai, Maharashtra, 410210