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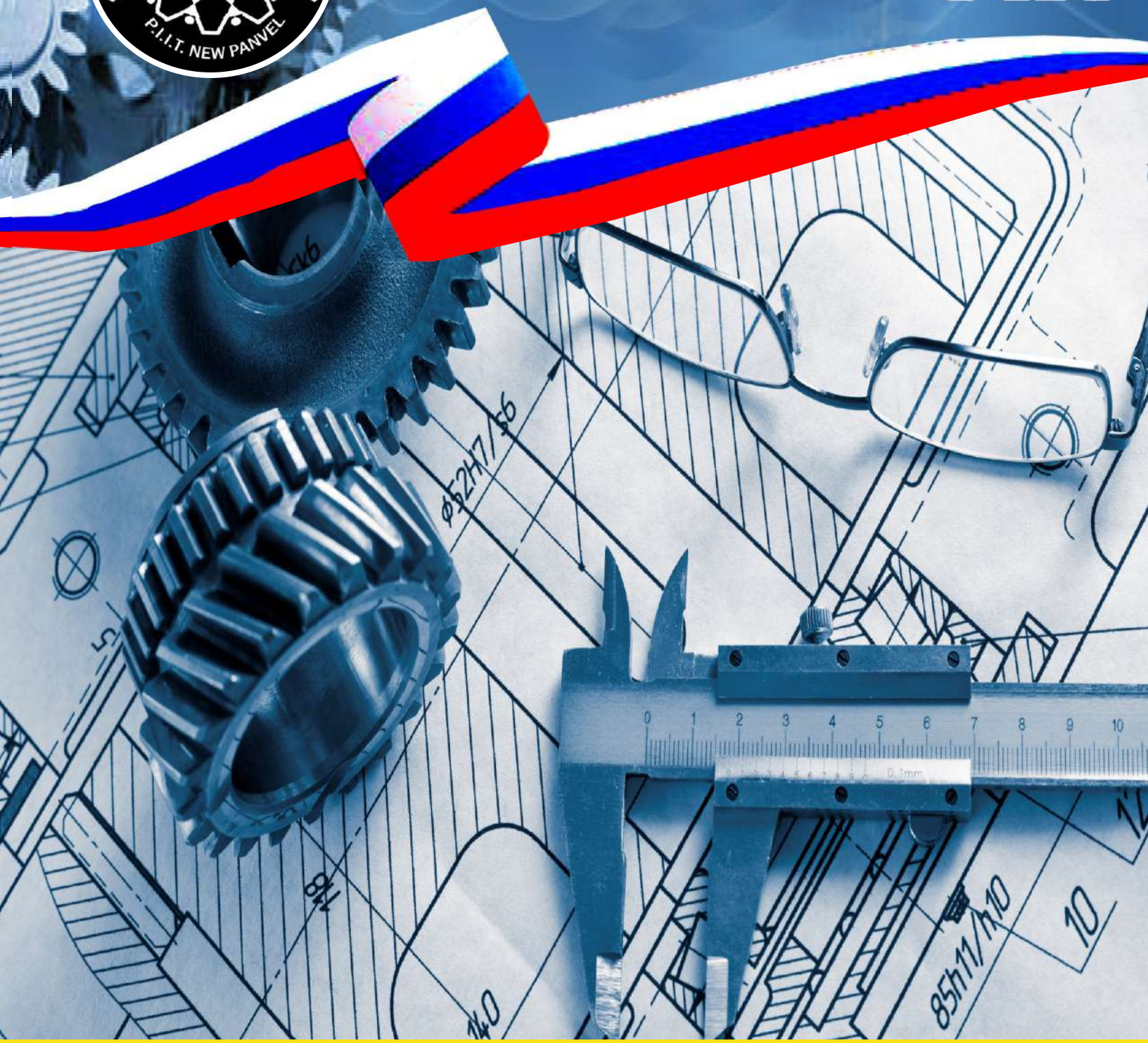

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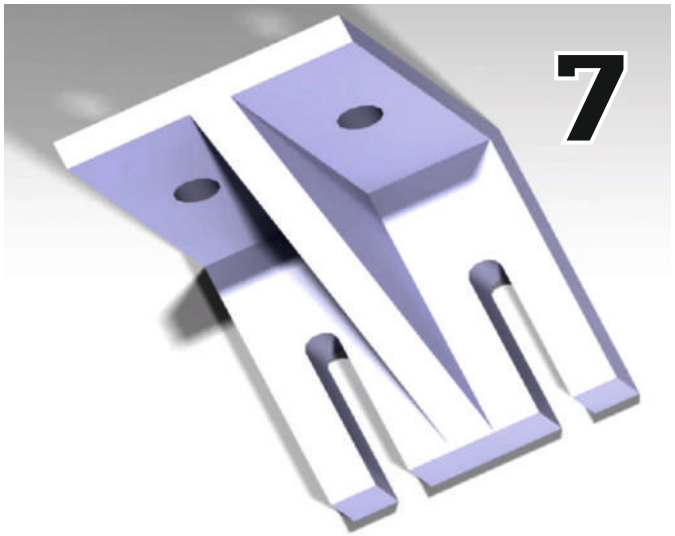

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Design and Fabrication of Quad Copter

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1.Abstract

This paper discusses the Design and fabrication of Quadcopter.A quadcopter is a multicopter that is lifted and propelled by four rotors. An Android cellular device would be used as a transmitter and a cellular device placed on the frame of the Quadcopter would act as a receiver, sensor and a visual feedback device. There are various uses of a quadcopter. They are a useful tool for research platform for university researchers to test and evaluate new ideas. Quadcopters can be used as unmanned aerial vehicles for surveillance and reconnaissance by military and law enforcement agencies. Thay also have commercial use in the field of aerial imagery.

Keywords- Quad copter, android, cellular device, frame, sensors, unmanned aerial vehicles

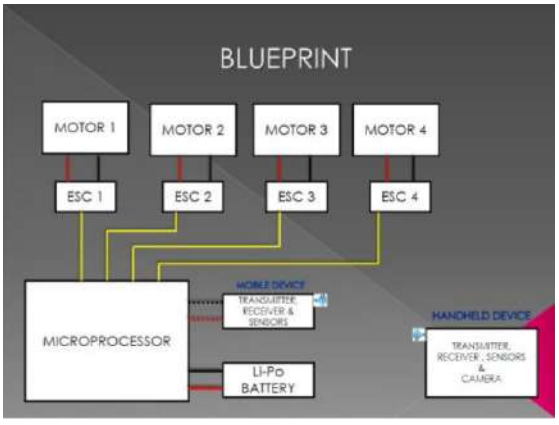

Fig [1] Blueprint of the Quadcopter

2.Introduction

A quadcopter is a multicopter that is lifted and propelled by four rotors. Quadcopters are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of revolving narrow-chord airfoils. Unlike most helicopters, quadcopters generally use symmetrically pitched blades. These blades can be adjusted as a group, a property known as 'collective', but not individually based upon the blade's position in the rotor disc, which is called 'cyclic'. Control of vehicle motion is achieved by altering the pitch and/or rotation rate of one or more rotor discs, thereby changing its torque load and thrust/lift characteristics. Early in the history of flight, quadcopter (referred to as 'quadrotor') configurations were seen as possible solutions to some of the persistent problems in vertical flight. Torque-induced control issues (as well as efficiency issues originating from the tail rotor, which generates no useful lift) can be eliminated by counter-rotation and the relatively short blades are much easier to construct. A number of manned designs appeared in the 1920s and 1930s. These vehicles were among the first successful heavier-than-air vertical take off and landing (VTOL) vehicles. However, early prototypes suffered from poor performance, and latter prototypes required too much pilot work load, due to poor stability augmentation and limited control authority

.

More recently quadcopter designs have become popular in unmanned aerial vehicle (UAV) research. These vehicles use an

an electronic control system and electronic sensors to stabilize the aircraft. With their small size and agile maneuverability, these quadcopters can quadcopters can be flown indoors as well as outdoors.

There are several advantages to quadcopters over comparably-scaled helicopters. First, quadcopters do not require mechanical linkages to vary the rotor blade pitch angle as they spin. This simplifies the design and maintenance of the vehicle. Second, the use of four rotors allows each individual rotor to have a smaller diameter than the equivalent helicopter rotor, allowing them to possess less kinetic energy during flight. This reduces the damage caused should the rotors hit anything. For small-scale UAVs, this makes the vehicles safer for close interaction. Some small-scale quadcopters have frames that enclose the rotors, permitting flights through more challenging environments, with lower risk of damaging the vehicle or its surroundings. environments, with lower risk.

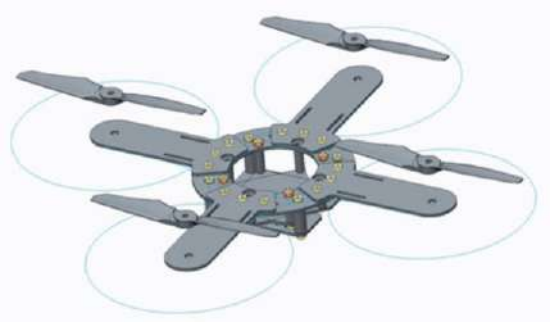

Fig [2] Quadcopter Designed using SolidWorks

3.Motivation and Project Description

We wanted to design an aerial vehicle which could be user friendly, to the extent that any individual with an Android mobile handset could own and control one. We also wanted to do a project with fair amount of hardware and software.
This ultimately led us to designand fabricate a quad copter which will:

Communicate wirelessly and be controlled via an ANDROID device.

4.Uses or Contributions to respective field

4.1 Research platform

Quadcopters are a useful tool for university researchers to test and evaluate new ideas in a number of different fields, including flight control theory, navigation, real time systems, and robotics. In recent years many universities have shown quadcopters performing increasingly complex aerial manoeuvres. Swarms of quadcopters can hover in mid-air, in formation, autonomously perform complex flying routines such as flips, darting through hula-hoops and organise themselves to fly through windows as a group.

There are numerous advantages for using quadcopters as versatile test platforms.They are relatively cheap, available in a variety of sizes and their simple mechanical design means that they can be built and maintained by amateurs. Due to the multi-disciplinary nature of operating a quadcopter, academics from a number of fields need to work together in order to make significant improvements to the way quadcopters perform. Quadcopter projects are typically collaborations between computer science, electrical engineering and mechanical engineering specialists.

Because they are so manoeuvrable, quadcopters could be useful in all kinds of situations and environments. Quadcopters capable of autonomous flight could help remove the need for people to put themselves in any number of dangerous positions. This is a prime reason that research interest has been increasing over the years. There are some world-class engineering research laboratories currently developing more advanced control techniques and applications for quadcopters These mainly include IIT and MIT's Aerospace Controls Lab, ETH's Flying Machine Arena and University of Pennsylvania's General Robotics,

Robotics, Automation, Sensing and Perception (GRASP) Lab.

4.2 Military and law enforcement

Quadcopters are used for surveillance and reconnaissance by military and law enforcement agencies, as well as search and rescue missions in urban environments. One such example is the Aeryon Scout, created by Canadian company Aeryon Labs, which is a small UAV that can quietly hover in place and use a camera to observe people and objects on the ground. The company claims that the machine played a key role in a drug bust in Central America by providing visual surveillance of a drug trafficker's compound deep in the jungle (Aeryon won't reveal the country's name and other specifics).

5. Salient features

1. The Quadcopter is extremely lightweight.
2. It uses an Android device as a transmitter.
3. It has a cellular device placed on the frame that acts as a sensor, and a visual feedback device.
4. It can lift a mass of atleast 2kg.
5. It canhover at least 6 inches from the ground.
6. The Quad-Copter can communicate wirelessly within a range of 100m.
7. The Quad-Copter can fly for a minimum of 5 minutes. (battery power)

6.Commercial Validity

The largest use of quadcopters has been in the field of aerial imagery although in the USA, it is currently illegal to use remote controlled vehicles for commercial purposes. Quadcopter UAVs are suitable for this job because of their autonomous nature and huge cost savings.Capturing aerial imagery with a quadcopter is as simple as programming GPS coordinates and hitting the go button. Using on-board cameras, users have the option of being streamed live to the ground. Many companies have used this for real estate photography to industrial systems inspection. Various organizations are taking advantage of the quadcopter's closed-circuit television capabilities and ability to provide an eye in the sky to the action below.

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Design and manufacturing of billet-type shear press machine.

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I. INTRODUCTION: -

A billet type shear press machine is used in industries to cut metal strips of various cross-sections and to reduce lead time of manufacturing. During the shearing process, when the cutting action takes place there is an upward reaction force acting on the metal strip that causes it to lift upwards. This upward lift tends to give a slant cut to the metal strip. This slant cut in the strip is undesirable and hence it is removed by an additional process of grinding. This causes loss of both time and precision. In order to overcome above drawbacks, design and manufacture a fixture (shown below) is to be introduced in the original design.

Advantages of the fixture are as follows:

- It prevents the metal strip from lifting upwards due to the reaction force, by holding the strip in place.
- The soft rubber in the fixture tends to absorb the shock on the strip during the shearing action.
- A straight cut is obtained hence saving grinding time also increasing the precision and eventually increasing the output of the industry.

An additional modification is done in the existing machine i.e. the cutting angle of the blade is slightly increased.

Advantages of increase in the shear angle are as follows:

- Hence the same machine having a particular load capacity is capable of shearing metal strips of greater cross-section with ease.

By introducing a press block in between the connecting rod and blade mounting an idling feature is added to the machine that allows the crankshaft to rotate but discontinues the movement of the shearing blade. When the block is in between the connecting rod and blade mounting the shearing blade will move along with the movement of the crank shaft but if the block is removed the crankshaft will rotate alone keeping the shearing blade still at the uppermost position.

Advantages of Idling are as follows:

This idling feature enables the technician who is working on the machine to halt the shearing process instantly in case of any mishap or misalignment of metal strip, without turning of the machine completely.to halt the shearing process instantly in case of any mishap or misalignment of metal strip, without turning of the machine completely. Putting the machine to idling mode is more easily accessible for the technician rather than switching of the machine completely from the main switch. If the machine is switched off from the mains, it won't stop immediately due to the inertia force of the flywheel thereby damaging the raw material. Whereas in the case of idling the shearing blade is stopped instantly.

LITERATURE REVIEW:-

Shearing process:

Most steel sheet fabrication processes require blanks of suitable sizes to be cut from steel strip or sheet by straight blade shearing, rotary shearing or slitting. In these processes, two blades are forced in opposite direction against the steel work piece, the two opposing forces being greater than the shear strength of the work piece material.

Although a sheared edge is inferior to machined edge, good practices will produce an edge which is adequate for wide range of end uses.

Straight blade shearing:

Straight blade shearing or guillotining utilizes a stationary lower blade and movable upper blade. The work piece is held securely in position between the blades by hold down feet (fixture) which prevent any movement of the sheet or strip during the cut. Shears are either mechanically or hydraulically operated, mechanical shears being more widely used.

To obtain optimum shearing performance the shears used should be of adequate capacity and maintained in good condition. The blade should be kept sharp to minimize burr, and the clearance between the blades set to give good edge quality. Some shears have an adjustable clearance feature. For shears which do not allow rapid clearance changes it is important to set the blades to a suitable clearance for the range of thickness to be sheared. If the thickness range to be sheared is wide it may be necessary to adjust clearance for groups of very thick to very thin metal strips.

Capacity of shears:

The capacity of shears is usually expressed in terms of maximum thickness of annealed low carbon steel which can be cut. Steels with tensile strength significantly higher than low carbon steel (i.e. above 450 MPa) reduce the capacity of the machine. Table below shows the relative thickness of steel which can be cut for tensile strength from 450-750 MPa compared to the thickness of annealed low carbon steel (300-450 Mpa).

Rake Angle or Shear Angle:

The maximum thickness which can be cut by a given shear can be increased by setting the upper shear blade at an angle to the lower shear blade.

Steel Tensile Strength MPa	Maximum Thickness for shearing Mm						
	1.0	1.5	2.0	2.5	3.0	3.5	Shearing Machine Rate Capacity Maximum Thickness mm
Up to 450	1.0	1.5	2.0	2.5	3.0	3.5	
450-550	0.9	1.3	1.7	2.1	2.5	2.9	
550-650	0.8	1.2	1.5	1.9	2.3	2.7	
650-750	0.7	1.1	1.4	1.8	2.1	2.5	

The angle known as shear angle or rake is defined as the ratio of x/y. Where shear is used, the work piece is sheared

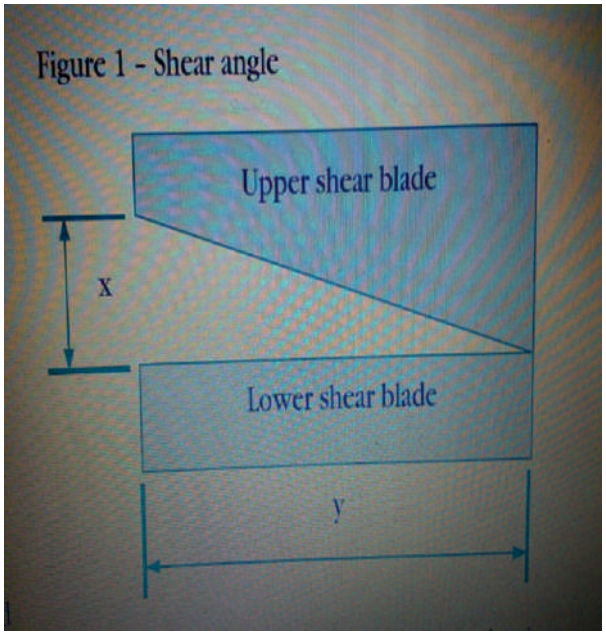


Figure 1 - Shear angle

progressively a little at a time, rather than instantaneously, as in the case with parallel blades. Rake, therefore, reduces the shearing force required to cut a strip of a given thickness. The maximum rake in common use is 1/8. As rake is increased further distortion of the work piece increases and the hold down forces necessary to avoid slippage increase. It is usual that high rake shears are less expensive than low rake shears of the same capacity, since the frame of high rake shear can be made lighter. However, in selecting shears it is necessary to consider both capital cost and the levels of distortion which are acceptable in the sheared parts.

Shear Blade Clearance:

The clearance between upper and lower shear blades determines the quality of the cut edge, and can influence shearing force.

Excessive clearance results in heavy burr, and where soft steels are being sheared, increased distortion of the cut edge. In extreme cases, the work pieces can be pulled between the blades causing overloading or blade damage.

PROBLEM DEFINITION:-

The main problem occurring in this type of shear press machines was because of the high shearing force acting on the metal strip an upward reaction force acts on the strip while cutting which results in a slant cut and adding an additional process of grinding. This is avoided by a fixture with a rubber piece at the bottom which holds the strip while shearing and absorbs the reaction force and the strips are cut accurately with a straight cut saving time and reducing lead time.

OBJECTIVES:

1. **Introduction of fixture:** The fixture enabled accuracy cutting of strips and reducing lead time by saving the additional grinding time.
2. **Increasing rake or shear angle:** Increasing the rake or shear angle has reduced the shearing force required to cut the metal strip.
3. **Idling block:** A feature which is necessary to be introduced in such a machine i.e. an idling block. This block is placed in such a way that when this block is removed with the bolt provided. This can be done when the machine is needed to kept idle with the current on or if any changes are to be made by the technician working on it.

Design Method:

As per the cross-section of the metal strip to be sheared, the force required was calculated and accordingly the cross-section of the frame was calculated. The calculations are mentioned in the excel spreadsheet below

1. Frame

Sr no	Data name	Value	Units
1	Material	mild steel	
2	Width	25.0	mm
3	Thickness	4.0	mm
4	Area	100.000	mm²
5	Factor of safety	3.0	
6	Yield strength(σ_{yt})	250.000	Newton/mm²
7	Tensile strength(σ_t)	83.333	Newton/mm²
8	Shear strength(τ)	41.667	Newton/mm²
9	Force(P)	4166.667	Newton
10	Cutting angle(θ')	1.333	
11	θ	4.056	Degree
12	Reduced force(P')	2916.667	Newton
13	Load for cutting acting on the fra	1041.667	Newton
14	Thicknes of frame	9.5	mm
15	Breadth of frame	60.0	mm
16	Area of frame cross-section	570.000	mm²
17	Actual bearing load on the frame	47500.000	Newton
18	Total load the structure can bear	190000.000	Newton
19	Slot length	120.000	mm
20	Maximum force P_{max}(assumed)	50000.000	Newton

2. Crankshaft

Sr. No.	Data Name	Value	Units
1	Material	En-8	
2	Factor of safety	3.000	
3	Yield strength(σ_{yt})	465.000	Newton/mm²
4	Tensile strength(σ_t)	155.000	Newton/mm²
5	Shear strength(τ)	77.500	Newton/mm²
6	Maximum bending stress(σ_b)	306.900	Newton/mm²
7	Maximum allowable bending stress considering	155.000	
8	Maximum bearing stress(σ_{crush})	124.000	Newton/mm²
9	Maximum force(P_{max})	50000.000	Newton

3. Connecting Rod

Sr. No.	Data	Value	Units
1	Greater side	70	mm
2	Lower Side	30	mm
3	Difference	20	mm
4	Height	155	mm
5	C_y	67.16666667	mm
6	C_x	35	mm
7	Thickness	15	mm
8	Width at centroid	52.67	mm
9	Max. Force	50000	Newton
10	Factor of safety	5	
11	Critical buckling load(p_{cr})	250000	Newton
12	Compressive yield stress	330	Newton/mm^2
13	Min. cross-sectional area at ce	757.58	mm^2
14	Cross-sectional area at centre	790	mm^2

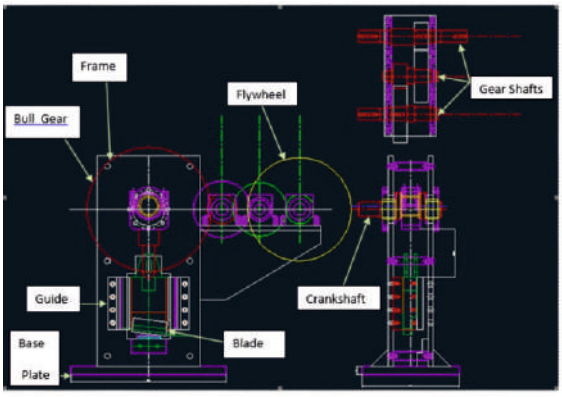
4. Flywheel and Flywheel shaft

Data	Value	Unit
Power	15000.00	Watts
Material	M.S.	
Mass density of material	7860.000	kg/m^3
RPM	320.000	rpm
Speed	33.510	rpm
C_1	0.200	
Diameter of flywheel	18.000	inch
Diameter of flywheel	457.200	mm
Diameter of flywheel in metre	0.457	metre

5. Gears

Gear	Teeth	M / DP		OD	C/C	Angle
A	25	M	3	81	112.5	0
B	50	M	3	156		
C	18	M	3	60	100.5	0
D	49	M	3	153		
E	16	M	4.5	81	193.5	0
F	70	M	4.5	324		

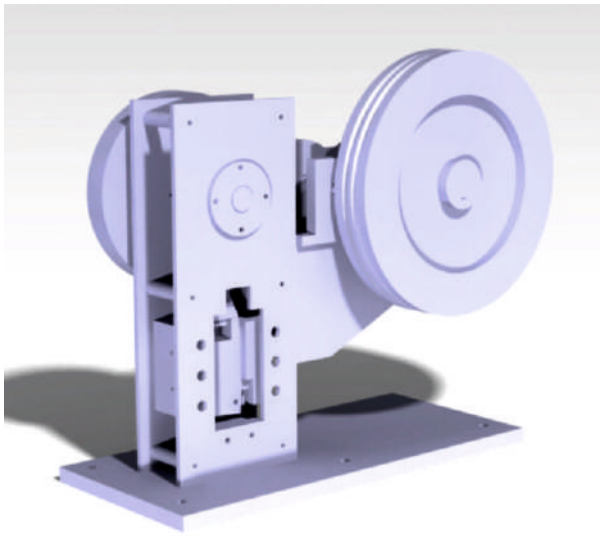
2D Layout:



Shearing Machine 2D CAD layout

The CAD model shows the basic components of the Billet type Shear press machine as per the design dimensions i.e. base plate, gears, shafts, guide, crankshaft, frame, blade and flywheel.

3D Layout (Catia V5):
Assembled Views of Shearing Machine:



Manufacturing process:

The manufacturing process was carried out in the following steps:

1. Preparing bill of material.
2. Checking feasibility.
3. Drafting of CAD design of components.
4. Buying raw material as per the design.
5. Getting the components machined as per the design.
6. Rectifying minor errors by cold processing.

Assembly:

The assembly took place in the following order:

1. Both the frames were aligned together with the spacers in between, and the bolts were tightened.
2. Respective cuts, grooves and holes

were made as per the design on the frames.

3. Frame was mounted on the base plate.
4. Crankshaft along with crank housing was fixed in frame.
5. Guide and Blade mounting block along with the wear plate were mounted together to the frame.
6. Idling block was inserted.
7. Gear mounting body was attached to the frame by welding it.
8. Gear shafts were prepared with the bearing blocks and gears on it.
9. Bull gear was fitted on the crankshaft.
10. Gear shafts were aligned with the bull gear and placed on the gear mounting body.
11. After verification of gear train assembly, the bearing blocks were welded on the gear mounting block.
12. The flywheel was mounted on the flywheel shaft and locked with a cup and bolt at the end.
13. The fixture was attached and welded to the blade mounting block.
14. The motor was mounted on a plate towards the right of the base plate and belt as per the length required is fitted.
15. After testing the working of the machine, the belts were removed and it was painted with red oxide and kept for 12 hours for drying.
16. Finally the machine was coated by enamel paint, belts were attached after drying and electrical connections of motor were done.

Conclusion:

By making a few changes to the actual design of the machine as per the cutting cross-section and even additional features like the fixture, increased rake or shear angle and idling block or press block, overcoming a few drawbacks we have designed and manufactured a shearing machine.

Future scope:

Instead of using a crankshaft with single crank pin a crankshaft with 3 crankpins can be designed spaced at 120° on the shaft. The machine that would previously perform only one operation due to a single crankpin can be upgraded to perform three different functions like shearing, dot punching and die punching respectively, by installing a three pin crankshaft. This will not only bring ease to the technician but also reduce the size and number required by three different machines.

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3D-Printer

REP-RAP Technology

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Abstract—**Home-built 3D printers are booming. In 2006 there were no such printers and 5 years later there are tens of thousands. There are currently hundreds of thousands of people wanting to start their own build waiting for the right moment to get started.**
The project that single-handily propelled home-built 3D printers out of nowhere is RepRap. It's an open-source project meaning that all the information and design plans you'll need are available. This report covers what is RepRap technology and how it is used to build a 3D-printer, in low cost sittin at home.

***Index Terms*—G-code**

I. INTRODUCTION

Home-built 3D printers are booming. In 2006 there were no such printers and 5 years later there are tens of thousands. There are currently hundreds of thousands of people wanting to start their own build waiting for the right moment to get started. The project that single-handily propelled home-built 3D printers out of nowhere is RepRap. It's an open-source project meaning that all the information and design plans you'll need are available free for all. Building a 3D printer yourself is a huge undertaking. You can build it for less than $500 or €500 but months might go by between getting started and printing your first part.

Building a 3D printer is very hands-on and will require all your technical skills. There isn't really any void that needs to be filled.

II.REPRAP TECHNOLOGY

The **RepRap project** is an initiative to develop a 3D printer that can print most of its own components. RepRap (short for replicating rapid prototyper) uses a variant of fused deposition modelling, an additive manufacturing technique. The project calls it Fused Filament Fabrication (FFF) to avoid trademark issues around the "fused deposition modelling" term.

As an open design, all of the designs produced by the project are released under a free software license, the GNU General Public License.

To date, the RepRap project has released four official 3D printing machines: "Darwin", released in March 2007, "Mendel", released in October 2009, "Prusa Mendel" and "Huxley" released in 2010, although hundreds of variations exist. The core developers have named each after famous evolutionary biologists, as "the point of RepRap is replication and evolution", however, other variants are often named after individual designers or names they prefer.

Due to the self-replicating ability of the machine, authors envision the possibility to cheaply distribute RepRap units to people and communities, enabling them to create (or

download from the Internet) complex products without the need for expensive industrial infrastructure (distributed manufacturing) including scientific equipment. They intend for the RepRap to demonstrate evolution in this process as well as for it to increase in number exponentially.

III.HOW THE PRINTER WORKS

This 3D printer builds objects by adding plastic material layer by layer until the object (also called printed part) is finished. The printer has a frame and three axes: X-axis (moves left to right), Y-axis (moves front-to-back) and Z-axis (moves up-and-down.) The *extruder* sits on the X-axis and feeds and melts plastic *filament*. The lowest part of the extruder is the *extruder head*, here the plastic is melted and *extruded* through a tiny hole with a diameter of less than 1mm. To print objects the electronics of the printer steer the three axes so that the extruder head is at the right spot to add plastic to the printed part. The three axes together with the extruder is called the *Cartesian robot*.

The printer is usually controlled by a PC with special software installed. In this software a solid model is loaded (these are called STL files) that gets converted to G-code. This G-code is sent to the electronics over USB and tells the robot what movements to make. At the end of all of these movements the modelled part should have been printed. Alternatively the same software can convert the model to G-code and save these codes on a SD-card. If the electronics of your printer is equipped with a SD-card reader you can print parts without the need to have a PC connected during the entire print job.

IV.PARTS OF THE PRINTER

The various parts of the printer are described as follows:

A. Frame

The frame gives the printer its stiffness. The three axes of the robot will be added to this frame. The frame consists of threaded rods connected together with printed parts (these are called the vertices.)

Apart from the vertices the frame also contains printed parts to hold and control the Y-axis and Z-axis. On the top left and top right you can see the printed parts that will hold the stepper motors of the Z-axis.

B. Y-Axis and Bushings

The Yaxis has one degree of freedom: it can move between the front and the back of the frame. The Y-axis is controlled by a belt attached to a stepper motor with pulley that you can also see on the image. The print bottom plate has four bushings attached that have been glued to the print bottom plate.

The RepRap axes - like many CNC machines - move over smooth rods with bushings or more recently with linear bearings. Bushings are actually plain bearings. They slide over smooth rods and provide almost no friction when moving up and down the rods. Usually plain bearings are used to turn around a cylinder (or to have the cylinder turn inside.) On the RepRap the bushings don't turn, instead they linearly move up and down the smooth rods following an imaginary line on the rods.

Linear bearings have little balls inside and provide free motion in one direction. Both bushings and linear bearings can be either printed or sourced as metal parts. Metal bushings are made from brass as it's the only metal that has low friction and is selflubricating. RepRap designs that use

linear bearings typically use LM8UU metal bearings. The standard RepRap Prusa Mendel design uses bushings that are more than good enough for the purpose. Some people believe a RepRap printer looks cooler when fitted with LM8UU linear bearings (but this drives up the price.)

C.Z-axis and Y-axis

The Z-axis and Y-axis are actually part of one construction. The Z-axis moves the X-axis up and down the frame. The X-axis moves the extruder left and right within the frame.

The Z-and-X axis construction consists of two printed parts called the X-end idler and X-end motor. The X-end idler has two vertical sections: a square open box and a hexagon structure. In the square open box two bushings are glued.

This box serves as a guide for the vertical smooth rod. In the hexagon structure two M8 bolts and a spring are mounted. A threaded rod is turned into these bolts. This threaded rod is also connected to the stepper motor on the top of the frame. The stepper motor will turn the threaded rod around its axis that in turn will make the X-end idler move up and down. The X-end motor has the same two sections and is assembled in a similar way. As you've noticed on the images the Z-axis is controlled by two stepper motors. It turns out it's both cheaper and improves accuracy to have two stepper motors on the Z-axis instead of one motor and a belt (mainly because the later requires a much more complicated construction and an expensive belt.) The Y-axis and X-axis are controlled by one motor and a belt, here two motors don't make sense.

D.Extruder

The RepRap Prusa Mendel is typically equiped with a Wade's geared extruder. This extruder consists of two parts: a cold top part that feeds the platic filament and a hot bottom part that melts and extrudes the plastic. These two parts are commonly called the Wade extruder (the cold part) and the hot-end (the hot part).

The Wade extruder consists of a large gear that is driven by a stepper motor. This large gear drives a bolt that pulls the plastic filament and pushes it into the hot-end where the plastic melts. The hot-end is usually a brass bolt with a hole drilled down its vertical axis. This screw is called a heater barrel. There are two sizes of filament available: 3mm wide and 1.75mm wide. The hole drilled in your heater barrel will have to match the size of your filament! At the tip of the heat barrel the exit hole narrows down to less than 1mm (typically 0.5mm.) Two methods exist for heating the hot-end: using a resistor or using a NiChrome wire. A NiChrome wire is the easiest to get started since you will only need a heater barrel with a nozzle. A resistor requires a heater block that is screwed onto the heater barrel.

The heater block is screwed into a heater barrel. A hot-end has three more crucial components: a thermistor to measure the temperature, a heat barrier to separate the hot-end from the cold-end (without this the cold-end would melt) and the nozzle where the melted plastic flows out of the heater barrel. The thermistor is connected to the electronics board - just like the resistor or NiChrome wire - and allows the electronics to measure and regulate the temperature of the heater barrel. The heater barrel operates at a configurable temperature, without the thermistor that temperature could not be reached and held.

The heat barrier prevents the heat from the heater barrel to rise to the cold part. The cold part consists of printed parts and these would melt if they became too hot. Typically PEEK is used as a heat barrier. PEEK can resist high temperature and transfers very little heat. PEEK however has a number of disadvantages: it's not easy to find in the format suitable for use on an extruder, it's pretty expensive as well and it requires a PFTE tube inside to help the flow of filament.

PFTE tube can be difficult to find as well. At least one person has assembled an extruder where PEEK and PFTE was replaced with a piece of bamboo. Bamboo has the same properties as PEEK: resists high temperature and transfers very little heat. It is however much cheaper and much easier to find. The nozzle is the most important part of the hot-end. The nozzle is the end of the heater barrel where the melted plastic is extruded. The nozzle needs to have a sharp enough tip and a central hole that is less than 1mm (typically 0.5mm).

E. X-carriage

The assembled extruder - including cold-end, heat barrier and hot-end - is mounted on the X-axis carriage. The X-carriage can use bushings or linear bearings. The X-carriage is controlled by one stepper motor and a belt.

F. Print Plate

Printed parts are printed on the print plate. The three axes move together so that the nozzle can move above the print plate in an area of 200mm wide by 200mm deep by 100mm high.

The print plate actually consists of two plates: the print bottom plate that is mounted on the X-axis smooth rods with bushings or linear bearings and the print top plate that is mounted on the bottom plate and that forms the print surface. The top print plate must be level! The top print plate is mounted with fours springs slid over four screws so that it can be easily adjusted.

The bottom print plate is mounted on the X-axis smooth rods with printed bushings. A popular add-on for your printer is the heated bed. These significantly reduce the amount of warping on printed parts, especially on the lower layers. Warping is caused by the uneven cooling of outer and inner sections of a printed part. The material at the outside of a part will cool and thus shrink faster than the material inside. This will cause the cooler material to warp or bend while the hot material won't. This uneven shrinking will cause straight edges to bend and might cause structural failure in parts. Warping is especially a problem for the lower layers of a part since the print plate will cool those layers much faster than higher layers.

The solution is to print on a heated bed so that the entire lower section of a part is kept at the same temperature. A heatbed can heat the top print plate up to 100C.

The heat bed remains on for the entire duration of the print. Usually a glass plate is installed on top of the heat bed. If the heat would be turned of after a few layers the printed part would eventually come loose due to the temperature drop and the print would fail. A heat bed can either be bought or home-made. Buying is of course easier but building it yourself is feasible and cheaper. When you install a heat bed be sure to check the temperature of the transistor on your electronics board. If it gets very hot you might have to install a little heat sink.

G.Electronics

The electronics board controls the printing process. Several electronics options exist for RepRap printers (they are all open-source.) Currently the most popular are: RAMPS, a DIY shield board for Arduino MEGA Sanguinololu, an all-in-one DIY board with microprocessor on board The RepRap electronics board has several functions: Process G-code instructions.

Control the four stepper motor controllers (there are five stepper motors on a RepRap Prusa Mendel but both Z-axis motors are connected to the same stepper motor controller.)

Control the temperature of the hot-end and monitor the hot-end thermistor. Monitor the end-stops (end-stops are used for homing the three axes, see later section.) Control the

temperature of the heated bed and monitor the heated bed thermistor (the heated bed is optional.) The electronics board is connected to the PC using a USB-to-serial converter. The Arduino used with the RAMPS board has such a converter built-in, so does the Sanguinololu board. The RAMPS electronics board has been around longer than the Sanguinololu and has seen regular updates. RAMPS is a shield board that needs to be connected to an Arduino MEGA 1280 or 2560 board (or a clone board.) The RAMPS has these additional features: One extra heater / thermistor channel (three in total).

Optional SD card reader The Sanguinololu board is a more recent addition. It doesn't offer the extra thermal channel of the RAMPS and connecting an SD reader is more difficult. However, all electronics are contained on one board and hence doesn't require an Arduino MEGA board. This makes the Sanguinololu cheaper than the RAMPS. A complete RAMPS DIY kit including Arduino MEGA clone and four Pololu stepper controllers will typically cost about $100 or €100. A complete Sanguinololu DIY kit will typically only cost about $80 or €80.

A few things have to be taken into account though. When building your own Sanguinololu you will have to solder a very small chip (the USB-to-serial Bridge). Also, you should make sure the ATMega microprocessor comes with the Sanguinololu boot loader installed. If this is not the case you will have to install this boot loader yourself and that is pretty complicated. Ask your vendor in case you are not sure whether or not the bootloader is pre-loaded.

Although both the RAMPS and Sanguinololu boards have been designed to be assembled by hand the PCB's cannot be etched at home. Actually, the Sanguinololu board can't be etched at home at all, RAMPS boards versions 1.25 or earlier can be etched at home with some tweaks.

If you want to follow the path of least resistance you should go for a RAMPS board. But maybe you like the Sanguinololu's small size and lower price.

H.Stepper Motor
There are five stepper motors on the RepRap Prusa Mendel:
One to control the Y-axis
One to control the X-axis
Two to control the Z-axis
One to control the extruder

Normally all five motors on a printer are the same but this is not required except for the two motors that control the Z-axis: these must be identical. The RepRap Prusa Mendel has been designed to use bipolar NEMA17 motors. NEMA17 determines some of the dimensions of a stepper motor.

A stepper motor is a special kind of electric motor that is often used in robotics. The motor has two sets of internal coils positioned around a central teethed shaft that contains a permanent magnet. Each set of coils is part of a phase. The coils belong to the same phase will generate magnetic fields with the same North-South orientation. The motors used on RepRap Prusa Mendel printers have two phases. The RepRap electronics board controls the stepper through micro-stepping. In this mode the percentage.

I.Stepper motor controllers
Controlling a bipolar stepper motor is pretty complicated, especially in micro-stepping mode. Unipolar stepper motors are easier to control but they offer less torque for the same motor size. Special stepper motor controllers have been developed that take over the complexities of controlling a stepper motor. With such a controller one only needs to send one signal to make one micro-step. This seriously simplifies controlling the stepper motor.

The RepRap community has chosen to use

Pololu stepper motor controllers. These come in the form of a small board with one IC - the Pololu stepper motor controller - and a few passive components. Pololu offers both the IC and the board. This board uses very small components so has to be factory assembled. In late 2010 Pololu was experiencing difficulties to ship enough boards so RepRap community member Joem decided to design an open-source version of this board called StepStick. This board still uses the Pololu IC that never was is short supply. One assembled StepStick board usually costs about $10 or €10.

Four StepStick boards are required for a RepRap Prusa Mendel printer. When stepper motors are in operation and stand still they still use current. For this reason each stepper motor controller has a potentiometer to control how much current is sent to the stepper. If you send too much current you might use more current than is required (and hence increase your electricity bill.)

For this reason is it advised to close the potentiometer on each stepper motor controller by turning counter-clockwise all the way and then open the potentiometer about ¼th of the way. When you discover one of your steppers does not provide enough torque, you can open the potentiometer of that stepper motor controller at little bit further.

J.End stops

At the start of a print job all three axes have to be moved to their starting or homing position. This is the zero position of the Cartesian robot. The axes can't move any further than zero (they can't move to a negative position.)
To achieve this three end stops need to be installed, one for each axis. A end stop needs to be installed at the position where the axis shouldn't move beyond: For the X-axis this should be the position where the nozzle reaches the left-hand side of the print plate.

For the Y-axis this should be on the back-side of the axis so that the print plate is moved to the back far enough that the nozzle ends up on the forward of the print plate.

For the Z-axis this should be the position where the nozzle barely touches the print plate. When printing the software will make sure the Z-axis is lifted a little before printing the first layer.

You can choose between two kinds of end stops: optical or mechanical switch. The mechanical switches are preferred since they are much cheaper, easier to install and work just as well as optical end stops. Mechanical vs. optical endstops Switches have a limited number of on/off cycles. However, most purpose built microswitches are rated for well over 10,000 cycles and will last years. Optical end stops are on paper more reliable than mechanical end stops but in practice they are not (todo: discuss.) You should go for mechanical end stops. Proximity sensors are especially useful for the Z-axis. The starting position of the nozzle over the print plate is crucial. A Hall sensor detects the presence of a magnetic field. A magnet is glued to the bottom of the X-end idler or X-end motor. A small potentiometer allows you to fine-tune the distance between the nozzle and the print plate. This is much more practical than moving your mechanical or optical end stop up and down.

End stops are not required at the opposite ends. The firmware you will install in the microprocessor knows how far each axis is allowed to move calculated from position zero.

V.Plastics

A RepRap 3D printer is most often used to print either of two thermoplastics: ABS or PLA. The plastic material is arranged in filament. ABS and PLA are very different plastics and they each require specific printer configurations. ABS is made from petroleum and is more flexible than PLA. PLA is biodegradable, is more rigid than ABS and

will dissolve in water. ABS is more prone to warping than PLA. Good printing results will require a heatbed for ABS. For PLA you can probably get printed parts without warping without a heatbed. There are many different kinds of ABS and PLA. If your printer is perfectly tuned for the plastic of one vendor you might need to redo your configuration after you've switched vendors. PLA has a lower melting temperature than ABS. Take into account however that the thermistor on a NiChrome wire hotend typically reports lower than actual temperatures. A thermistor on a heatblock typically reports higher than actual temperatures. Your hotend temperature, extruder speed and axes speeds all need to be in harmony for good printing results. First try to get good printing results at a lower extruder speed
(100mm per second). Afterwards you can try to increase the speed. As a rule of thumb printing quality at higher speeds will be worse than at lower speeds although the degradation is usually acceptable.

VI. CONCLUSION

3d printer was studied, and we have started making a prototype depending upon the information we are having. Once the prototype is ready we will make changes according to the flaws that have been occurred while building the prototype. Though this printer has been in production since 2006, but we are trying to increase its efficiency and the production rate. Once our project is ready we will start accessing more data and improve our model, and program it to build more complex objects.

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The Longest Experiment

Science is concerned with experiments and experimentation. But you'd never expect experiments to go on forever, did you? Well, here's is an experiment that started in 1927 and over 80 years has been continuously conducted. You read it right, it is the pitch drop experiment.

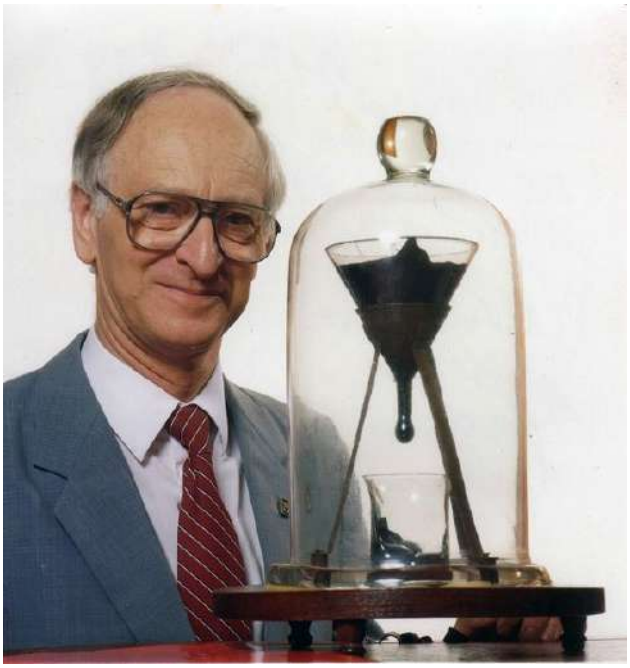
The pitch drop experiment is an experiment done to measure the flow of a piece of pitch over many years. Now, the first question that you might want to ask is what is pitch? Pitch is the name given to any number of liquids that are so highly viscous that it appears solid. The most common example is Bitumen. At room temperature, the tar pitch flows so slow that it can take several years to form a single drop. And how slow does it flow? "Australia is moving north at six centimeters a year due to continental drift. The pitch drop is 10 times slower than the continental drift", says Professor Andrew White, the current custodian of the experiment.

Professor Thomas Parnell of University of Queensland, Brisbane, Australia first conducted this experiment in 1927 to demonstrate to his students that some solids are actually very high viscosity fluids. A heated sample of pitch was poured into a sealed funnel and allowed to settle for three years. Then, in 1930, the seal at the neck of the funnel was cut, allowing the pitch to start flowing. A glass dome was placed on the funnel and then displaced outside a lecture hall.

Surprisingly, it takes 7 to 13 years for a drop to form, but only a tenth of a second for it to fall. The viscosity of the pitch was calculated to be 230 billion (2.3×10^{11}) times that of water the year 2000, when the eight drop fell.

This is the longest recorded continuously running laboratory experiment and has enough pitch to continue for at least another hundred years. It predates by two other still active scientific devices, the Oxford Electric Bell (1840) and the Beverly Clock (1864), but these have been interrupted since.

Initially, the experiment wasn't carried out under controlled conditions, so the viscosity could vary throughout the year with fluctuations in temperature. After the seventh drop fell in 1988, air conditioning was added to where the experiment was being conducted. This temperature stability has lengthened each drop's stretch before it separates from the rest of the pitch.



The University of Queensland pitch drop experiment, featuring its then-current custodian, Professor John Mainstone

Date	Event	Duration (months)	Duration (years)
1927	Hot pitch poured	-	-
October 1930	Stem cut	0	0.0
December 1938	1st drop fell	98	8.1
February 1947	2nd drop fell	99	8.2
April 1954	3rd drop fell	86	7.2
May 1962	4th drop fell	97	8.1
August 1970	5th drop fell	99	8.3
April 1979	6th drop fell	104	8.7
July 1988	7th drop fell	111	9.2
November 2000	8th drop fell	148	12.3

A similar experiment was conducted by an unknown colleague of Ernest Walton while he was in the physics department of Trinity College. This setup was forgotten about and a number of drops formed also gathering dust with it. It wasn't until in 2013 that physicists noticed a drop forming. The setup was then moved to a table and observed under a webcam.

In April 2013, about a decade after the previous pitch drop, physicists at Trinity College noticed that another drip was forming. They moved the experiment to a table to monitor and record the falling drip with a webcam, allowing all present to watch. The pitch dripped around 5:00pm on 11 July 2013, marking the first time that a pitch drop was successfully recorded on camera.

Scientists used to believe glass to be a slow moving liquid too, but the myth was busted later

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Abhilash Kothari
Be Mech

ROBOTICS TECHNOLOGY IN SPACE

INTRODUCTION

Space technology is essential in social and economic life of global society and the most challenging application of robotics is space environment. Nowadays robotic system act as key factor of technology evolution, plays important role in space exploration by using series of spacecraft. Space robotics is an ultimate field of development of machines for space environment that perform exploration, assembly, construction, maintenance, servicing or other tasks.

In outer space the environment is very harsh with extreme temperatures, vacuum, radiation, gravity and great distances and therefore human access is limited. To boost the human activities in space for constructing and maintaining space modules and structures, robotic systems playing important role in orbital operations. Moreover, the scope of exploration elaborating beyond the areas of human access, robots that land and travel on planetary surfaces have been greatly commit our knowledge of the solar system. In solar system there are nine planets, countless asteroids and many other bodies are there which contain materials that we need to feed our growing civilization.

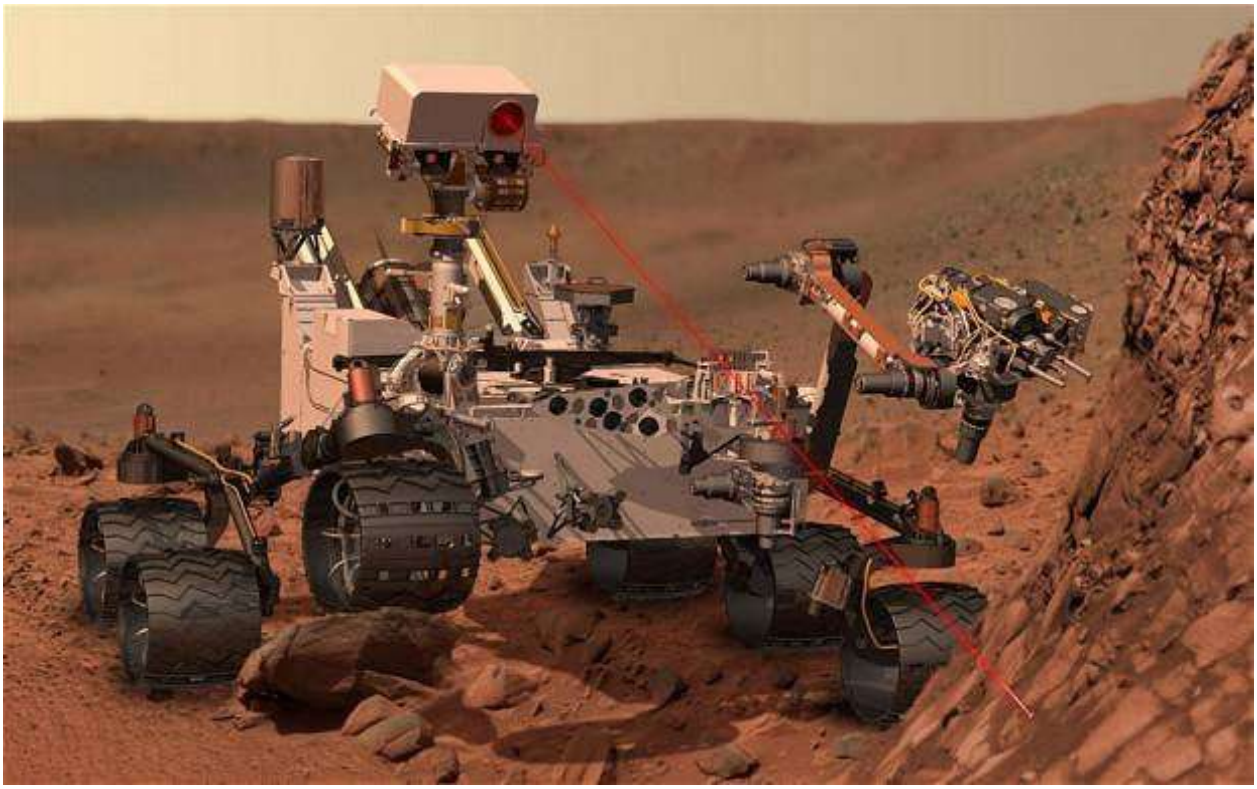
The space robotics deal with two things such as man-machine interface and system design. These two concept described the telerobotic control processes initiated from ground station, which gives the motion of robotic programming languages, voice recognition software, virtual reality systems and overall ground station computer hardware.

TYPES OF SPACE ROBOTS

PROBES

A space probe is a robotic spacecraft with no human on board, under telerobotic control. Space probes are sent to explore space and gather scientific information and for many space mission telerobotic operation is preferred than crewed operation because of lower cost and risk factors. A probe is launched in space with some specific set of instrument and tools that can be used to study the atmosphere and composition of space. Space probes have visited the asteroids, moon, comets and every planet in the solar system except Pluto. A probe may operate in orbit, land on a planet or a moon. It may make a one-way journey, or it may bring back samples and transmit data to earth by using radio. There are different types of probes such as interplanetary, orbiters and landers because they collect different science information about various different environment. Since 1950 human have been sending space probes into space. The first space probe launched in space is Sputnik1 in October 1957. The next generation of probes will study samples taken from asteroids, comets, and Mars.

The design of space probes consist of physical structure, thermal control, electrical power, attitude control and telemetry, tracking and commanding. The structure provides overall mechanical integrity, ensures spacecraft components are supported and can withstand loads. Spacecraft are protected from temperature fluctuation with insulation, mirrors and sunshades.

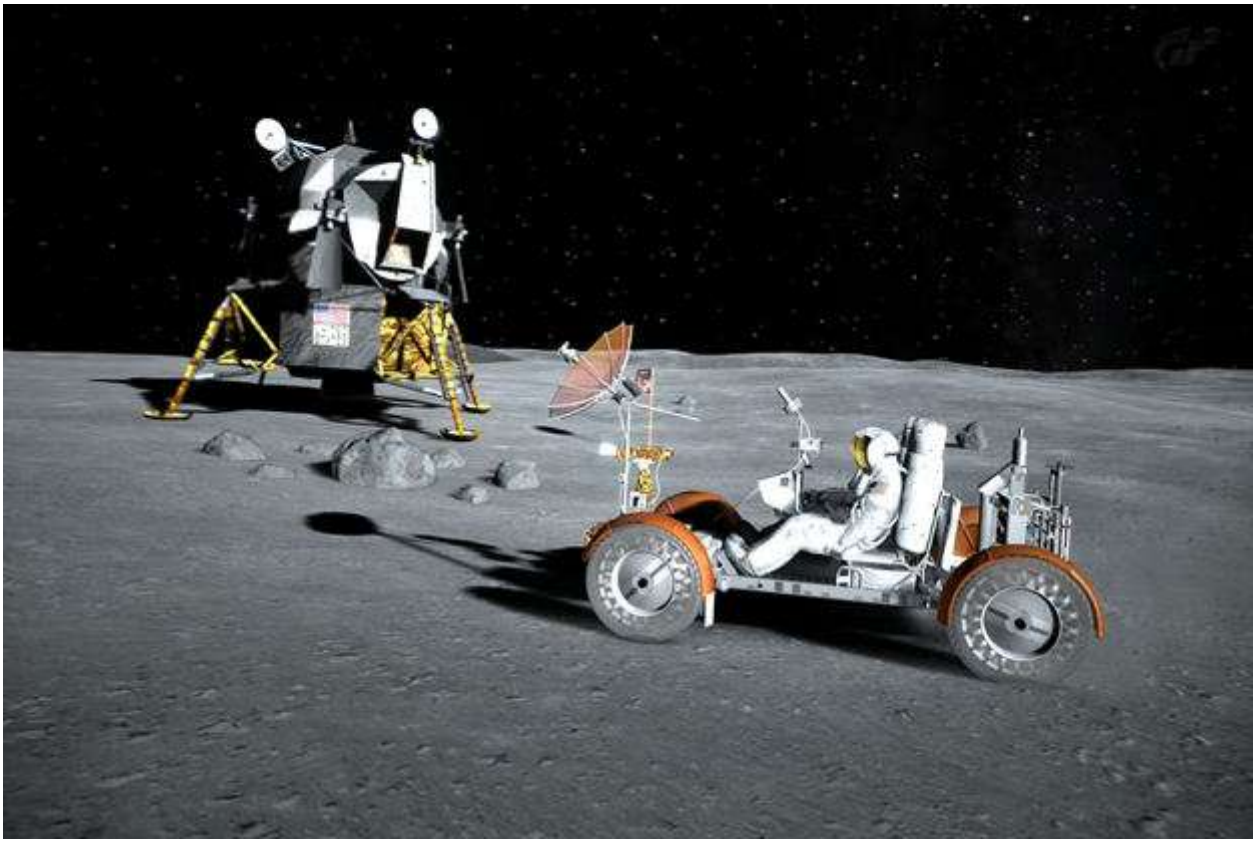


The electric power supply to the spacecraft by using photovoltaic cell or radioisotope thermoelectric generator. Batteries and distribution circuitry are the other component of subsystem which connect the components to power sources. Attitude control is mainly responsible for proper orientation of spacecraft in space despite external disturbance-gravity gradient effects, magnetic-field torques, solar radiation and aerodynamic drag. Telecommunication subsystem include radio antennas, transmitters and receivers that can be used to communicate with ground station on Earth, or with other spacecraft. Commanding and tracking are often responsible for command sequence storage, maintaining the spacecraft clock, collecting and reporting spacecraft telemetry data, mission data. For deployment after launch or prior to landing mechanical component need to be moved.

ROVERS

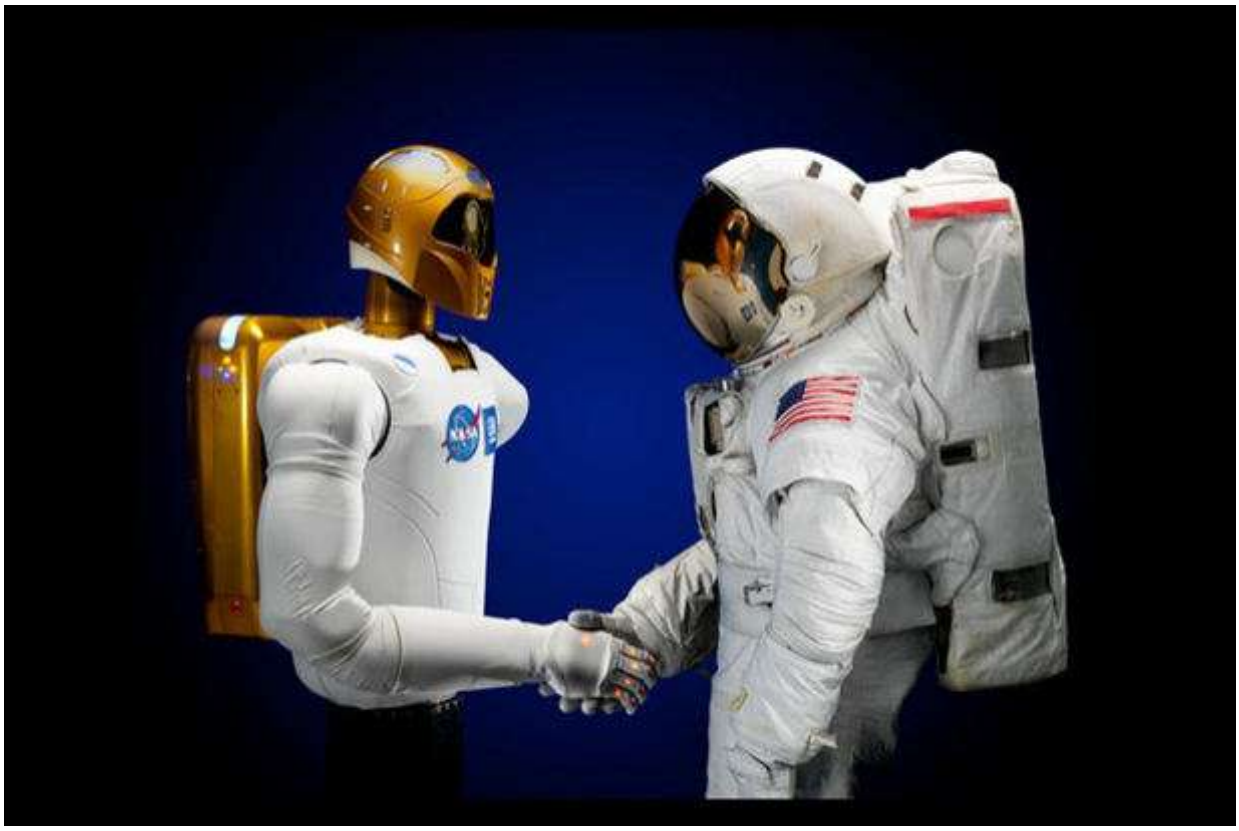
A rover is a space exploration vehicle which are designed to move across the surface of planet or other celestial body. Rovers are used in very distinct condition from the Earth, which require some demands on their design such as wheel motion and robotics parts. Rovers are remain functional without repair for operational period of time and withstand high level of acceleration, high and low temperatures, pressure dust, corrosion, cosmic rays. They are attached to a spacecraft because they have limited capacity, and have to be deployed. Rovers cannot be remotely controlled in real-time when they land on celestial bodies which are far from Earth because the speed at which radio signals travel is too slow for real time. These rovers are capable of operating autonomously from ground control but still they require human input for identifying target. Lunakhod1 was the first rover to be launched in space in 1970. The recent rovers on Mars are Spirit Rover and Opportunity Rover.

The rover consists of a structure which protects the rover. It contains computers which process the information. Temperature controls act as internal heater, a layer of insulation and more. Cameras and instrument gives the information about their environment whereas wheels act as part of mobility. Power is supplied by batteries and solar panels and for communication purpose antennas are used. The data will be transferred to the base station wirelessly, which is connected to the computer. Data can be viewed by user interface in real time.



ROBONAUT

Robonaut is a humanoid robotic machine that can be used to help human work and explore in space. A Robonaut was first built and designed at NASA Johnson Space Center in Houston, Texas. The robonaut can work alongside with human and can take over simple, repetitive, or dangerous tasks on places such as international space station. Robonaut is a robot that reduces the need of specialized tools, it uses the same tools that astronauts currently use. Robonaut can climb 420 kilometres above the Earth and perform normal clean chores and fascinating things for the human crew. Robonaut is the first anthropoid robot that has the fine motion and force-torque control for any task needed in space environment. One such important task is a spacewalk, human astronauts require long and tedious pre and post-space-walk procedures but that problem was solved by Robonaut. It can potentially minimize operation time, risk and improve quality of work during spacewalk mission. The Robonaut 2 was launched in space on 24th February 2011.



The Robonaut consists of an arm structure in which avionics elements are fixed within each link, hence minimizing cabling and noise contamination. It is a biologically inspired neurological unit which have computational symmetry, sensor and power duality and kinematical redundancy. Robonaut uses a chordate way to data management, all feedback is given to the central nervous system, where low level servo control is performed and it is basically an optimization of mechanical, electrical and software form.

Smartphone controlled Robots

Free-flying robots in space have limited capabilities,so to increase processing capability, communication, a camera, accelerometers and other sensors are used. NASA plans to send Google's 3D smartphones into space to function as the “eyes and brains” of free flying robots. The robots, known as SPHERES (Synchronized Position Hold, Engage, Reorient, and Experimental Satellites) were inspired by the Training Remotes from Star Wars. The robots were usually very expensive and complex but by using consumer electronics such as smartphones, it can significantly reduce the development cost for robots with high-performance capabilities. The Google's 3D smartphones equipped with an infrared depth sensor and motion sensing camera. The sensors produce a 3D map by detecting angles within the space station.

ADVANTAGES OF ROBOTS

1. Robots can perform complicated tasks and can be used in situation where there is risk for humans.
2. Robots can perform task faster than humans with higher accuracy.
3. Robot missions are economical.
4. Robots working in space do not require any salary and food and gives information that human can't get.

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Nafees Parbulkar
TE Mech

Industrial Visit to Europe - Germany and France

About 19 students from PIIT, New Panvel and PHCET, Rasayani led by Dr. R.I.K. Moorthy Sir, Principal, PIITR and Mrs. Nivedita Shreyans, Chief of Public Relations, Pillai Group of Institutions went on an industrial visit to Germany and France.

The trip to Germany began in Berlin. The students got a tour of the city and moved on to Dresden to visit the Volkswagen factory. This Volkswagen plant is the only one in the world which assembles the Phaeton. Students saw the different stages of the assembly line which consisted of three different circuits.

After an overnight stay, the students then travelled to Stuttgart to visit the Mercedes Museum and to Munich, the next day, to visit the BMW Museum. The students, especially the ones from the automobile branch enjoyed the few hours spent there.

The group then headed to iSTec, a company the principal Dr. R.I.K. Moorthy, made his mark a few years ago. They were received by one of his colleagues, Mr. Reinhold Sunder and taken down for lunch where Mr. Alenxander Kolbaseff joined them. After lunch, a small presentation was given by Mr. Kolbaseff on the involvements of the company in Security and Diagnostics in Nucleur Energy, Wind Energy and recently, High Speed Trains. The session ended with a small presentation by Mrs. Nivedita Shreyans about the college and a presentation by one of the students, Priyank Nandu, on India.

On the next day, the students went to Dutsches Museum in Berlin, the biggest technical museum in the world before boarding a train to Paris.

After sightseeing around Paris, the students finally moved onto Toulouse. In Toulouse, the students visited the Airbus Assembly Line where they were received by Mr. Francis Meyselles, Senior Director of Customer Relations, South East Asia and Japan. The students started by viewing the assembly lines of the A320's and the A380's and learnt about the capacity, range and functions of the models. The visit ended with a vote of thanks to Mr. Francis. The students also visited the University of Toulouse and were informed about the facilities available.
This concluded the trip to Europe. The students are looking forward to such endeavors taken by the Pillai Group.

Jasvinder Singh Batra
(With inputs from Bradley Desouza)

Engineer's Day Celebration

On 21st September 2013, MESA and AESA organized a special presentation by Mr. Jitendra Bhambhure, Executive VP, R&D and Technology, Bluestar on the topic New Product Development.

The event was inaugurated by Dr. Priam Pillai, COO,MES and Dr. R.I.K Moorthy, Principal, PIIT. The meritorious students of Second Year were felicitated by Dr. Priam Pillai.

The event started with the screening of a documentary on the life of Sir Mokshagundam Visvesvarayya in whose honor the day is celebrated.

The students won some prizes in a small quiz that was organized. The student chapter of ISHRAE was also established on this day.

Clockwise from left: Mr Bhambhure lighting the lamp; the student committee of ISHRAE student chapter; Dr. Priam felicitating the students; Mr. Bhambhure giving the presentation; Dr. Moorthy felicitating Mr. Bhambhure.

Jasvinder Singh Batra

Solidworks Competition held for students

A very successful competition of "CAD Designing" was conducted under the guidance of the faculty Prof. Vaishali Kumbhar, Prof. Anoop Sambherao & Prof. G.V.Patil on 5th Oct.2013 at CAD/CAM lab R-101 started from 9.00 am onwards.

The Competitors were allowed to use Solidworks or Pro-e software for designing. The competition was conducted in 3 sections, Eliminations, Pre-finals & Finals coordinated by MESA & AESA committee. The total no of entries for the competition were 75.
The event was inaugurated by the judges. The 75 participants were reduced to 25 for 2nd round. Refreshments were served to the participants of 2nd stage & judges during the competition. Total 8 finalists were selected in the finals and 3 winners- 1st Mr Shreyas Sanjeevan (SE AUTO), 2nd Naveen Joshi (SE AUTO), Viraj Sant (SE MECH) were selected. The winners were felicitated by of Dr. Priyam Pillai, COO (MES).

The event was successful due to the participation of all the students and cooperation of the faculty and combined efforts of the MESA and AESA committee.

Clockwisefrom top:Students showing off their Solidworks skills; Dr. Priam Pillai felicitating the winners.

Rohan Desai

Oppurtunities in FSAE

An incredibly value adding session on " Opportunities in FSAE " took place under the guidance of our very own Prof. Amey Mhatre on 9thoctober 2013, at the Conclave from 3pm-5pm in the presences of our very own Dr. K.M. Vasudevan Pillai, Dr. Priam Pillai,COO,MES and Dr. R.I.K. Moorthy. It was a great honor for the committee to have all the great achievers in front of them, sitting on chairs & giving their precious time to give an ear on to the ideas of the committee.

The session was organized to put forth the Innovation & creation of plans for the next 3 years by Team Hyperions (team FSAE), the event got support of students from SE MECH & SE AUTO of PIIT & faculty from Mechanical & Automobile Engineering, and also about 10 student representatives from SE Auto & TE Mech form the HOC Campus. The dignitaries appreciated the efforts of the team and briefed them with new fabrication facilities being commissioned.

At the end, all the Authorities acknowledged the efforts of the students. The supports of all the students and especially the experts, helped to make this a successful event.

Viraj Sant

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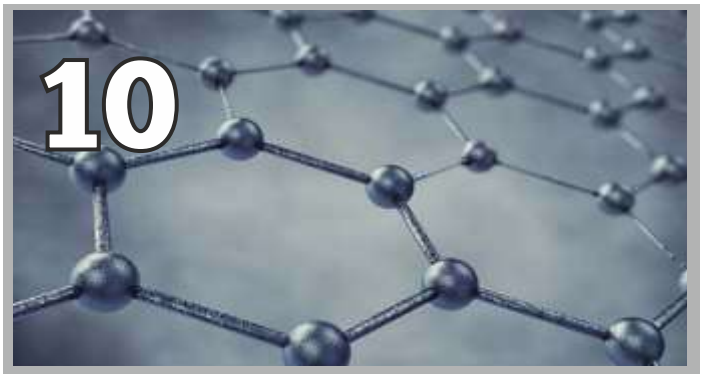

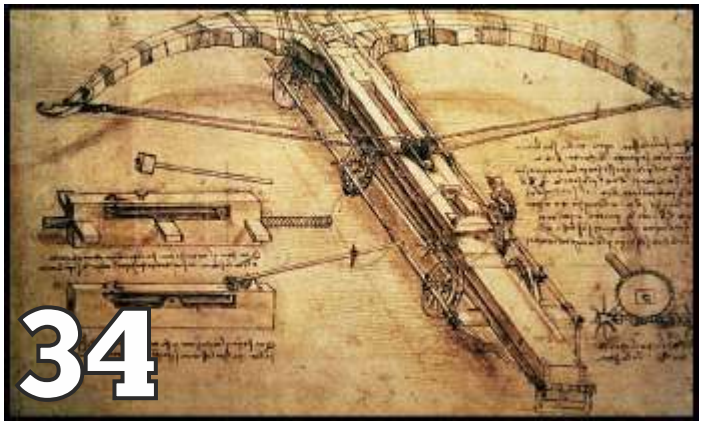

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The Power House of Growing Demands in Autotronics- 42 VOLT TECHNOLOGY

Abstract : With the increasing demand for more fuel efficiency and environmentally friendly car coupled with the consumers' drive for more comfort, safety and luxury car has led to the introduction of more electrical and electronic systems to the passenger car. Some anticipated features, such as electromechanical engine valves, will demand both conversion and sophisticated control at power levels in the 2 kW to 10 kW range. This paper suggests improvements to the existing methodology to meet the new growing electrical power demands with minimum fuel consumptions and looking into increasing the present voltage threefold, from 14V to 42V for future cars. An increase in the demand to shift towards a 42V system is strongly needed. Thus it will bring about improvements in fuel efficiency, power, safety, comfort, and convince.

I. INTRODUCTION

Today, one of the major trends in the automotive industry is the increasing amount of installed electrical and electronics system on the passenger car which results in a growing consumption of electrical energy. Today's consumer wants more and more features in their cars to increase comfort, safety and luxury. Another strong trend in the automotive industry is to replace mechanical and hydraulic powered components by introducing new electrically powered solution. In this way, they consume energy only when they are in use, resulting in lower fuel consumption and better overall system efficiency.

However, looking back through the years, the increasing loads are not recent phenomena. In the near future, higher growth in the average power for vehicle loads is expected to rise to 4kW by 2015. This further corroborated by the automobile industry which estimate that power demand will be in the range of 4 to 5kW by 2010. This tendency will push the electrical power demand beyond the handling capability of the today's standard 14V DC system which is around 1kW with peaks above 2kW.

In order to meet the growing electrical power demands with minimum fuel consumption and minimum environmental effects, the automobile industries have agreed to increase the present voltage to 42V, given the name “42V Power Net”, which represents a three-fold increase in the system voltage.

Fig1:Typical vehicle average load current draw versus time.

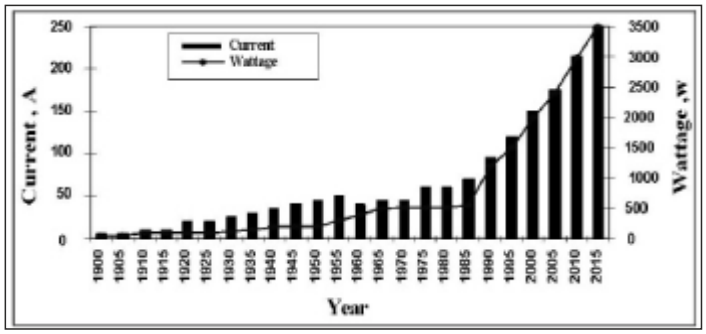


Table 1: 14V, 28V and 42V system specification

Electrical system	14V *Car*	28V *Truck*	42V *PowerNet*
Battery voltage	12V	24V	36V
Nominal voltages	14V	28V	42V
Maximum voltages	24V	34V	50V (*ripple*)
Maximum dynamic voltage	-	-	58V (Load *Dump)*
Power *Electronics* rating	60-40V	80-60V	100-75V

II. TIMELINE OF AUTOMOTIVE ELECTRICAL POWER SOURCE

The various milestones in the automotive electrical power source are as given below:

- Invention of cars used 6 V technologies.
- 1912: Electric starter motor developed which changed electric needs of a car.
- 1950: 6 volt batteries transited to 12V batteries. It is sometimes referred to as 14V also as the charging voltage for the battery was 14V. Transition was easy as the new systems utilized 6V technology that was simply adapted to work on higher voltages.
- 1960s and 70s: Radios became compact and portable and thus were fitted in cars. Along with this came the requirement of instantaneous warm-up, electronic engine controls, seat belt/starter interlock systems were the first to show up on cars.
- 1980s: Power demands of cars growing by 4% a year, and we are already crossing the 2kW mark. 3kW is a kind of breaking point for the 12V battery system. At 3kW power consumption, 79% of engine power will not make it to the driveline.
- 1990s: Thought of beltless engines, which means engine, drives only drivelines. Compressor fuel pumps etc. are driven by alternate electric source. It was here that 42V technology was coined.
- 2002-2003: Early predictions of 1990s showed that 42V systems would be introduced in cars by this year. However many roadblocks prevented it from hitting the road.
- 2004: European OEMs claim to have ready technology to incorporate the 42Vsystems.
- 2015: Estimated time by which 42V technology will be introduced in production cars.

It is only recently that manufacturers have begun to appreciate the electrical system's influence on vehicle performance and price. The result has been an increasing interest in re-placing mechanical actuators by electrical, improving electrical system efficiency, finding alternatives to the present 14 V DC system, and improving safety and comfort by introducing new functions that are best controlled electrically. A further, rather interesting, motivation to electrify functions is that electrically driven "things" provide packaging flexibility.

III. ROADBLOCKS

In spite of the potential advantages of the technology, the industry is not completely sure on the profit aspects of the system. A few roadblocks in transition are as given below:

Economic hurdles:

1. Is market ready yet: Although people are increasing in their automotive power demand, will they pay for such a change in technology? It is a fact that most power hungry vehicles are only the high end luxury cars. What about the low end versions?

2. Today's electric components may become obsolete: Components used today work on 12V technology. Shifting to a 42V technology means that all these components need to be changed and upgraded or additional circuitry be introduced to incorporate the same old components.

3. Change in standards: International and local government automotive standards are based on 12V technology. To incorporate the new technology, theses institutes need to create workgroups and redefine the standards, which again is a costly process.

4. Wait till the need arises: Due to many of these disadvantages, many automotive and supplier companies are simply looking to the other way. This means that they wish to tackle the problem only when an urgent need has been raised.

Technical hurdles:

1. Roadside assistance: Jumpstarting a 42V technology run vehicle by an older version can result in catastrophic results, causing permanent damage to the 12Vsystem. This also needs to be incorporated in the research procedure.

2. Lighting: Today`s vehicles, mostly use tungsten filament bulbs. A 42V technology means that the filaments need to be

further thinned out in order to produce the same luminosity. This possesses a serious challenge to OEMs. An alternate is to use white lights known as High Intensity Discharge (HID), but then they are costly.

3. Voltage regulations: To incorporate today`s technology of 12 V in further 42Vtechnology requires some sort of DC to DC conversion. However DC to DC converters are not cheap, and hence would add on to increase in cost.

IV. Benefits adding to current technology

Current Technology	42 volt Architecture
Electric power steering	More power, improved fuel economy
Electric brakes	Redundant power
Power windows, power seats, power hatchback lifts	Reduced size and mass of motors; more efficient operation
Heated catalytic converter	Lower emissions; quicker light-off time
Heating, ventilation, airconditioning blower motors and cooling fans	Greater efficiency; smaller/lighter units; flexible packaging
Mobile multimedia	More power available for video, mobile phones, navigation systems, audio amplifiers, fax machines
Electric water pumps	Improved efficiency; longer service life
Selected engine management system components (e.g. exhaust gas recirculation valves, ignition systems, control actuators)	Reduced size and mass; increased performance
Fuel pumps	Reduced size and mass
Heated seats	Faster heating, more efficient operation; increased power

Along with the above benefits, a few systems are elaborated below:

☞ Efficiency:

The alternator operation requires a lot of fuel. With the present day 14V alternators, the engine efficiency over the entire speed range is not more than 60%. In a mixed driving environment (city and highways) more than 2 liters of fuel is required for 1Kw load output per 65 miles. The 42Vtechnology will bring it down to about 0.5 liters.

☞ Wiring Harness:

The wire size will reduce as the increased voltage means less current can be supplied to almost all applications. Thus the wiring harness flexibility will increase

.

☞ Increased performance:

There are 3 ways in which the performance will increase. One is the decrease in amount of power drained out of the power train. Thus a potential increase in fuel economy. And lastly is the possibility of including additional equipment in the car, preferably for Driver's assistance.

☞ Cheaper semiconductors:

This is achieved in semiconductors. Today's semiconductors are built in with protection against high voltages (of up to 60V).However a carefully designed, new 42V system will remove this need and smaller semiconductors can be used which will enhance multiplexing.

☞ Reduced Mass/Cost ratio:

Weights of solenoids decrease almost linearly with the increase in voltage. For motors the decrement in weight is slightly less dramatic as the gears etc. will still be there. However, Reiner Emig, VP-Engineering at Bosch says that weight reductions of up to 20% can be achieved.

V. POTENTIAL APPLICATIONS :

Integrated Starter Generator (ISG)

The ISG is a novel idea which combines the starter and generator and works on 42V technology. The ISG is usually mounted directly on the crankshaft between the engine and the transmission, owing to its compact size. It electromagnetically transmits the force to the crankshaft when the key is turned, and starts the engine at a fraction of time (around 0.2s. The reason for this that it does not have to drive the pinion in mesh with the ring gear and this saves time. For this it can be used to reduce fuel economy and emissions. Thus the car can have no start switch, and the car would simply accelerate on application of the accelerator pedal. And the engine would switch off on application of brake, hence start-stop. Moreover, the ISG can create 10kW of power which is a requirement of 42Vtechnology.

Electromagnetic valves

Most piston engines today employ a camshaft to operate poppet valves. One of the approaches designed to overcome problems with the conventional mechanically operated cam, but which has proved difficult to implement, is Camless Valve Trains using solenoids or magnetic systems. Camless engines would be more efficient as the valves could be computer-controlled. Infinitely variable valve timing would be possible, though variable valve lift would be more difficult. This means that 2 cylinders of a V8 engine can be deactivated by temporarily closing the inlet valve and at the same time opening the exhaust valve of those cylinders. Thus the V8 engine will function as a V6 engine with an extra pair of redundant pistons. Even more intriguing is the ability to combine it with direct fuel injection and start an engine statically using no external rotator means. Valves of the appropriate cylinders would-be closed and an amount of fuel will be injected, which will then be sparked, thus engine is started.

Electrical active suspension

Active suspension refers to the system that keeps the passenger compartment in the same horizontal line or flat trajectory when the car encounters a pot hole or a bump. Active suspension is an automotive technology that controls the vertical movement of the wheels via an onboard system rather than the movement being determined entirely by the surface on which the car is driving. The system therefore virtually eliminates body roll and pitch variation in many driving situations including cornering, accelerating, and braking. Electromagnetic recuperative active suspension is one such type that has high power requirement, which can be easily answered by 42V technology. This technology allows car manufacturers to achieve a higher degree of both ride quality and car handling by keeping the tires perpendicular to the road in corners, allowing for much higher levels of grip and control.

Electronic power steering

Electric power steering (EPS or EPAS) is designed to use an electric motor to reduce effort by providing assist to the driver of a vehicle. Most EPS systems have variable assist, which allows for more assistance as the speed of a vehicle decreases and less assistance from the system during high-speed situations. This functionality requires a delicate balance of power and control that has only been available to manufacturers in recent years. The EPS system has replaced the hydraulic steering system (HPS or HPAS) in many passenger cars recently.

Electromechanical brakes (EMB)

Brake-by-wire represents the replacement of traditional components such as the pumps, hoses, fluids, belts and brake boosters and master cylinders with electronic sensors and actuators. Once the driver inputs a brake command to the system via the brake pedal, four independent brake commands are generated by the ECU based on high level brake functions such as anti-lock braking system (ABS) or vehicle stability control (VSC). These command signals are sent to the four electric calipers (e-calipers) via a communication network. Thus in an EMB, ABS, traction control, vehicle stability and panic brake assist will not be controlled by hydraulic but electrically operated gearboxes, monitored by the ECM.

Electric Air Conditioning

In today's cars, the air conditioner compressor is driven by the engine. This creates similar problem as discussed above. An electric motor is the best solution for this problem. Also, the need for an AC arises not only when the engine is driving but also when the engine is off, like in traffic jams. 42V technology solves this problem.

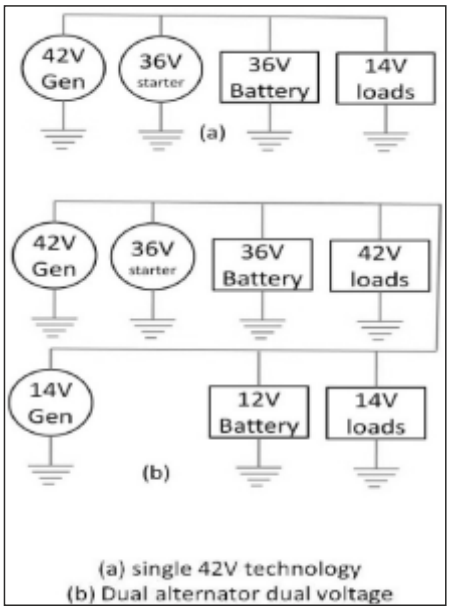
Batteries

As a conventional lead acid battery has a limited charging discharging cycle, it cannot be used in that case. In urban conditions the battery needs to supply sharp bursts of energy, and also needs to recharge also quite fast. Current lead acid batteries are still able to give the required boost, buts fails in the regenerative braking phenomenon. Thus lithium ion batteries are mostly proposed for the use in 42V technology. These batteries are currently in production in non-automotive applications, and have been tested for one million cycles of charging and discharging and also have a good combination of specific energy and specific power. The downfall, however is the high cost incorporated. In general terms of physical size, the 36V battery will be bigger than a 12V battery as it would have 24 cells instead of 8. Using lightweight but similar batteries currently used in motor sports will solve the problem.

VI. PROPOSED ARCHITECTURE OF 42V SYSTEMS:

Single 42V system:

It is the simplest design on paper, but the most difficult one to implement. In the long term, however this would avoid cost, weight and packaging problems created by 2 batteries. The assumption is that energy management system would be smart enough to monitor a single battery and manage loads to prevent depleting the 36V battery to the point where vehicle cannot be started. This is yet expensive initially and would be inappropriate for the manufacturer to change over all their vehicles at once.



(a) single 42V technology
(b) Dual alternator dual voltage

- By Bhargava Saripalli and Pratish Golchha, BE Automobile, Pillai's Institute of Information Technology, Engineering, Media Studies & Research, New Panvel

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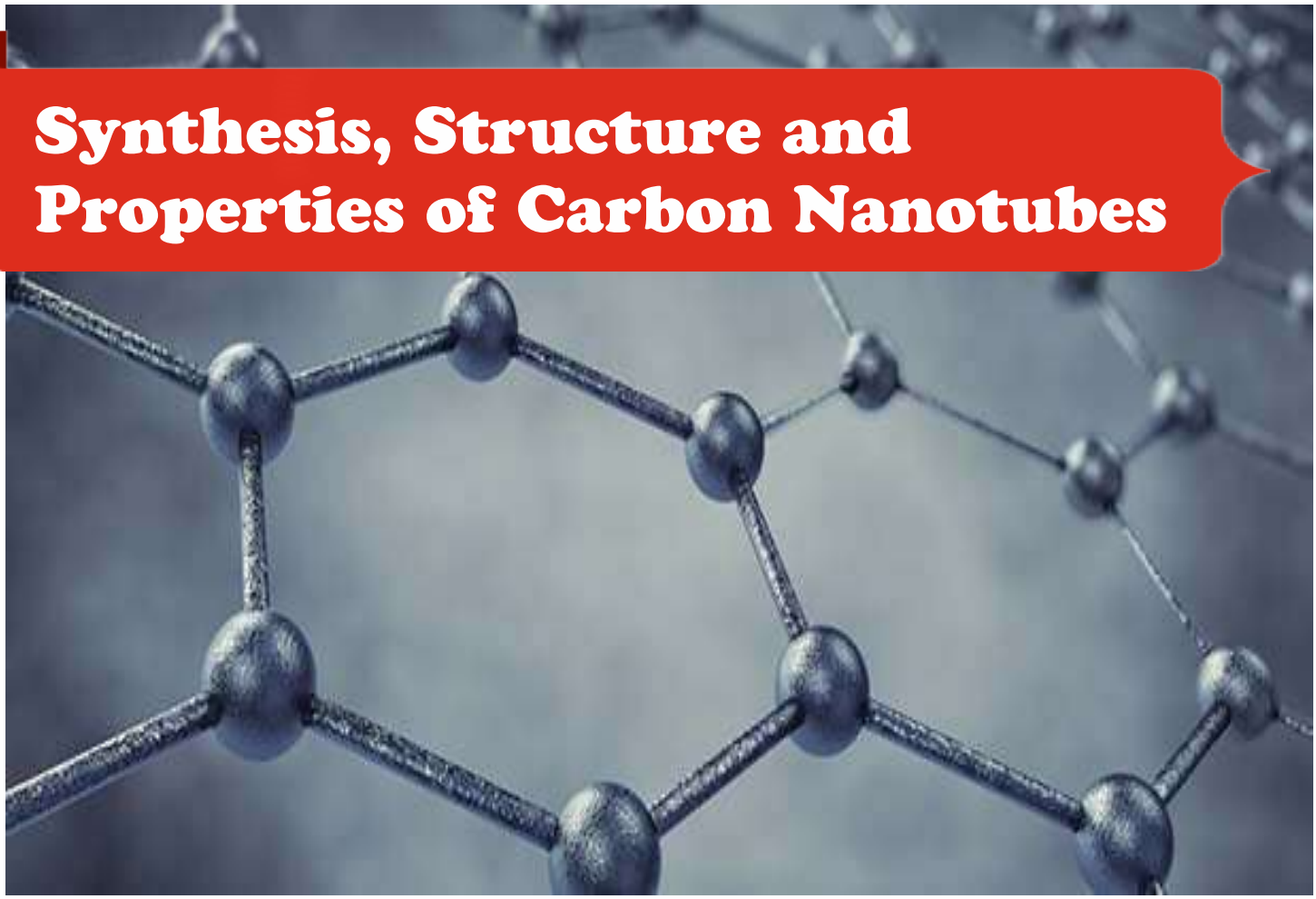
Synthesis, Structure and Properties of Carbon Nanotubes



Features of the article

- Structure and Properties of Carbon Nanotubes
- Synthesis of Carbon Nanotubes :
  1) Electric Arc–discharge Process
  2) Laser Ablation of Carbon
  3) Chemical Vapor Deposition (CVD)
  4) High Pressure CO Disproportionation Process (HiPCO)
- Purification of Carbon Nanotubes

Carbon has four electron in its outer valance shell and is a chemically genius material. They can bond in various ways to create structures with entirely different properties. Diamond and graphite are the two natural crystalline forms of pure carbon (Saito et al., 1998; Terrones (2003)). The four electrons in carbon, when shared equally (sp3 hybridization), create isotropically strong 'diamond'. But when only three are shared covalently between the neighboring atoms in a plane and the fourth is delocalized among all atoms (sp2 hybridization), the resulting material is called 'graphite'. The strong in-plane bond in sp2 set forms the hexagonal honeycomb lattice, typical of a sheet of graphite and weak out-of-plane bonding of van der Waals type. Typical C-C bond length in sp3 and sp2 hybridization is 1.56 Å and 1.42 Å where as, graphitic inter planer spacing is 3.35 Å. Graphite is a thermodynamically stable phase at very high temperatures where as diamond is kinetically stable phase. Fullerene and carbon nanotubes are the other new forms of pure carbon, which belongs to sp2 hybridization family. The significant

importance of CNT came in to existence after the discovery reported by S. Iijima in year 1991 (Iijima (1991)).

A] Structure and Properties of Carbon Nanotubes :

Depending on the way graphite sheets rolling up along the edge, CNT forms two type of arrangements 'non-chiral' and 'chiral' arrangement. In non-chiral geometries, the honeycomb lattice, located at the top and bottom of the tube, are always parallel to the tube axis. These geometries are known as 'armchair' and 'zigzag' arrangements (Terrones (2003)). In armchair arrangement the two C-C bonds on the opposite side of each hexagon are perpendicular to the tube axis where as in zigzag arrangement these bonds are parallel to tube axis. All the other conformations in which the C-C bond lies at an angle to the tube axis are known as 'chiral' or 'helical' structures. Fig. 2.1 shows the different chiralities of carbon nanotubes. All the armchair arrangement is metallic where as the zigzag and helical tubes are either metallic or semi-conducting. This gives them better electrical properties and finds applications in electronic industries (Ajayan (1999)).

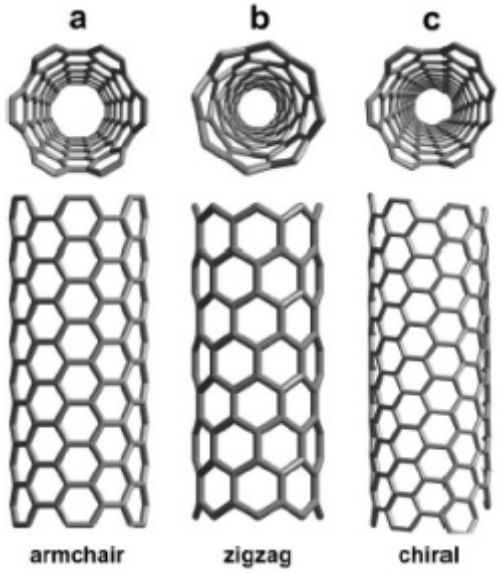
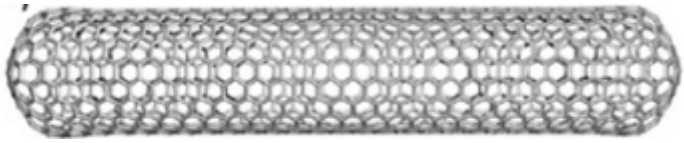
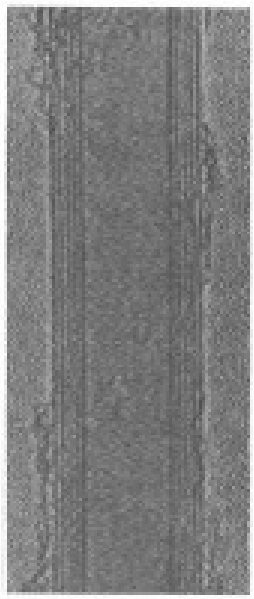


Fig. 1 Molecular model of SWNT exhibiting various types of chiralities

Based on the number of co-axial cylinders rolled up in a given structure, CNT are termed either single-wall carbon nanotubes (SWNT) or multi-wall carbon nanotubes (MWNT). In SWNT, single graphene sheet gets rolled up and forms a seamless tube where ends are capped whereas, in MWNT more than one graphene sheet get rolled up co-axially one over another to form concentric cylinder type arrangement with an interlayer spacing of 0.34–0.36 nm. CNT diameter range from ~ 0.4 to > 3 nm for SWNT and from ~ 1.4 to at least 100 nm for MWNT. Nanotube properties can be very well tuned by changing the diameter. Typically the tube length varies from 1-10 micron. Density of MWNT and SWNT are 1.75 gm/cc and 1.4 gm/cc respectively (Baughman et al., 2002). Fig. 2.2 shows typical HRTEM images of SWNT and MWNT.



(a) SWNT



(b) MWNT

Fig. 2 High-resolution TEM images of (a) SWNT and (b) MWNT

Each MWNT exhibits unique conductivity properties that can lead to both metallic and semiconducting behavior (resistivites at 300 K of ~1.2x10-4 – 5.1x10-6 ohm cm; activation energies < 300 meV for semiconducting tubes). The geometric differences (e.g. defects, chirality, diameter etc.) and degree of crystallinity (hexagonal lattice perfection) of tubular surface plays key role in the electronic response. Bundles of SWNT have been shown to behave as metal with resistivites in the range of 0.34 x 10-4 to 1.0 x 10-4 ohm cm.

Because of strong C–C bond observed in graphite, carbon nanotubes possess excellent stiffness. TEM observations showed that MWNT and SWNT are flexible and do not break upon bending. Treacy and co-workers first made an attempt to determine the Young's modulus for individual MWNT. The authors demonstrated that carbon nanotubes possess an average Young's modulus of 1–1.8 TPa which is much higher than that of commercially available carbon fibers (800 GPa) (Rao et al,2001). Other research groups performed direct measurement on Young's modulus of individual MWNT taking bending force as a function of displacement inside atomic force microscope (AFM). The value of Young's modulus is found to lie in the range of 0.32–1.47 TPa. Gao et al. demonstrated theoretically that the mechanical properties of SWNT are dependent on the diameter and estimated the Young's modulus in the range of 0.6–0.7 TPa of carbon nanotubes of diameter ~ 1 nm.

Ruoff and Lorents first stated that the thermal conductivity of carbon nanotubes along the tube axis may be one of the highest ever compared to other allotropes of carbon such as diamond and graphite. In graphite, photons dominate the specific heat above the 20 K, whereas in case of MWNT and SWNT, the photon dominates at all the temperatures. Yi et al. demonstrated in their conductivity experiments that thermal conductivity of MWNT (produced by pyrolytic method) varies linearly with temperature from 4 to 300 K. The authors also observed that at room temperature thermal conductivity of MWNT is comparable to that observed in noncrystalline carbon fiber owing to the small crystal size in the graphitic domains. Kim et al. determined thermal conductivity of individual MWNT and found that it is higher than graphite (3000 W/K) at room temperature and two orders of magnitude higher than those observed for bulk MWNT. Smalley and coworkers measured the thermal conductivity of SWNT (produced by laser technique) and observed the temperature dependency of thermal conductivity of the carbon nanotubes. Hones measured the thermal conductivity of randomly oriented SWNT (35 W/K) and aligned SWNT (> 200 W/K). (Terrones (2003))

B] Synthesis of Carbon Nanotubes

Carbon nanotubes (SWNT and MWNT) can be produced using various catalytic and non-catalytic synthetic routes. Carbon nanotubes produced of these methods have different properties and require different raw materials. Carbon nanotubes have been produced by several techniques such as,

1) Electric Arc–discharge Process
2) Laser Ablation of Carbon
3) Chemical Vapor Deposition (CVD)
4) High Pressure CO Disproportionation Process (HiPCO)

2.1 Electric Arc Discharge Process

In this batch process, a direct current (80 – 100 A) is passed through two high-pure graphite electrodes (6-10 mm OD) separated by ~ 1-2 mm, under He atmosphere (500 torr). During arc discharge, a deposit forms on cathode (negative electrode) whereas the anode (positive electrode) gets consumed. Iijima discovered MWNT using arc discharge method. SWNT can also be produced by this technique using transition metals or metal complexes like Fe, Co, Ni or a mixture of Co-Pt, Co-Ru, Ni-Y etc. Catalyst mixture of Ni-Y produces SWNT of < 90% purity with ~ 1.4 nm tube diameter and is now a days used widely for high yield. Recently, alternatively arc discharge plasma jet methods using metal-doped graphite have also been developed for production of larger quantities of SWNT (1.2 gm/min) (Terrones(2003); Saito et al.,1998). Fig. 2.3 shows a schematic diagram for CNT synthesis by this method.

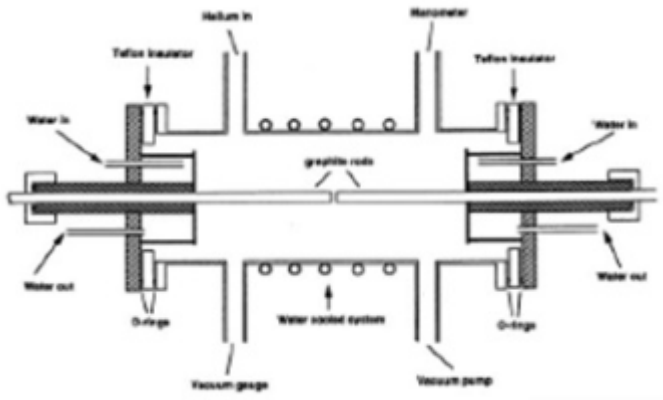


Fig. 3 Schematic diagram of Electric Arc-Discharge Method

Electric arc technique involves high purity graphite electrodes, metal powders (only for SWNT production) and high purity He or Ar gases, due to which the cost associated with the CNT production is high. Highly crystalline, stiff, near perfect material of CNT is obtained in this technique with poor control over dimensions as well as low aspect ratio. Byproducts such as polyhedral graphite (in case of MWNT), encapsulated metal particles (in case of SWNT) and amorphous carbon are also formed.

2.2 Laser Ablation of Carbon

Laser ablation technique avoids the high electric field involved in the arc-discharge method. This technique involves high power laser vaporization of pure graphite targets inside a furnace at 1200oC, under Ar atmosphere for generating MWNT. Tube growth takes place by the attachment of incoming carbon species at the edge of adjacent growing graphene tubules and thus finally results in a multilayered tube. SWNT can be produced using laser ablation technique; it is necessary to add metal particles as catalyst to graphite target. These et al. were the first to obtain SWNT bundles of diameter 13.8 Å using graphite-Co-Ni targets. It is also possible to produce SWNTs using a CO2-laser focused on graphite metal target in absence of an oven. For this method, Ar and N2 gases were found to generate better atmosphere compared to He gas. It has been reported that the diameter of the carbon nanotubes depends on the laser power. Unfortunately, the laser technique is not economically advantageous because, process involves high purity graphite, high laser power requirements and less throughput of the process in terms of CNT quantity. Fig. 2.4 shows a schematic diagram of experimental setup for laser ablation process.

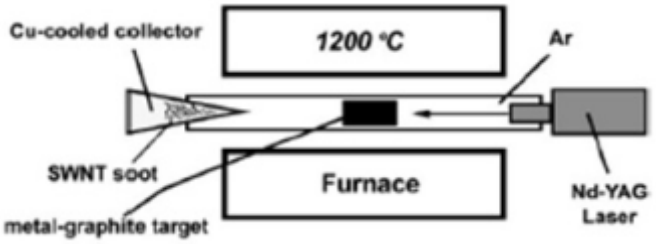


Fig. 4 Schematics of experimental setup for laser ablation process

2.3 Chemical Vapor Deposition (CVD)

This is a very promising method from large-scale production of carbon nanofiber (CNF), SWNT and MWNT. Hydrocarbons (e.g. methane, benzene, acetylene, naphthalene, ethylene, n- hexane etc) are allowed to decompose over metal catalysts (e.g. Co, Ni, Fe, Pt or alloy of these metals deposited on substrates such as silicon, graphite and silica) to produce CNT (Njuguna and Pielichowski, 2004). Various research groups have proposed the mechanisms for the formation of carbon filaments via pyrolytic approach. Dia et al. has reported the generation of SWNT via thermolytic process involving Mo particles in conjunction with CO at 1200oC. Typical yields for CVD are approximately 30%.

2.4 High pressure CO Disproportionation Process (HiPCO)

The high pressure CO disproportionation process (HiPCO) is a technique for catalytic production of SWNT in a continuous-flow gas phase using CO as the carbon feedstock and Fe(CO)5 as the iron-containing catalyst precursor. SWNT are produced by flowing CO, mixed with a small amount of Fe(CO)5 through a heated reactor. Fig. 2.5 shows the layout of CO flow-tube reactor.

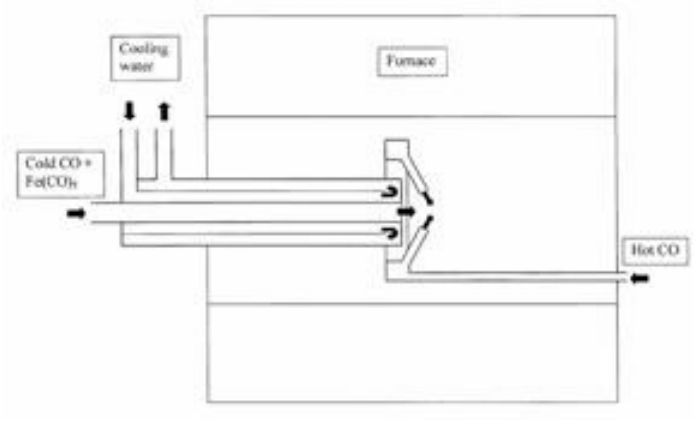


Fig. 5 Layout of CO flow-tube reactor

Size and diameter distribution of the nanotubes can be roughly selected by controlling the pressure of CO. This process is promising for bulk production of carbon nanotubes. Nanotubes as small as 0.7 nm in diameter, which are expected to be the smallest achievable chemically stable SWNT have been produced by this method. The average diameter of SWNT produced by this technique is ~ 1.1 nm. The yield that could be achieved is approximately 70% as well as 97% pure SWNT can be produced by this technique. The higher yield and smallest nanotubes diameters can be produced at the highest accessible temperature and pressure. 1

Apart from the above-mentioned techniques for synthesis of carbon nanotubes, techniques such as hydrothermal process, electrolysis of graphite and use of solar energy for carbon nanotube production were also reported for the same (Njuguna and Pielichowski, 2004; Terrones,2003).

3 Purification of Carbon Nanotubes

As discussed in carbon nanotube synthesis section, during synthesis various other byproducts also produced such as polyhedral carbon, metal catalyst coated with carbon, amorphous carbon and fullerenes. Various purification techniques such as filtration, chromatography, centrifugation, gas phase oxidation, and chemical treatment are used.

Oxidation technique is used to remove the polyhedral carbon obtained during arc discharge method for producing MWNT. Great disadvantage of this method is 95% of starting product is destroyed and remaining carbon nanotube become more reactive due to presence of dangling bonds at the ends. High temperature annealing (2800oC) is reported to eliminate such dangling bonds. Other nondestructive methods for removal of polyhedral carbon particle involve the use of well-dispersed colloidal suspension of tubes/particles coupled with surfactant (surfactant, polymer or other colloidal particles) treatment, which prevent aggregation. Further filtration of suspension, using porous filters and size exclusion chromatography gives almost pure nanotubes. (Mamalis et al.,2004; Terrones,2003)

Ultrasonically assisted microfiltration techniques have been used for purification of SWNT from catalytic particle and amorphous carbon. Dujardin and co-worker reported an efficient and simple method for SWNT purification. The process involves treatment of SWNT in boiling nitric acid aqueous solution, whereas Colomer and co-workers reported treatment of SWNT with hydrofluoric acid followed by an oxidation treatment. Recently Eklund and coworkers reported a novel technique for SWNT purification. Process involve microwave heating in air flowed by hydrochloric acid treatment. However, it has been reported that these methods alter the structural surface of the tubes, which may result in change in electrical and mechanical properties of the carbon nanotubes. Fig. 2.6 shows the TEM images of (a) raw SWNT material (b) nitric acid treated sample (c) air oxidized sample (d) and annealed sample.

This article was submitted in fulfillment of PHD program.

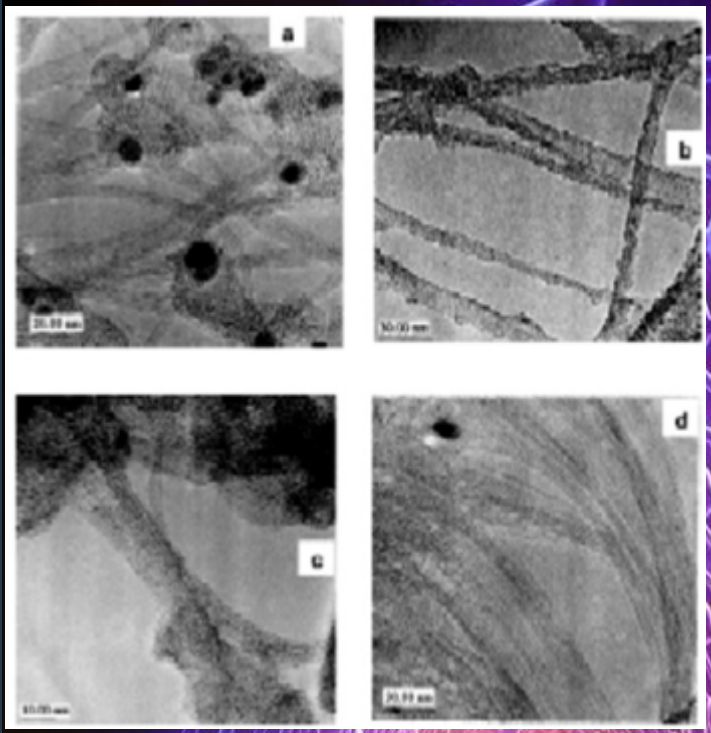


Fig. 6 (a) it shows that SWNT bundles are homogeneous in size (10–20 nm), after Acid treatment (b) some bundles appears broken and curled up and more amorphous carbon coating on their surface, Air-oxidized sample (c) the bundle tend to gather together the size being between 50 and 100 nm and only slightly coated with amorphous carbon, Annealed sample (d) seems to be more similar to air-oxidized sample (Martinez et al.,2003).

- By Dr Biswajit Panda
Assistant Professor, Dept of Applied Chemistry, PIIT

The Camless Valve (Air Actuation)

2013 is considered to be the year when humans are at the top of technological innovation and design. The automobile industry is a very large and lucrative field and where secrecy is of utmost importance since the competition is cutthroat.
The increasing fuel prices have motivated many minds to think radically and come up with ideas which will help us continue the use of conventional ICE (Internal Combustion Engine). We thought that by the time, an ICE becomes too expensive to run, science would have come up with a solution. But till date, all alternatives are either not practical, or too expensive for an average citizen to purchase and run. I have illustrated one of the technological innovations which I find to be very interesting and will have a great impact on the automobile industry.

Basic Working of Internal Combustion Engine

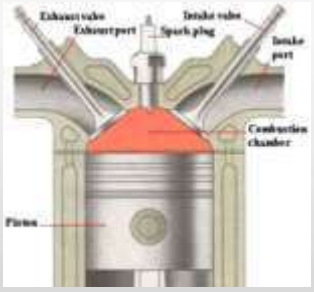
Engines based on the four-strokes have one power stroke for every four strokes (up-down-up-down) and employ spark plug ignition. Combustion occurs rapidly, and during combustion the volume varies little. They are used in cars, larger boats, some motorcycles, and many light aircraft. They are generally quieter, more efficient, and larger than their two-stroke counterparts.
The steps involved here are:

1. Intake stroke: The first stroke of the internal combustion engine is also known as the suction stroke because the piston moves to the maximum volume position (downward direction in the cylinder). The inlet valve opens as a result of the cam lobe pressing down on the valve stem, and the vaporized fuel mixture enters the combustion chamber. The inlet valve closes at the end of this stroke.
2. Compression stroke: In this stroke, both valves are closed and the piston starts its movement to the minimum volume position (upward direction in the cylinder) and compresses the fuel mixture. During the compression process, pressure,

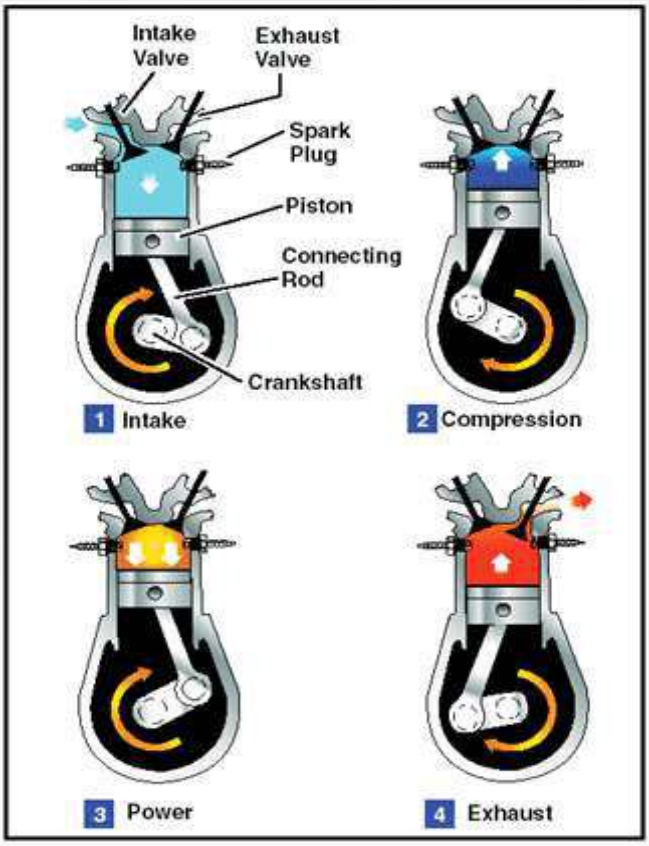
temperature and the density of the fuel mixture increases.

3. Power stroke: When the piston reaches a point just before top dead center, the spark plug ignites the fuel mixture. The point at which the fuel ignites varies by engine; typically it is about 10 degrees before top dead center. This expansion of gases caused by ignition of the fuel produces the power that is transmitted to the crank shaft mechanism.

4. Exhaust stroke: In the end of the power stroke, the exhaust valve opens. During this stroke, the piston starts its movement in the maximum volume position. The open exhaust valve allows the exhaust gases to escape the cylinder. At the end of this stroke, the exhaust valve closes, the inlet valve opens, and the sequence repeats in the next cycle. Four-stroke engines require two revolutions.



THE COMBUTION CHAMBER



VALVE

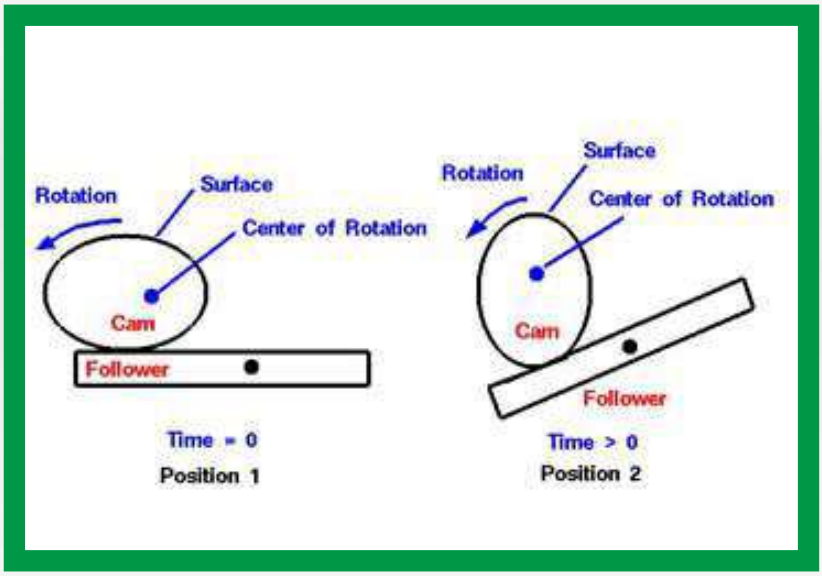
In a 4 stroke engine, the 4 strokes can take place only when the valves open and close at the precise moment that they should. The valves take in the vaporized fuel and air mixture, in the precise volume required, and at the right time. Then in the compression stroke it must close at the right time for the controlled and efficient compression of the fuel air mixture. In the power stroke they must remain completely closed. And in the exhaust stroke, the right valve must open at the exact time it's supposed to, to remove the exhaust gasses from the combustion chamber in time for the next intake stroke. This timing is controlled by the Engine Control Unit (ECU).

ECU

An engine control unit (ECU), most commonly called the powertrain control module (PCM), is a type of electronic control unit that controls a series of actuators on an internal combustion engine to ensure the optimum running. It does this by reading values from a multitude of sensors within the engine bay, interpreting the data using multidimensional performance maps (called Look-up tables),and adjusting the engine actuators accordingly. The ECU controls the camshaft in order to control the valves.

What is a camshaft?

A camshaft is the controlling factor of the valve, and the camshaft decides when a valve opens, and for how long. In most low cost engines there is only one camshaft per cylinder bank. This is cost-efficient but not very efficient in its working. But in premium engines there are 2 camshafts per cylinder bank, which gives the engine more flexibility. This camshaft is composed of the central cylindrical rod, with alternatively positioned lobes. These lobes keep turning and they have a smooth circular surface for most of its circumference, but there is a specific undulation at one end, which lifts the valve at the precise moment it should open. This is called valve timing. The camshaft rotates with half the rpm of the crankshaft (in most engines).



Why the camshaft needs a replacement?

Well, there is no urgent need for its replacement since there are not many mechanical issues with it, and also because since it has been used since the 1206 where it was used in a pump designed to pump water to a higher altitude. But with newer tech, we can limitlessly change the working of an ICE with true variable valve timing. Also the fuel price hike, and increasing standards of living, demand newer and more efficient technology.

THE AIR ACTUATED VALVE

Now there is a new concept which is being experimented by engineer Urban Carlos working in Koenigsegg along with other automotive companies such as Renault,BMW,Fiat, GeneralMotors, Lotus Engineering, Ford etc. They have made an air actuated valve system where the valves are timed and opened when desired by the ECU (Engine Control Unit). It is called aCamless Valve. This technology completely replaces a conventional camshaft. The air actuated valves can run up to 20,000 rpm. This makes it compatible with any ICE existing today without any hardware modifications. Since this technology make the camshaft absolute, the engine size significantly reduces.

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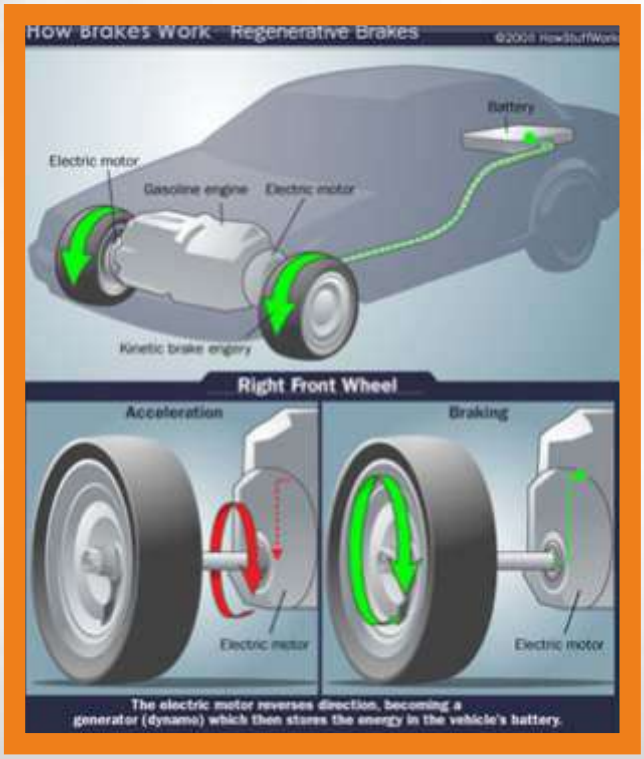

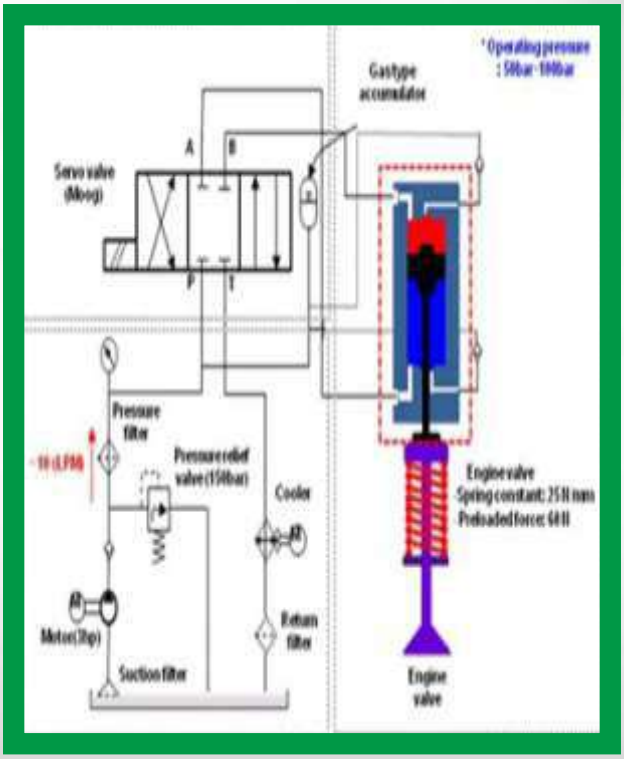

ENERGY RECOVORY (REGENERATIVE BREAKING)

Also, we can recover energy which is usually wasted as heat. During excessive breaking, the momentum and energy lost can be recovered with the help of a few motors, can be used to pressurize air in a tank, for the working of the air actuated valves.

WORKING OF AIR ACTUATED VALVE

In an air actuated valve, there is a free valve actuator, which pushes the valve in, and it pushed out with a conventional mechanical spring. This makes the camshaft absolute and this is extremely beneficial to the engine.

SECTION OF AIR ACTUATED VALVE

Since this technology makes each valve truly independent, in larger engines for example in a V8, when the power requirement is not maximum, the ECU can completely shut down 4 valves and stop the 4 respective cylinders as well effectively making it a 4 cylinder engine with increased fuel economy.

This technology makes the engine smoother since there are fewer moving parts. It also makes the engine simpler due to which engine failures are significantly reduced. It also makes the engine cheaper to build as there is less material required, and also makes it environmentally friendly as the valves become more efficient and thus the fuel is burnt more cleanly and completely with fewer toxic exhausts.

This technology has still not been incorporated in any mass production ICE, since it is still under intense testing. This technology is revolutionary and will completely change the working of an ICE in our benefit.

Written By: Naveen Joshy (F.E Sem2)

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You tube:http://www.youtube.com/watch?v=Bch5B23_pu0 2/5/2103 1 P.M

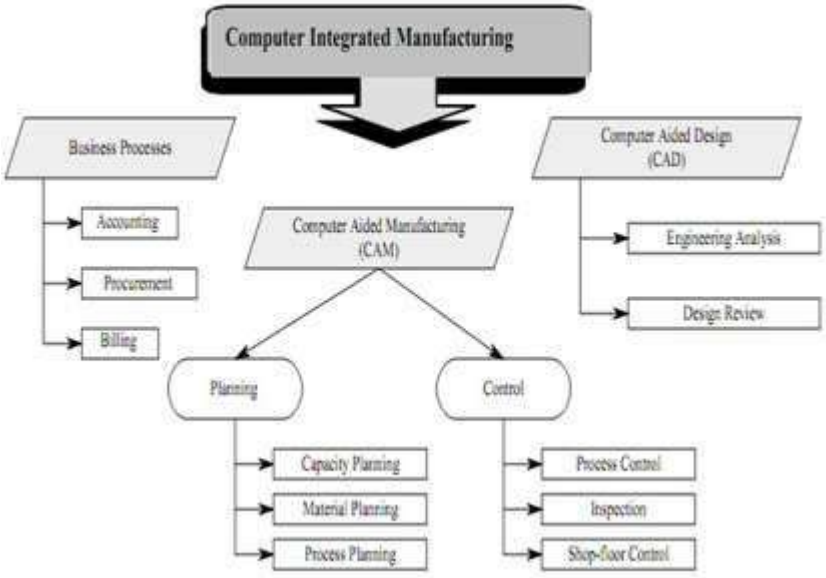
This article is an overview of various available online open source resources.

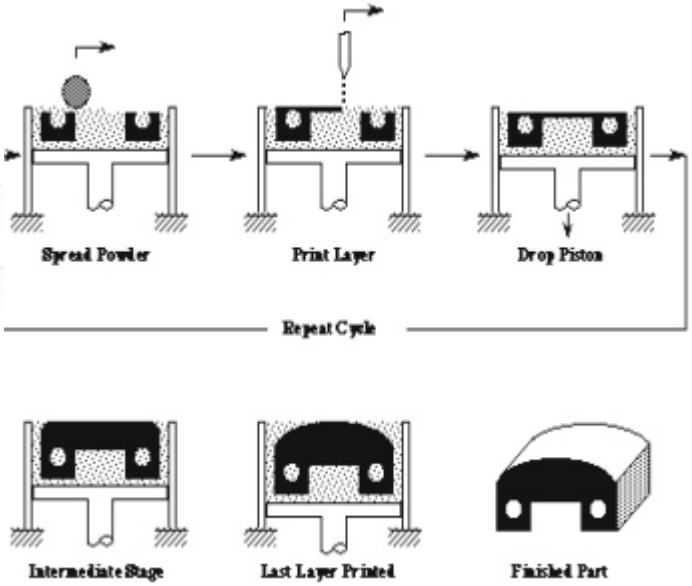
Advancements In Manufacturing

The process of manufacturing is ever changing. Gone are the days when a lot of man hours were invested to make a product. Technology has advanced such that it is now possible to mass produce products with minimal human intervention. Technology is constantly evolving with processes such as additive manufacture, also known as 3D printing wherein a product is produced layer by layer out of thin air.The future holds many such technologies which can change the way the way the industry works. Here are some of the highlights.There is another process similar to 3D printing called cold spraying which involves blasting metal particles through a nozzle at high speeds such that they bind together. 3D objects can thus be made by controlling the nozzle.

Additive Manufacturing

Three dimensional printers are used to make a product. It involves the transformation of 'art' (CAD) to 'part' (product). This process has been around since the 1980s but became more widely accepted in the 2010s. Printers are now capable of making products from over 1000 materials such as plastics, ceramics, metals, etc. The raw material is laid down, a thin layer at a time to make the product as directed by a digital file.





It is a promising technology that has scope in the energy, defense, aerospace, medical and commercial sectors. As it can build up objects directly, it makes for a good alternative to conventional machining techniques such as machining, forging and molding. Though it is suitable for making complex parts in small quantities, research is being done to increase the volume of the product.

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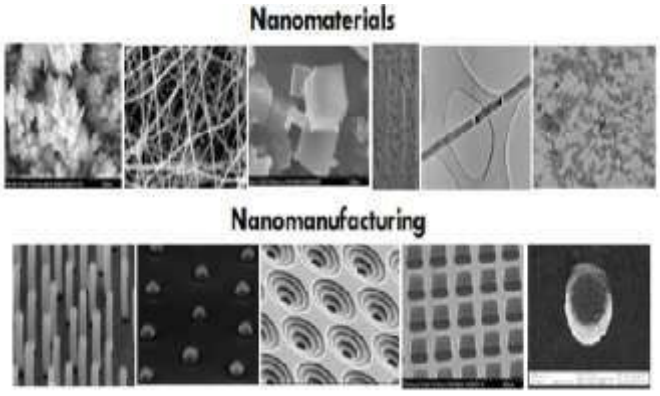
Nanomanufacture :

A nanometer is one-billionth of a meter, and nano manufacture thus means manufacturing at the molecular or the atomic scale. There are two approaches to nano manufacture, top-down and bottom-up. In top-down method, larger materials are broken down to the nano scale similar to a sculpture being made of a wooden block. This approach requires larger amounts of materials and leading to waste. The bottom-up approach involves building
up products from the atomic or molecular level and is time consuming. Structures and properties of materials can be improved by this processes. The materials can be made such that they have better properties such as strength, ductility, durability, conductivity, reflectivity, etc.



Biomanufacturing :

This method uses a biological organism to produce a product such as synthetic drugs. Transport of energy and mass is the fundamental of many environmental processes. Micro-

organisms or components of cells like enzymes are used to generate industrially useful products in sectors such as chemicals, food and feed, detergents, paper and pulp, textiles and bio fuels. Researchers at Harvard University have developed a new material inspired by the exoskeletons of grasshoppers to make a new material called Shrilk. Shrilk is composed of chitin commonly extracted from discarded shrimp shells and fibroin protein from silk. This material can be used to make packaging materials that degrade quickly. In 2010, automaker Mercedes Benz came up with a concept car that was completely biodegradable and was made of an organic material called BioFibre. This material is lighter than plastic and yet stronger than steel.

Digital manufacturing technologies :

Computer-aided modeling tools have been used to not only design products but also to test and modify them digitally bypassing the physical processes.The use of computers allows individual processes to exchange information with each other and initiate actions. The process becomes automated and hence, faster and error-prone. Cloud computing has made it possible to use hand held plug and play gadgets to connect the manufacturing plant with the headquarters, thus reducing the time to take quality decisions.

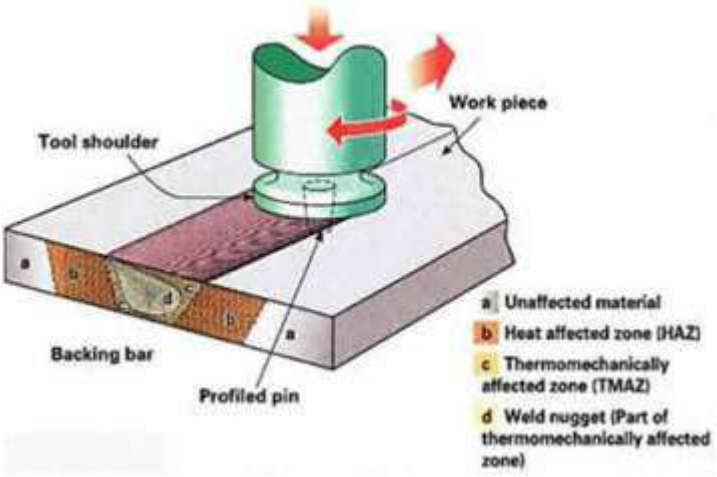
Industrial Robotics :

Industrial robots can work 24x7 with great precisions that cannot be seen by the human eye. These robots give accurate reports and can improve their performance when fitted with advanced sensors. With advances in nanotechnology and biotechnology, robots can now also be used to synthesize human organs.

Advanced joining techniques :

Current manufacturing methods rely on conventional welding, forging, machining, etc.
However new methods can be used for joining metals. Welding techniques such as friction ,stir welding , laser welding, electron welding are gaining popularity.

Friction Stir Welding



Materials design, synthesis and processing :

New materials will enable the creation of entirely new machines. New composites are being fabricated to break materials down to an atomic or molecular level so that they can be manipulated to get the desired properties. Fungal foam is an example of biomaterials that can replace conventional materials. Researchers have designed extreme duty, iron based, glassy alloy coatings for industrial drill bits, bores and cutters that can make this equipment more resistant to failure due to high stresses. Nano Super Hard Inexpensive Laser Deposited (also known as NanoSHIELD) coatings require a laser to fuse alloy powder to the surface of cutters and other tools. The coatings are less expensive than conventional materials such as tungsten carbide cobalt and also have a high operating

life, thus improving the efficiency.

By Jasvindersingh Batra
T.E Mechanical

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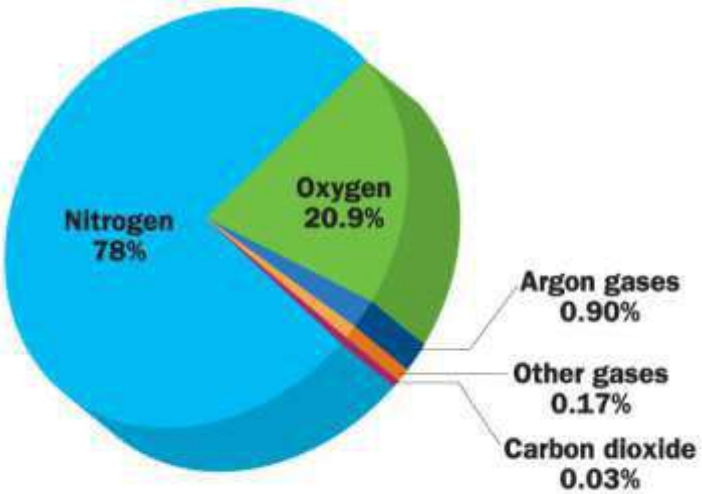
Nitrogen Inflated Tyres for Cars

One of the most frequent maintenance-related jobs one has to perform on automobiles is the inflation of tyres. One must maintain the correct pressure in different tyres, and these pressures change from car to car. This piece lists the scientific reasons and advantages of using pure Nitrogen as an alternative gaseous mixture for tyre inflation.

Properties of the Traditional Gaseous Mixture

The traditional compressed air mixture which is used to inflate car tyres is a mixture of 78% nitrogen, 20.9% oxygen, 0.9% Argon and other Noble Gases, 0.03% Carbon Dioxide and 0.17% of other gases. The cause of the unsuitability of this mixture is the high proportion of Oxygen. It is a very reactive gas, which has the ability to bind with a wide variety of materials. This Oxidation can lead to heating effects, thus reducing the life of the tyre, and may also result in blow outs. An under-inflated tyre is highly prone to friction, resulting in a steering problem.

When introduced into the tyres through compressed air, Oxygen penetrates the tyre walls and causes under inflation. This also causes the decaying of rubber chain molecule. Additionally, in an air inflated tyre, steel belts and steel beads may rust due to the presence of Oxygen.



Property	Value
Density	101.325 kPa / 1.251 g/L (0 °C)
Molar Heat capacity	29.124 J·mol−1·K−1
Oxidation states	5, 4, 3, 2, 1, −1, −2, −3 (strongly acidic oxide)
Electronegativity	3.04 (Pauling scale)
Thermal conductivity	25.83 × 10−3 W·m−1·K−1

Properties of Nitrogen

Compared to Oxygen, Nitrogen is a relatively inert gas. It has lower electronegativity and higher Ionization Energies. Hence, it does not cause rusting and corrosion of metal components, and does not react with the rubber based polymers used in tyres. It is lighter and less dense than Oxygen, and has a lower Molar Heat Capacity and Thermal Conductivity. Due to this, the possibility of overeating is reduced, which improves the life of the tyre, increases braking efficiency and improves fuel economy. The thermal expansion of Nitrogen is easier to measure and predict which makes it suitable for use in sensitive or high load applications.

Advantages of Nitrogen Filled Tyres :

1 **Infrequent Filling -** Unlike in air filled tyres, the tyre pressure only needs to be checked every six months. Moreover, replacing compressed air with nitrogen is a simple process. The tyre must be completely deflated before being filled with nitrogen. Even tubeless tyres can be inflated with nitrogen gas without any issues. Many garages now offer nitrogen filling instead of conventional air filling.

2 **Improved Fuel Efficiency -** As nitrogen is less dense than air, the weight of the tyres, and hence the load on the car is reduced, which in turn improves the fuel efficiency by ~5%. It ensures minimum leakage and maintains proper pressure inside the tyre for a longer time, compared to compressed air.

3 **Reduced Corrosion -** Crude nitrogen is treated to reduce the amount of water vapour it contains, before making it available for filling. This lack of moisture ensures that nitrogen filled tyres are rust free.

4 **Eco-Friendly Nature -** Nitrogen is a colourless, odourless and non-toxic gas that forms about 78% of the earth's atmosphere. Nitrogen's thermal properties ensure that it does not heat up the inner rubber lining of the tyre, which precludes the possibility of the release of toxic gases that are one of the major causes of pollution. In a related point, nitrogen inflated tyres increase fuel efficiency, which eventually reduces carbon dioxide emissions.

5 **Long Life -** Nitrogen's chemical inertness ensures that it will not oxidize and degrade the polymer compound that the tyre is composed of. Oxidation ages the rubber, resulting in poor strength and durability. Air tyres sometimes experience high temperatures which cause tyre blow outs. In contrast, the use of nitrogen in tyres increases their life by up to 25%.

6 **Improved Safety -** Nitrogen inflated tyres are much safer than air filled tyres. 90 percent of tyre burst events are due to pressure drops in air filled tires, which cause many car accidents. Nitrogen helps to maintain an adequate tyre pressure, reducing the chances of blow outs and hence any road mishaps. Moreover, nitrogen being an inert gas has no fire risk.

7 **Improved Ride Quality -** Though not very significant, nitrogen inflated tyres are believed to enhance the ride quality of a car. This is mainly due to its light nature.

Disadvantages of Nitrogen Filled Tyres :

1 **Cost -** Filling tyres with nitrogen is expensive compared to compressed air. Nitrogen inflated tyres also require more maintenance.

2 **Availability -** Nitrogen gas is not available at any petrol pump station. It is generally found with specialist tyre dealers' service centres.

3 **Pressure Maintenance –** The pressure of nitrogen inflated tyres if not adjusted at an optimum level, may counteract the advantages of nitrogen inflation. Even addition of a small amount of compressed air would affect the tyre performance.

Current Commercial Applications of Nitrogen-filled tyres :

Nitrogen is pumped into tyres with the help of 'nitrogen inflators' which extract nitrogen from atmospheric air. The inflators cost approximately 3,00,000 rupees in India. Since this involves a large investment, petrol pump operators are forced to levy high charges for filling tyres with nitrogen, while compressed air is available in most of the gas stations in the country without any charge. Nitrogen filling charges range from a hundred to two hundred rupees per vehicle, and can be filled in any kind of tyre.

1 **NASCAR - NASCAR (National Association for Stock Car Auto Racing)** teams use nitrogen, as it helps to predict tyre pressure fluctuations accurately. Though nitrogen pressure does fluctuate with temperature changes, this change is lesser, when compared to conventional air.

2 **Formula 1** – F1 racing cars have to meet extremely high safety standards. The reduced heating effects and non-flammability of Nitrogen make it suitable for tyre inflation. Additionally, the ease in predicting its thermal expansion allows teams to maintain optimal pressure at all times,

resulting in maximum performance.

3 **Commercial Airlines –** All commercial aircraft tyres are nitrogen inflated. This helps to resist the freezing of water vapour inside the tyres at high altitudes, which could lead to possibly disastrous situations during landing. Some of the aircraft manufacturers such as Boeing use nitrogen membranes in their On-Board Inert Gas Generation Systems (OBIGGS). The OBIGGS is an on-board system that uses dry nitrogen-enriched air "blanket" for the fuel tank, instead of a flammable fuel-air mixture. This on-board system reduces the risk of fire inside the aircraft engine, thereby ensuring its safety.

This article is an overview of various available online

open source resources.

By Jaidev Ramkrishna
T.E Comps

HTR-PM Nuclear Reactor

Introduction :

The world is searching for new sources of energy, to keep up with the accelerated rate of economic and industrial growth.Experts believe that this need for power can be met by nuclear energy. In the current scenario, cheap and safe electricity is main aim of nuclear research. In future, hydrogen production and desalination of sea-water may become important applications of nuclear technology. These will borrow from the technological base created during the research and development of safer and more powerful nuclear reactors.

If we consider the sharp rise in oil prices, and the degradation of the environment due to emissions of CO2and other greenhouse gases, then it is clear that we have to leverage renewable sources of energy, like nuclear energy, for power generation.After the spate of nuclear accidents which have occurred around the world in recent times, scientists startedresearch and development intoa new generation of nuclear reactors, which provideenhanced safety features.

Following the successful operation of the 10MW High-Temperature Gas-cooled Test Reactor(HTR-10), the Institute of Nuclear and New Energy Technology (INET) at Tsinghua University in China developed and designed a new HTR demonstration reactor, called the HTR-PM (High-Temperature-Reactor Pebble-bed Module), as a proof of concept. This reactorwas based upon the design of the HTR-10. It was designed by experts in the field of nuclear energy, and their industrial partners. The HTR-PM prototype could generate thermal power up to 500 MW, even thoughthe maximum fuel temperature was limited aftera failure in the cooling system, which is its most important safety feature.

Development History :

After the experimental verification of the HTR10 in 2001, China was launched the HTR-PM project in November 2003.The Chinergy Company was selected as the main contractor of the HTR-PM nuclear island. The preliminary investment agreement was signed in December 2004 by the China Huaneng Group, China Nuclear Engineering Corporation and The Tsinghua Holding Corporation. In January 2006, the project named " Large Advanced Pressurized Water Reactor and High-Temperature Gas-cooled Reactor Nuclear Power Plants" became one of the 16 top projects of the "Chinese Science and Technology Plan" for the period 2006 – 2020. In January 2007 the "Huaneng Shandong Shidao Bay Nuclear Power Company" was the owner of HTR-PM demonstration plant. By February 2008 the implementation plan and budget was authorized by the State council of China. The construction of demonstration plant is scheduled to be completed by the end of 2013 because construction of HTR-PM was postponed after March 2011 accident at Fukushima-Daiichi in Japan. The gas-cooled HTR-PM, which has twin reactor modules of 250 MW each driving a single 210 MW steam turbine, will start generating commercial electricity by the end of 2017, HSNPC said in a statement.

The HTR-PM generates 500 MW of power, while the HTR-10 generates 10 MW. The outlet temperature of the HTR-PM is 750ºC, whereas the outlet temperature of the HTR-10 is around 900°C. The HTR-PM is much safer than HTR-10 because when the reactor shut down itself, coolant circulation ceases the fuel at initial high temperature whereas in case of HTR-10 circulator was shut off without the reactor being shut down and temperature increases steadily. In HTR-PM the fuel is 520,000 element giving 80 GWd/t discharge burn up while in HTR-10 the fuel is of 27,000 element of oxide fuel giving average burn up of GWday/t U.

The capacity of HTR-PM is 210 MWe and the capacity of HTR-10 is 200 MWe. One of the major difference between HTR-PM and HTR-10 is ratio of height to diameter analogous to the core of HTR-PM is much larger than that of HTR-10.

Components of the HTR-PM :

1 **Reactor Interior -** The reactor interior includes graphitic, carbonic and metallic components. The graphite components provide a set of helium flow channels, absorber borings, and act as neutron reflectors. Metallic components supportto the graphite and carbon components, along with the ceramic structure of the pebble-bed core; and move the various loads and forces to the pressure vessel.

2 **Control rod system and Small absorber sphere system -**

The control rod system and small absorber sphere system are the two independent control system of reactivity. These systems satisfy the requirements of diversity and redundancy. The system contain 8 control rods and 22 small absorber sphere units, both are located in reflector region.

3 **Reactor primary pressure vessels -** The reactor

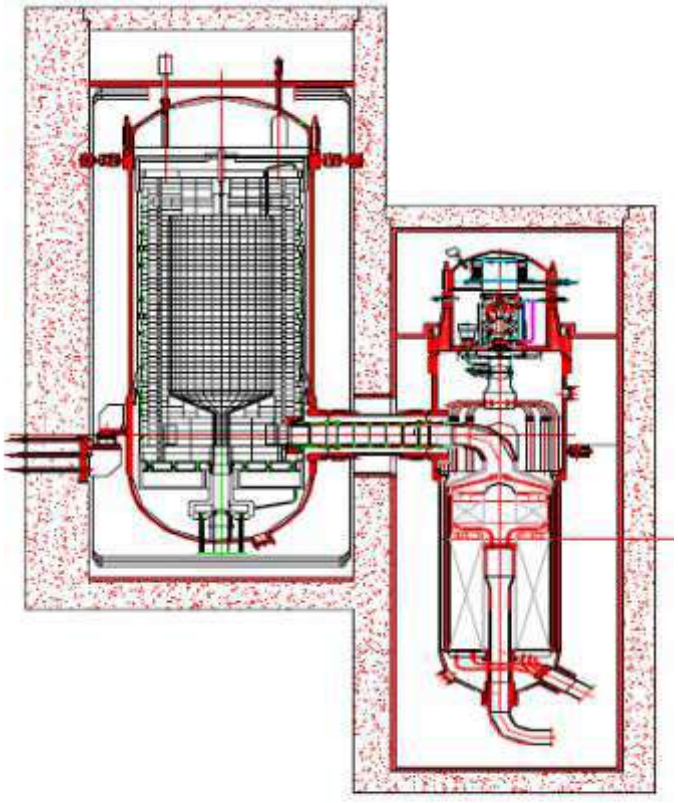
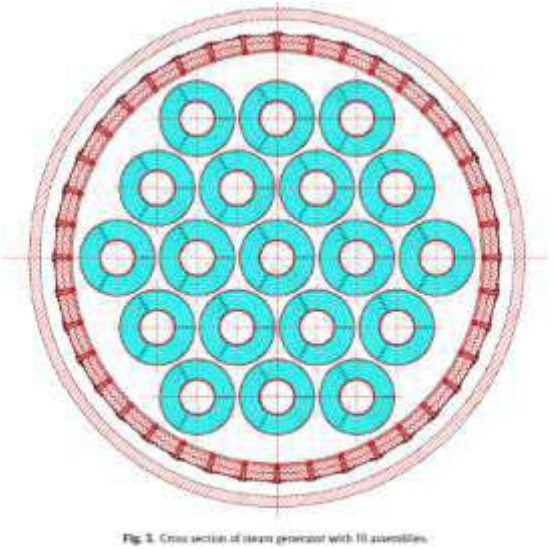


FIGURE 1 Primary system of HTR-PM

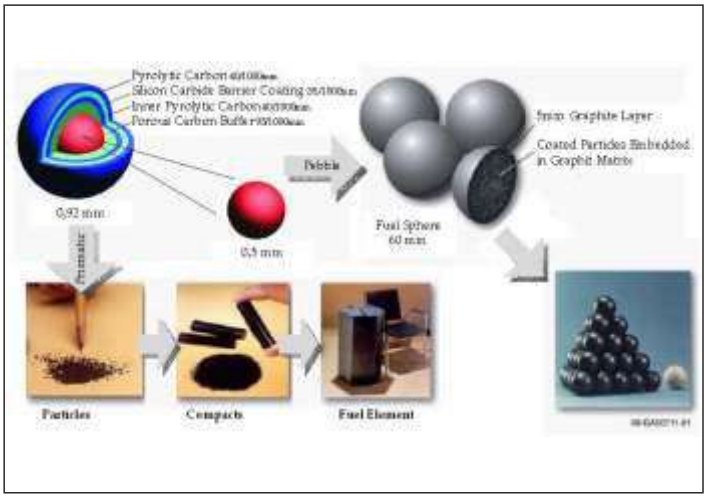
contain three pressure vessels which are composed of SA533-B steel as plate material and 508-3 as forging material. These materials satisfy the technical requirement of ASME-III-1-NB. All three primary loop vessels protect the primary loop from external loads.

4 **Helium blower-** Helium blower is installed on the top of steam generator. The electric motor is mounted on assembly. Outside the pressure vessel converter is connected which drive the motor. A magnetic bearing system is considered. The core inlet temperature was 250◦C while the outlet temperature was 750◦C. The high-pressure superheated steam is generated in steam generator due to reactor heat transfer by blower which can be used for drive the steam turbine.

5 **Steam generator -** Steam generator contain 19



separate helical tube assemblies; each assembly include 5 layers and 35 helical tubes. For two phase flow stability at the entrance of all helical tubes throttling aperture are installed. The assembly type design of steam generator is based on experience of HTR-10 nuclear reactor. The two steam generators and two reactor modules coupled and connected to the steam turbine-generator of 200 MW electric power. The reactor and steam generator are installed inside two separate pressure vessels.



6 **Spherical fuel element -** The fuel is used as spherical element of 60 mm diameter with ceramic coated particle. The coated fuel particle are embedded in graphite matrix of 50 mm in diameter. Each spherical fuel element contain 1200 coated fuel particles. The diameter of coated fuel particle is 1 mm which is composed with UO2 kernels of diameter 0.5 mm and three PyC layers and one silicon layer(TRISO).

Working of the HTR-PM :

In the working of nuclear reactor continuous fuel loading and discharging of fuel element is happened. From central fuel loading tube the spherical fuel element drop into the reactor core and discharge through fuel extraction pipe at the core bottom. One by one discharge fuel element burn up. Depending on their state of burn up they will be discharged or transferred to the spent fuel storage tank from which the fuel element will be re-inserted into reactor to pass the core once again.

Safety Features :

1 For any accident, rise in fuel element temperature will not cause additional release of radioactive substances from fuel element.

2 Reactor core is surrounded by high temperature resistant ceramic materials of graphite and carbon materials.

3 Decay heat can be removed through mechanism, such as heat conduction, heat radiation etc.

4 No emergency cooling system is required.

5 It has replaceable reflector.

6 Two independent shut down system are installed.

Advantages :

1 High efficiency electricity generate due to high core outlet temperature.

2 Continuous charging and discharging takes place of fuel element.

3 High efficiency of 47% with excellent passive safety features compared to other nuclear reactor.

4 Excellent fission product with strong negative temperature coefficient.

5 Economically attractive with simple design.

6 It is the fast neutron reactor.

Disadvantages :

To maintain the reactor extremely high temperature and pressure required to sustain a fusion reaction. We have not been able to sustain a controlled fusion reaction for more than moment of time. Fusion reaction is spontaneous therefore we can't control the reaction.

Conclusion :

There is lots of research going on nuclear reactor therefore many scientist research for new technique of producing nuclear energy which can be useful for economic growth as well as to control the fusion reaction. If the technique is develop then we can achieve sustainable life and it is the one of the biggest achievement of world.

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Da Vinci's DeSign

Abstract :

Many of us know Leonardo Da Vinci as a great painter of the Italian Renaissance but do u know that Da Vinci was a renowned architect too? This review paper outlines the efforts of Da Vinci not only as a scholar but also as a dreamer. Da Vinci imagined those designs which were beyond the scope of human knowledge during that era but nowadays we can see them in use. Many of his drawings, notes and discoveries have inspired inventors from hundreds of years later to invent things like aero planes, helicopters possibly cars.

Introduction :

Leonardo di ser Piero da Vinci was an Italian Renaissance polymath: painter, sculptor, architect, musician, mathematician, engineer, inventor, anatomist, geologist, cartographer, botanist, and writer. Leonardo started his carrier as an artist even though his father was a notary (official). It was during this carrier when he created some of the most famous paintings in the world, including the Mona Lisa. Da Vinci was also interested in science, anatomy and architecture. He valued his own observation above anything he read in a book. He wrote that his writings would be based on a "much greater and much more noble" authority than any written description. His genius, perhaps more than that of any other figure, epitomized the Renaissance humanist ideal. He dreamed up inventions and innovations across a variety of fields. Whether designing weapons of war, flying machines, water systems or work tools, Da Vinci was never afraid to look beyond traditional thinking or dream big.

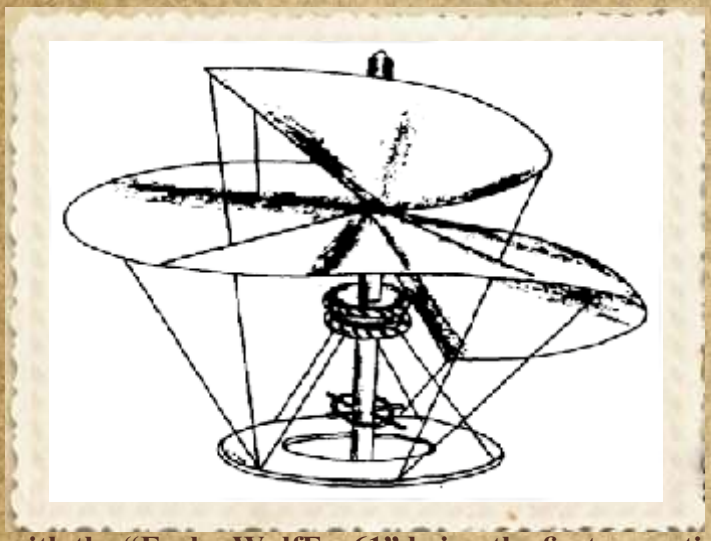
Helical Air Screw :

The word helix in Greek means “spiral”. This was later combined with another Greek word , patron, meaning “wing” in later years the word fused in such a manner that the term “helicopter” was born. Although the first true helicopter wasn't built until the 1940s, it is believed that Leonardo Da Vinci's sketches from the late fifteenth century were the predecessors to the modern day flying machine. Although Da Vinci never tested many of his designs, his sketches and blue prints described their working.

The device built by Da Vinci was popularly known as the "helical air screw", and was based on the idea of compressing air in order to power flight. His helicopter measured more than 15 feet in diameter and was made from reed, linen and wire. The machine called for a four-man team to stand on a base and employ a pumping action to spin the rotary blade in order to lift the device off the ground. With enough rotation, Da Vinci believed the invention would fly.

Modern day helicopters work on the same principle described by Da Vinci. A helicopter has spinning wings instead of the helical aerofoil, which are commonly known as rotors or blades. As the blades rotate, they create a downward force known as lift, which makes the helicopter rise upwards. A helicopter also has rotors at the back which help with mid-air steering and stability.

Many efforts were made later to modify the helical air screw design to create a working helicopter. In 1906, two French brothers, Jacques and Louis Breguet created a design with airfoils for the helicopter called the Gyroplane 1, which flew for one minute at a height of two feet. On 14 April 1924 Frenchman Oehmichen set the first helicopter world record by flying a quad rotor helicopter for 4mins and 11 seconds for about half a mile. Many helicopters were developed and built during the first half-century of flight,



with the “Focke-WulfFw 61” being the first operational helicopter in 1936.

Later helicopters were used in many fields like transport, military services, geographical monitoring, medical services, rescue operations, etc. And it was Da Vinci's contribution which proved fruitful in developing this modern day technology.

The Parachute :

The parachute is one of Da Vinci's inventions which has remain largely unchanged to this day. Leonardo's parachute consists of sealed linen cloth (about 23 feet across and twelve in depth) held open by a pyramid of wooden poles, about seven meters long. The parachute was able to make a safe landing from a considerable height. Like many of Da Vinci's ideas, the invention was never actually built or tested by Leonardo himself. But, in 2000, daredevil Adrian Nichols constructed a prototype based on Da Vinci's

design and tested it. The test was carried out by jumping from a hot air balloon from a height of 3000 m. The parachute offered a smoother landing than modern day ones but the major drawbacks were the lack of harness and the weight of the parachute.

The modern parachute was invented in the late 18th century by Louis Sébastien Lenormand in France, who made the first recorded public jump in 1783. With the First World War came the advent of parachutes that could be folded and stored in a backpack, and were deployed by pulling a static line. These parachutes were used on a large scale by the airborne troops during the war. Most modern parachutes are self-inflating "ram-air" airfoils that provide control of speed and direction similar to Para gliders.

Later parachutes were made using light, strong and durable nylon and silk fabrics which offered the air drag required for landing. Parachutes are also made in different shapes and designs nowadays the most common being the round parachutes. Others include Ram Air parachutes, Cruciform (square) parachutes, pull down apex parachutes etc. Parachutes nowadays are used in aero plane emergency systems, for entertainment (stunts), to increase the air drag of planes while landing (known as the "Rogallo Wing" parachute), etc.

The Flying Machine

Another invention of Da Vinci was the "flying machine". This idea was a precursor to the modern airplane. When Leonardo's manuscripts were translated and published at the end of the 19th century, his designs of the flying machine were rediscovered. Leonardo drew about 500 sketches related to the flying machine. He was a keen

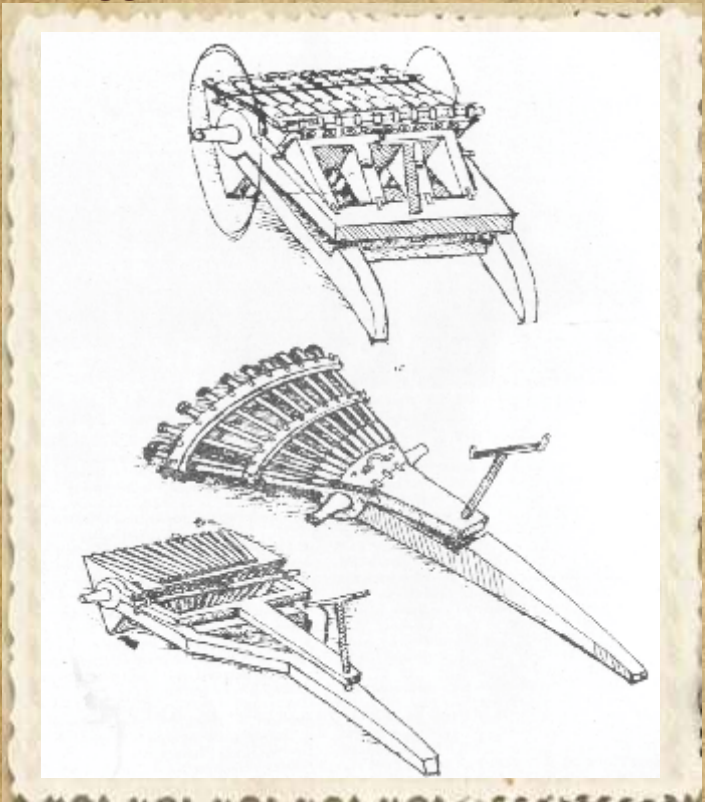
observer and was very much impressed by the flight of a bird and the physics behind it. One of his statements was "the bird is an instrument working according to mathematical law". The design of this machine was similar to the flight of a bird.

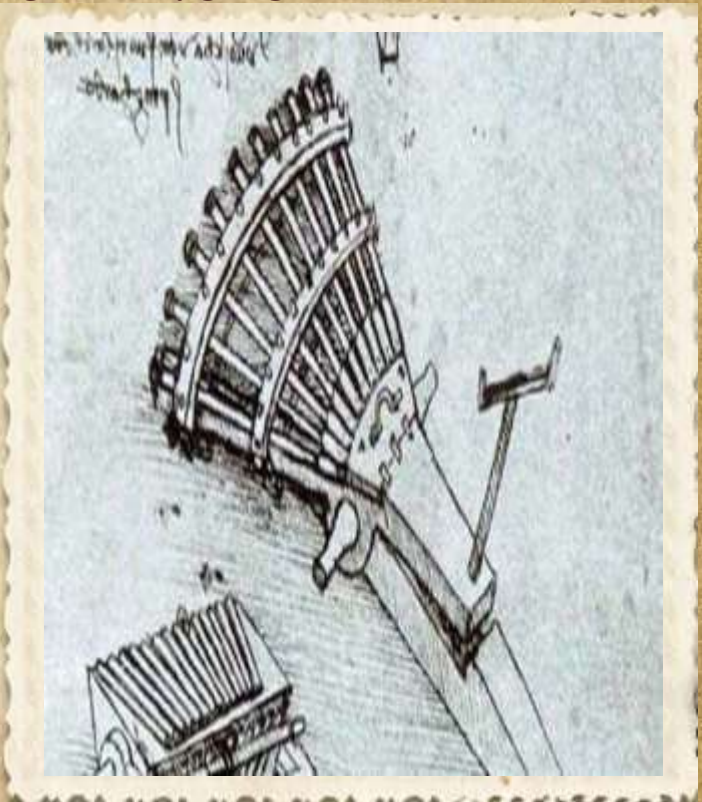
It was an assembly of cables, cranks, pulleys and linkages .The pilot would lie face down in the center of the invention on a board. To power the wings, the pilot would pedal a crank connected to a rod-and-pulley system. The wing like structure was designed to perform a four stage cycle which included flapping

from the shoulder joint, twisting, minor flapping of the outer wings and the return stroke. There was a crank to increase the energy output, and a head piece for steering. As the pilot spins the crank by his hands and feet the wings of the machine would flap (similar to a bird). The inspiration of nature in the invention is apparent in the way the wings were designed to twist as they flapped. The main drawback of this mechanism was that the constant peddling and movement of arms would exhaust the driver so the machine never gained enough power to obtain a lift but the principles of aviation set forth by Da Vinci were recognized and adopted by many designers in the future.

In 1880, Lawerence Hargrave did his research on wing structures and constructed a box kite which was able to lift the weight of a man. In 1903 two brothers Orville and Wilbur Wright designed and developed the first flying machine, a powered fixed-wing aircraft. The most important feature of the aircraft was the three axis control system, which helped in steering and also maintaining equilibrium. The Wright Flier 1 was built by using a strong, light weight wooden frame, and propellers powered by a gasoline engine. The Wrights finally took to the air on December 7, 1903 flying at 27 miles per hour for 120 feet which was a remarkable accomplishment. With World War 1 came the development of airplanes that were used for military operations. German Lieutenant Kurt Wintgens came with the idea of mounting a machine gun on the aircraft during the war.

Then came the era of the jet engines. The jet engine sucks in air with the turbine. A compressor is a fan with many blades and is attached to the shaft which it is used to raise the pressure of the air. The compressor blades then compress the air. This air when mixed with fuel and spark is ignited and the burning gases exit from the nozzle at the back of the engine thereby giving the desired thrust. The first





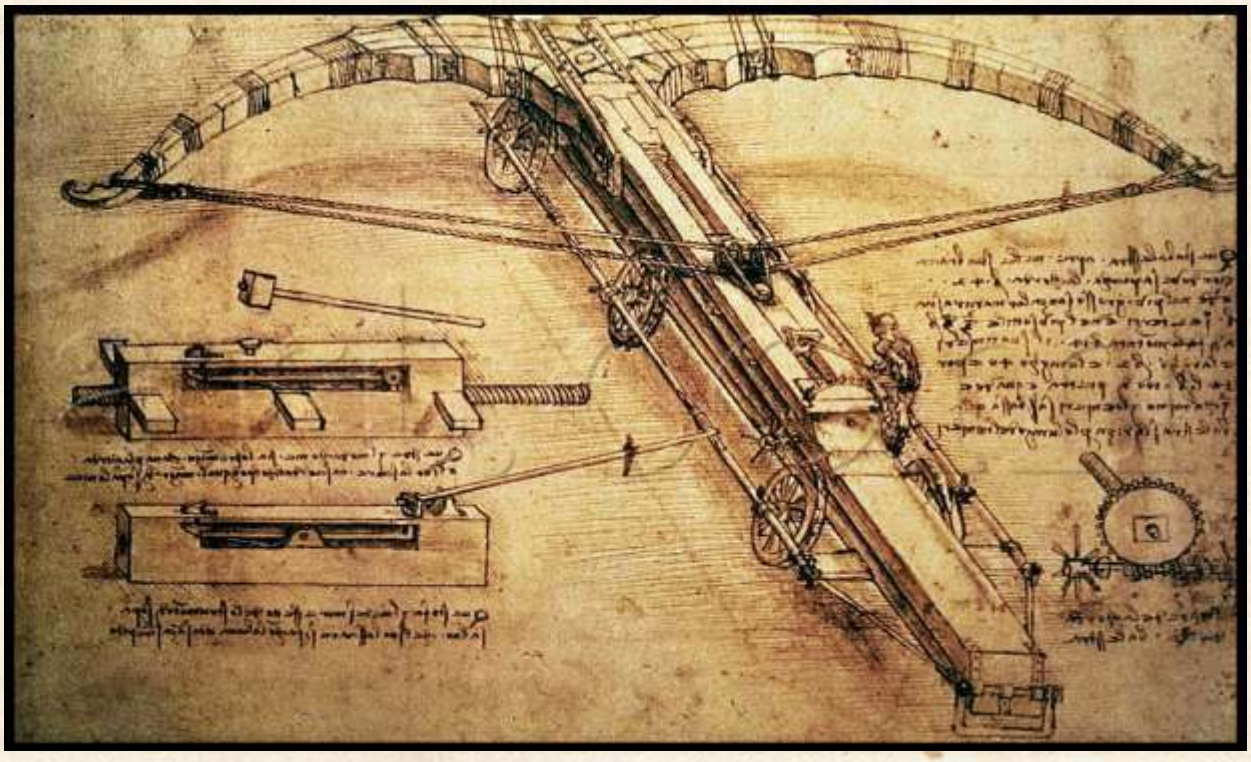
'operational' jet aircraft was the German Heinkel He 178, which was tested in 1939. It was the first aircraft to exceed the speed of sound.

Later aircrafts were generally used for traveling (A380). Military aircrafts were used in warfare (F 22), for spying (drones), gathering geographical information, transporting troops, etc. The idea and dream of flying is now a reality and it was Da Vinci's flying machine which provided the spark for such a tremendous development.

33 Barreled Organ :

In addition to aeronautics, Da Vinci also contributed a lot in the field of weapons and arms. Early rifles took a long time to reload and fire, which was a major drawback during wars. Da Vinci's solution to that problem was to build multi-barreled guns that could be loaded and fired simultaneously. This idea gave birth to the 33-barreled organ. The canons were divided into three rows consisting of 11 barrels in each row, all connected to a single revolving platform. Attached to the sides of the platform were large wheels. All the guns on the organ would be loaded and then, during battle, the first row of 11 would be fired. The platform would then be rotated to properly aim the next row of canons. The idea was to fire one set of barrels while the other was reloading. This system allowed soldiers to repeatedly fire without interruption. This design also formed the basis of the modern machine gun.

During World War 1, General John T Thompson from the United States army built the first machine gun and later developed many new designs (45 caliber rimless cartridge) .The 42 caliber machine gun was widely used during both the World Wars. The machine gun provided an excellent rate of fire and accuracy against multiple targets, and proved to be a lethal weapon in the war. John browning was considered the most successful fire arms designer of the 20thcentaury who designed the browning rifles. Earlier machine guns were difficult and time consuming to load and operate whereas the modern guns achieved a good rate of fire. The cartridge used allows a soldier to carry multiple rounds which was not possible in earlier guns (flintlocks).



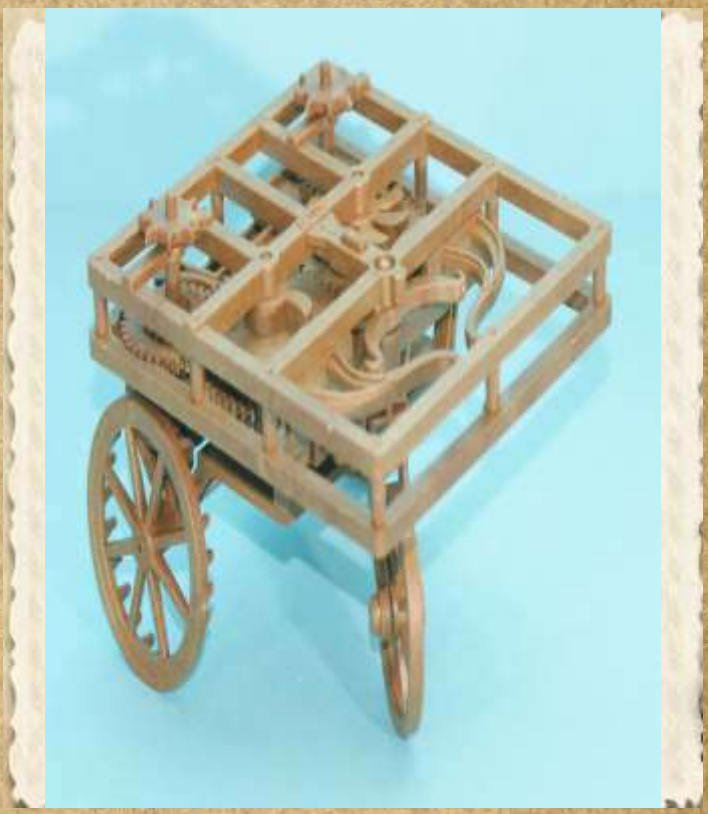
The Crossbow :

We all are familiar with the concept of a crossbow. Da Vinci played an important part in redesigning the giant crossbow. The invention of crossbow caused a great advancement in long range weaponry. The crossbow has been around for a long time, having been invented in the 6th century by the Chinese. It was the first projectile weapon which was long ranged, effective and cheap to build. Da Vinci redesigned

the existing crossbow by making it bigger, stronger and increasing its range. Designed for pure intimidation, Da Vinci's crossbow was to measure 27 yards across. The device would have six wheels (three on each side) for mobility. A worm screw was used to stretch the shooting rope and the bow was made from wood with good flexibility, thereby allowing
increased spring action during its release. The crossbow was not only used to shoot giant arrows but was also designed to fire large stones or possibly flaming bombs (which were also designed by Da Vinci). For use, a soldier spins a crank to pull back the bow and loads the artillery. The soldier would then use a hammer (mallet) to knock out a holding pin and fire the weapon. Another release mechanism used a rope which was pulled in order to release the bow. The potential energy stored in the string was converted into kinetic energy as the bow was released.
The weapon proved to be devastating during the renaissance period, but due to improved artillery in recent times, the crossbow concept has become almost obsolete. Nowadays crossbows are available in many sizes and designs depending upon the amount of impact one wants or the range needed. The recurve crossbow has tips curving away from the operator and has a longer draw length which increases the acceleration of the shot. Some crossbows even have a scope attached for aiming purposes. Gas powered crossbows use energy from compressed gas to fire the bolts, and have high penetration.

Leonardo's Cart :

During the renaissance period the major means of travel by land was the horse or the cart but Leonardo



Da Vinci designed a self-propelled cart capable of moving without being pushed. Leonardo's cart was powered by two symmetric coiled springs, and also featured steering and brake capabilities. When the brake was released, the car would be propelled forward. The use of mechanisms similar to differentials allowed setting of turning angles and the steering was programmable to either straight or pre-set angles. The machine also used balanced wheels, which made the ride smoother. In 2006, Italy's Institute and

Museum of the History of Science in Florence built a working prototype of the cart, which worked according to the description. Some experts noted that it looked similar to the Mars Land Rover. The cart built by Da Vinci was never mass produced as it lacked the basic seat in it but it was used as an attraction during the festivals.

In the year 1672 Ferdinand Verbiest designed the first working steam powered vehicle. In 1878, Karl Benz designed the internal combustion engines which marked the age of fuel powered automobiles. This made Benz the largest company in the world till the end of 19th century. In 1893, the first operational gasoline powered American car was built and road-tested by the Duryea brothers of Springfield, Massachusetts. Many companies started making their mark in the automobile industry. Mass production of vehicles was started with the development of assembly lines and availability of interchangeable parts. Henry ford expanded this concept later in 1914. In the upcoming years automobile industries flourished, with many new companies emerging.
New parameters like comfort, efficiency of the engine, safety measures, indicators, GPS (Global Positioning System), disc brakes, hydraulics, suspension, etc. were introduced. The outcome of all this is the car which we all see in the present. The Automobile industry achieved massive progress over the years, and it was Da Vinci who had foreseen this idea.

Da Vinci's Tank :

Leonardo built the tank for the army during the renaissance to protect soldiers and to strike fear into the enemy.
Da Vinci's inspiration was the shell of a turtle, and he designed his tank on similar principles. His tank was capable of moving in any direction, with the firing platform having many light cannons mounted on it. The platform was able to rotate 360 degrees to fire at any required angle. The outer shell of the tank

was protected by metal armor. The armor was made slanting so that the projectiles would bounce off its angular skin. The slanting structure made the tank more powerful, and helped it to withstand more enemy fire. The tank was powered by four or eight men rotating the crank. This would result in slow motion on the ground. The other team would fire the cannons by rotating the platform at a desired angle. The major flaw in the tank was the crank mechanism which restricted the movement of the tank in the forward direction.

Tanks became a powerful and strategic components of the armies in both the World Wars. Common tanks were the Panzer 4, Tiger Ace and the Stug from Germany. The Americans used the Sherman and the tank destroyer widely. Tanks were developed further by reducing their weight, improving their armor, redesigning the turret, using night visions and scopes for navigation, etc.

Modern tanks have an excellent firing power and rate. Caterpillar Tracks are provided for locomotion, which carry the entire weight of tank efficiently and can move the tank on any terrain. Firepower is normally provided by a large-caliber main gun in a rotating turret and secondary machine guns, while heavy armor and all-terrain mobility provide protection for the tank and its crew.

Conclusion :

Da Vinci's contribution to the field of science was a collection and presentation of new ideas. He conducted most of his research by observing the nature. His innovations were studied, implemented and improved by many researchers. He also proved himself useful in the field of biology by studying the anatomy of not only humans but also of animals and birds. His simple ideas have helped us achieve many things today. We have indeed taken a leap into the future and it was Leonardo Da Vinci who is the man behind the curtains.

By Sharvil Dalvi
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PIIT NEWS

Demonstration on Automobile Powertrain

The members of MESA and AESA conducted a demonstration session on Automobile Powertrain under the guidance of Mr. Anil Kumar Pillai on 19th and 20th March in the automobile laboratory. About 70 MESA and 40 AESA students benefitted from the session.

A 4 Stroke C I Engine, Single Plate Clutch Assembly (TATA-407) and Gear Box Assembly (Synchro-Mesh) were dismantled and explained to the students with the help of PPTs and Avs.

The session was followed by an interactive session with the speaker on new advancements in technology.

PIIT NEWS

Seminar on IPR

On 7th and 9th April, Mechanical Engineers Students' Association held a seminar on Intellectual Property Rights for the students and faculty of PIIT. Intellectual Property Rights are the exclusive rights granted by an authority to creations of the mind.

The keynote speakers were Dr. Rakesh Kumar, Dy. Controller of Patents and Design, Mr. Yogesh Bajaj, Mr. NK Mohanty and Mr. Pankaj Borkar, Assistant Controller of Patents and Design. The students came to know of the procedure to patent their research and about the various patent laws in an interactive session.

The seminar was held over four sessions for each of the departments and the faculty in the Conclave. The speakers gave a presentation on the procedure to patent and the legal course of action to follow to claim royalties. The session culminated in a question answer session with the speakers.


Dr. K. M. VASUDEVAN PILLAI
CAMPUS

PIIT NEWS

Alegria 2014
The festival of Joy

Navi Mumbai recently witnessed its largest college festival at Dr. K.M.V Pillai campus, New Panvel. panning over 5 days from 28th January to 1st February, 2014. Students from all over Mumbai, Navi Mumbai and Thane participated in the various technical, cultural and sporting events. Numerous esteemed personalities from Bollywood, Artists, Academics and Industry graced the occasion. With over 90 events in every genre, students having different interests got a chance to showcase their talents.

The event was inaugurated by Dr. KM Vasudevan Pillai, CEO Mahatma Education Society, Dr. Priyam Pillai, COO and Mr. Franav Pillai, Deputy CEO.

The technical workshops conducted were Robotics L1, L2, L3 and aquabotics.

There were various technical events conducted such as Robotics L1, L2, L3, Aquabotics, Robowars. Robosoccer, Robomaze, Technical Paper Presentation, Online Treasure Hunt, Junkyard Wars, Tech Roadies, 3D Modelling, Code Master and Mock Interview.

Celebrities such as Elli Avram, Rayo Bhakirta , ace Olympian and Commonwealth Gold medalist Ashwini Ponnappa, actress Rakul Preet Singh, Mr. Asia R. Murali Kumar graced the occasion with their presence. All-rounder Farhan Akhtar and rapper Yo Yo Honey Singh performed live and drew huge crowds to the festival. International DJs- DJ Yves V and DJ Allure performed for the first time in the country.

By Jasvindersingh Batra
T.E Mechanical


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