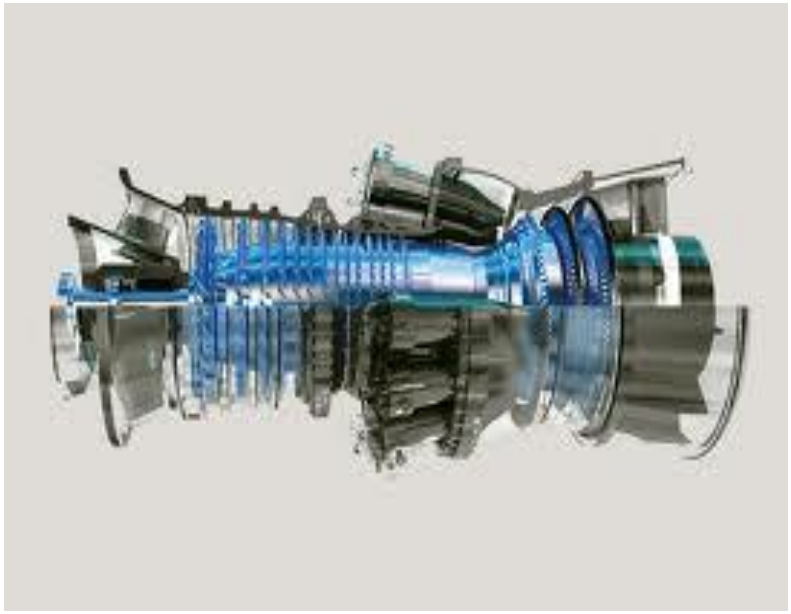
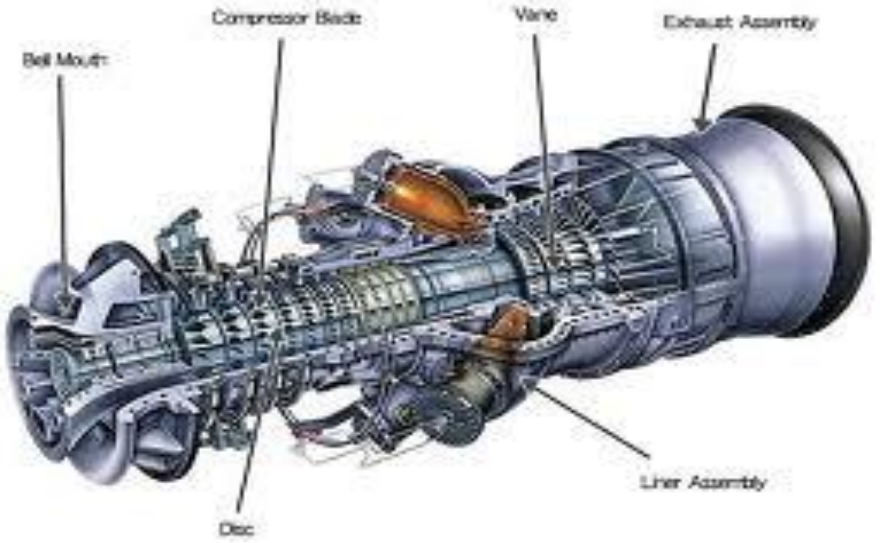
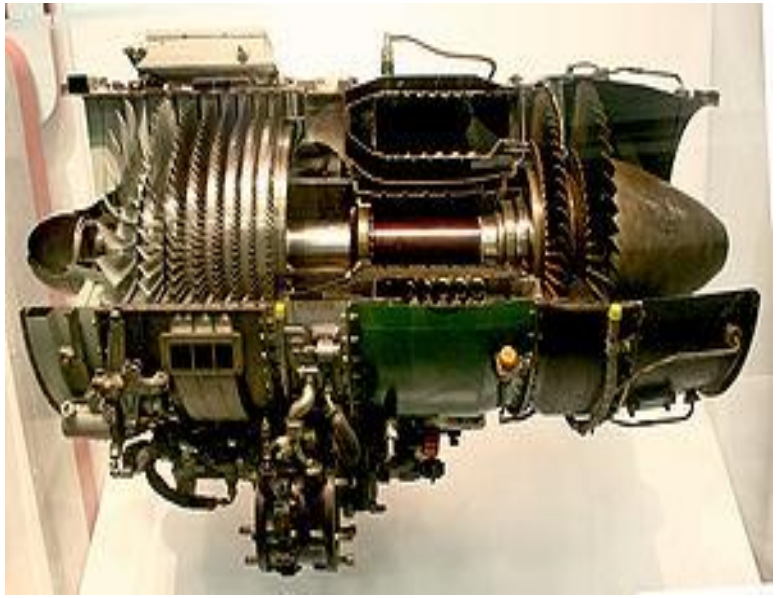
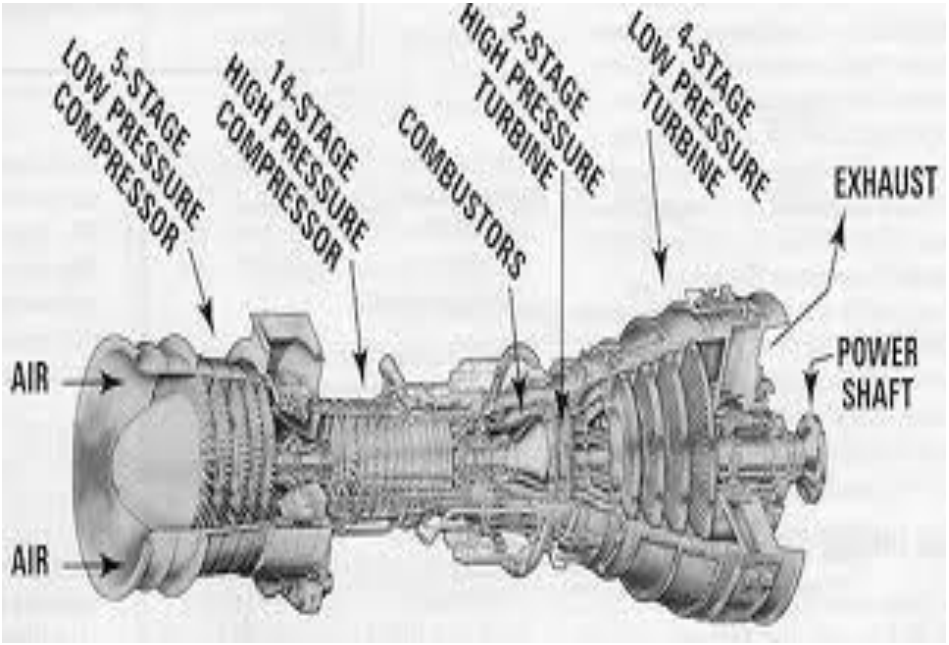
ENGINEERING APPLICATIONS OF WOOD WITH REFERENCE TO PROTOTYPE MANUFACTURING USING RAPID PROTOTYPING TECHNOLOGY.

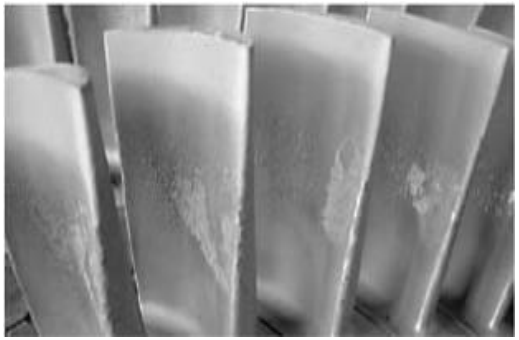


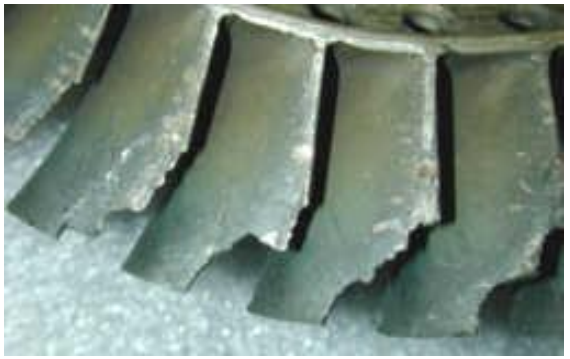

Compressor Blade
Vane
Exhaust Assembly
Bell Mouth
Liner Assembly
Disc

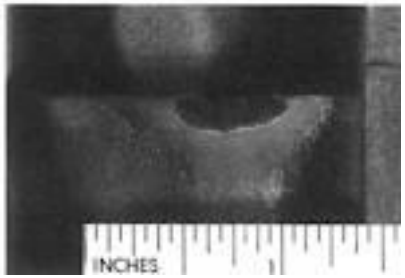



5-STAGE LOW PRESSURE COMPRESSOR
14-STAGE HIGH PRESSURE COMPRESSOR
COMBUSTORS
2-STAGE HIGH PRESSURE TURBINE
4-STAGE LOW PRESSURE TURBINE
EXHAUST
POWER SHAFT
AIR
AIR


VTT
5 cm






INCHES


Stage-1
Stage-2

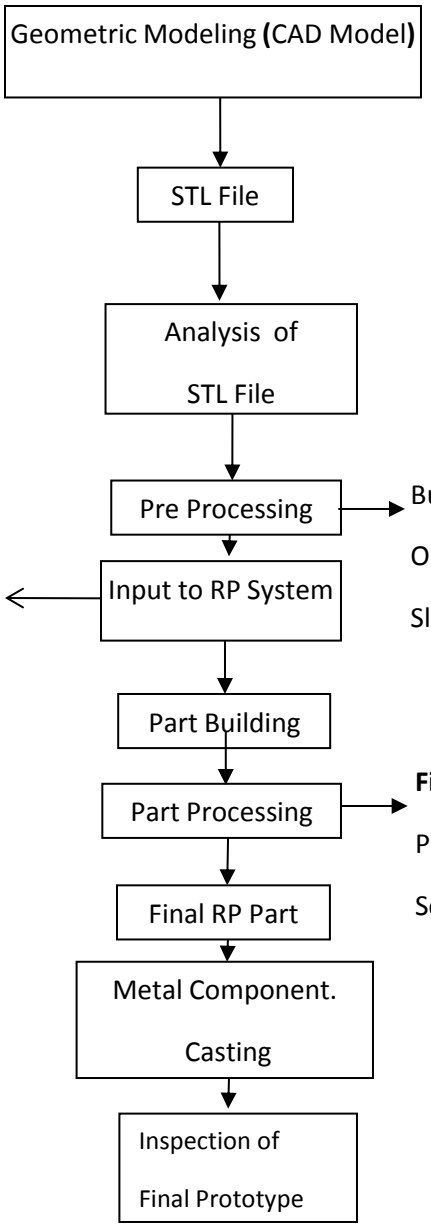
Rapid Prototyping

- Rapid Prototyping Technology (RPT) is an emerging tool in prototypes and product manufacturing.
- It is a technology that transforms digital designs into three dimensional solid objects for production of machine parts, models, prototypes and moulds.
- It is an additive manufacturing technique in which high quality solid models are built overnight instead of taking weeks or months without the complications of NC programming and jigs and fixture designing.
- Many researchers all over the globe are contributing towards the development of this technology and exploring its advantages.

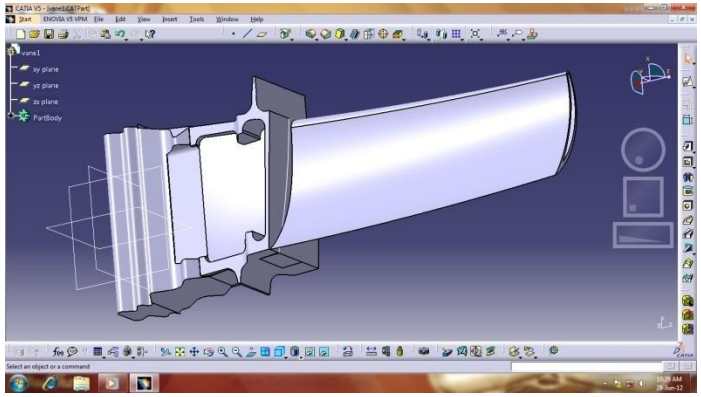
Methods of Rapid Prototyping

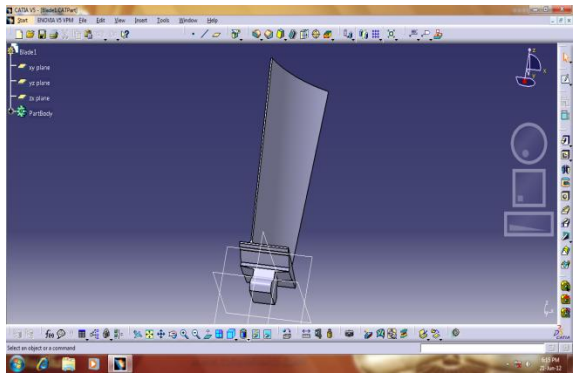
- Solid Based
- Liquid Based
- Powder Based

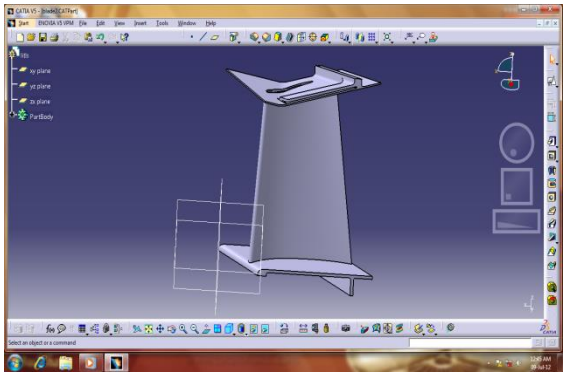
Commonly used RP Machines



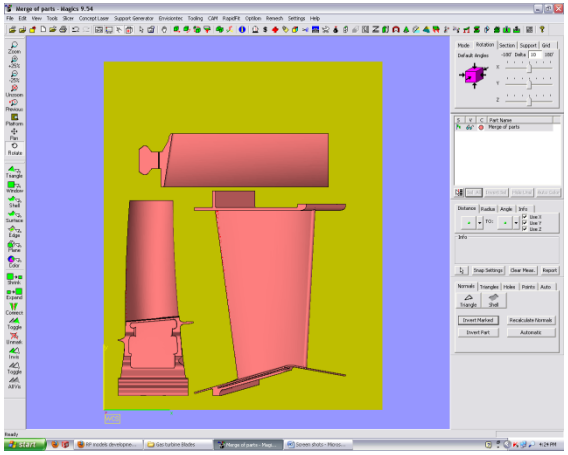
Sequential Flow Chart of transformation of CAD Model into final prototype through Rapid Prototyping Technology.



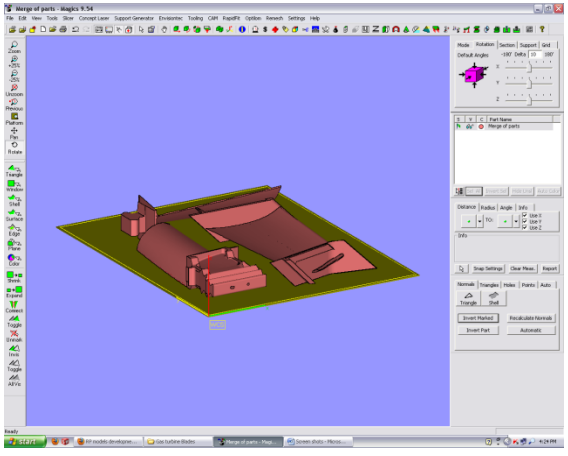




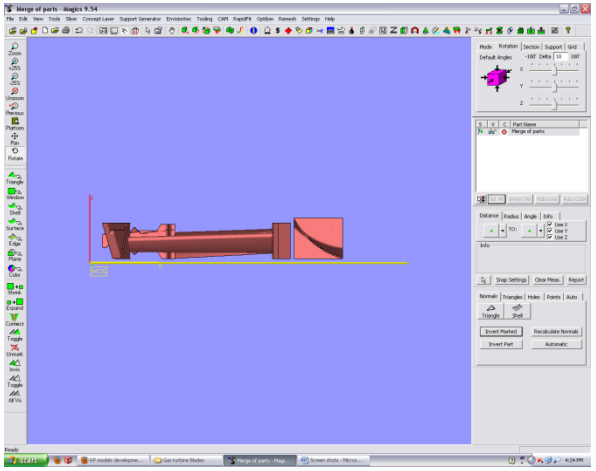
CAD Files of the Component Prototypes of Aero Gas Turbine Engines



Top View

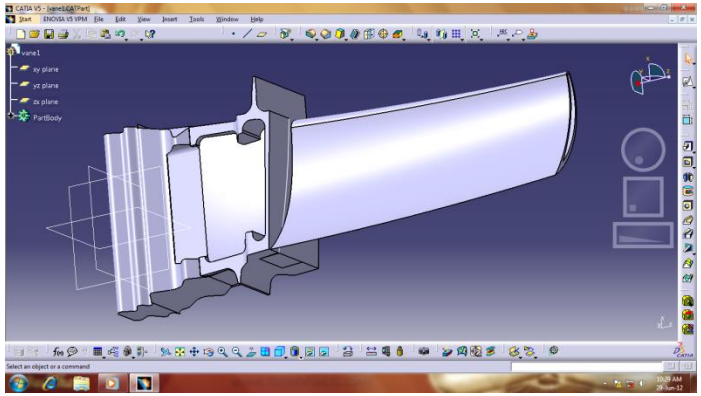


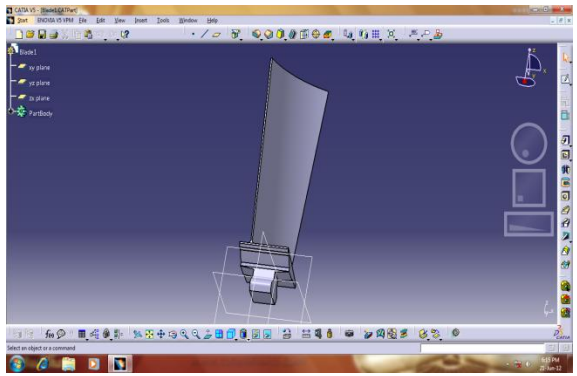
Isometric View

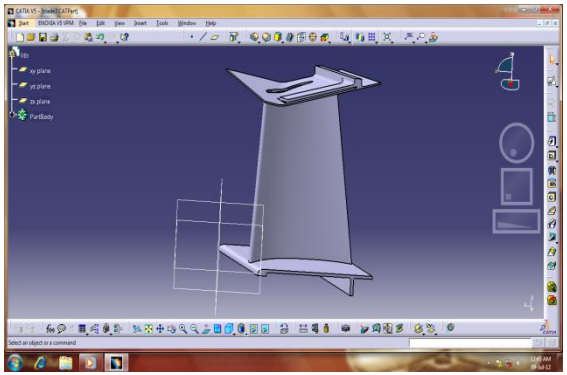


Side View

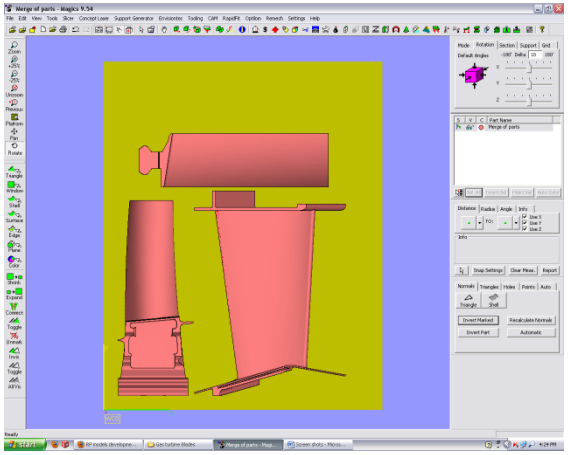
STL Files of Components Oriented to be fabricated in RPT domain



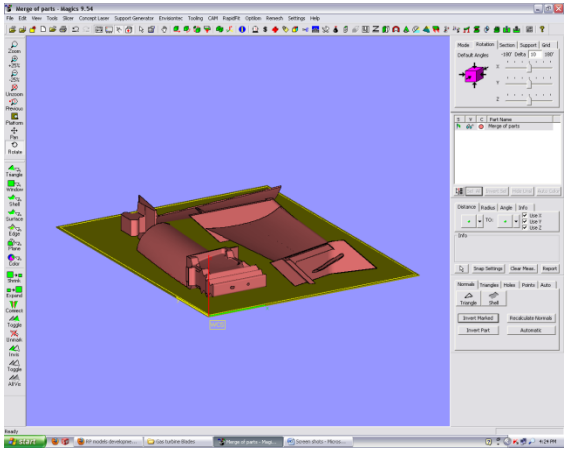




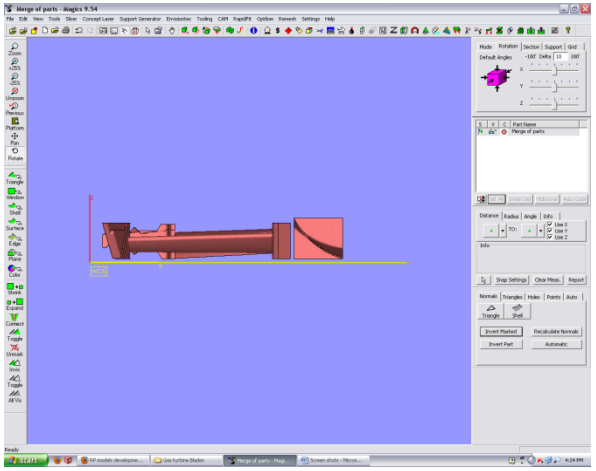
CAD Files of the Component Prototypes of Aero Gas Turbine Engines



Top View



Isometric View



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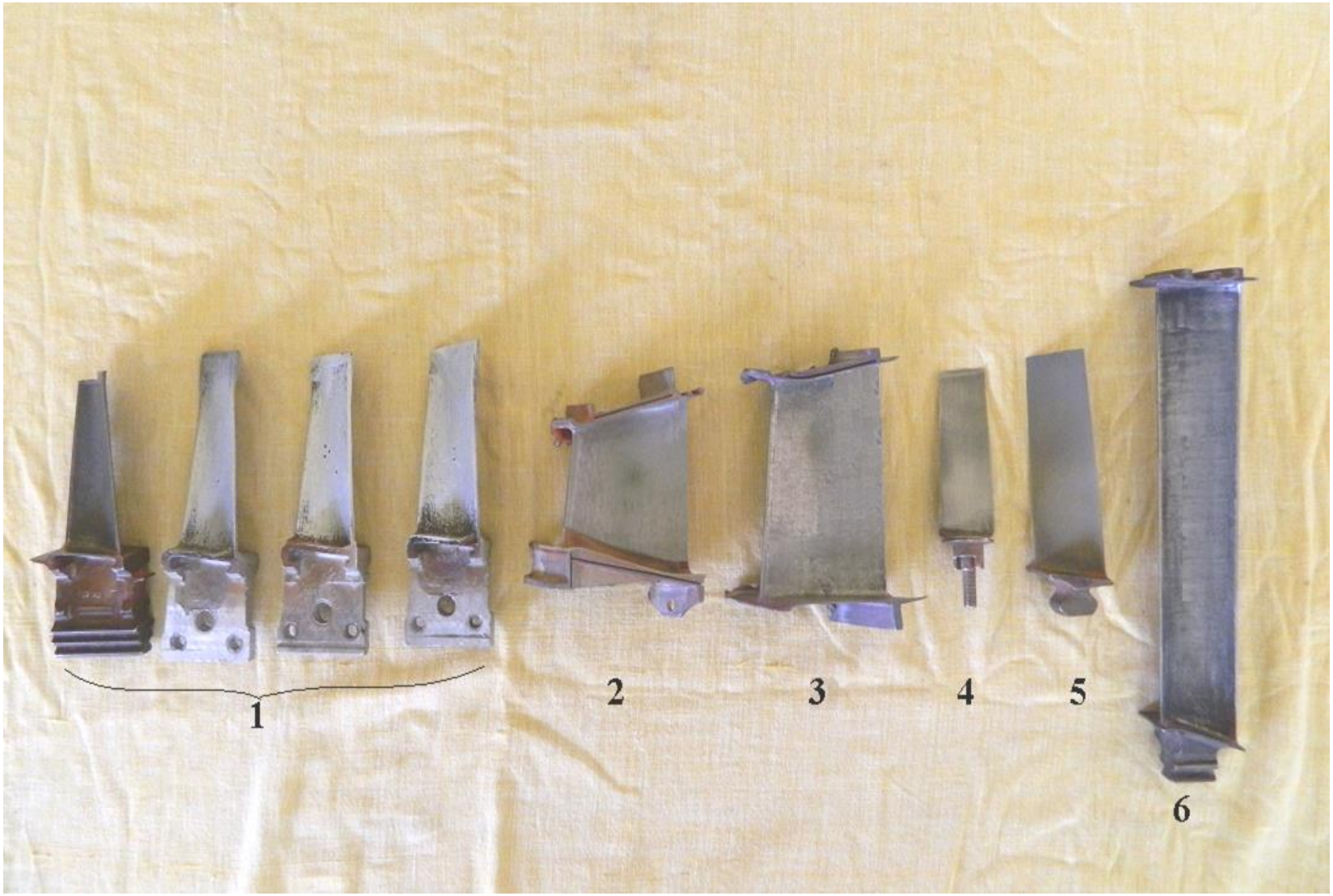


Actual Gas turbine component Prototypes

Wood Based RPT

Advantages of Wood as a raw material

- Cheap Cost : Various types of resins and thermopolymer materials are used in liquid and solid forms as a raw material. The high cost of these raw materials is the major problem with the current RPT.
- The cheapest material currently available is for Laminated Object Manufacturing (LOM) which is about 9.63-17.08 USD per kg while the most expensive material is for StereoLithography Apparattus (SLA) and Fused Deposition Modelling (FDM) available about 250-458 USD per kg

Eco-friendly and Sustainable in nature :

- Induction of wood shall allow a sustainable material to be introduced in the product development cycle.
- Wood is a biodegradable organic material and can be looked upon as an environmentally responsible alternative with multiple advantages over the other raw materials used for prototyping.
- Procurement of wood is less polluting than extraction of other materials.
- The transportation is risk free with copious supply in all types of market irrespective of their location.
- Manufacturing of wood powder requires less energy and water than other non sustainable materials hazardous for our ecosystem.
- The wood energy is neutral in CO2 production.

Easily mixed with other materials
I

- Wood is capable of being easily combined with other materials to create hybrid alternatives.
- Any material that can be recycled and has less commercial value can be crushed or fiberised to be combined with wood powder to give reconditioned wood flour.

Advantages of Teak

- Teak tree can reach in ideal circumstances, a height from 40 to 50 meters, with a trunk useful from 20 to 30 meters.
- These trunks are of cylindrical form and reach a diameter up to 1,5 meter. Every year the trunk diameter approximately grows by 2 cm.
- Teak is fatty and rich in natural oils and always allows a very smooth completion.
- Teak is extremely water resistance with minimum moisture content and safe for any climatic conditions
- It does not support rust or corrosion when it is in contact with oxydable metals.
- Balsa and bamboo are also recommended for prototype fabrication.

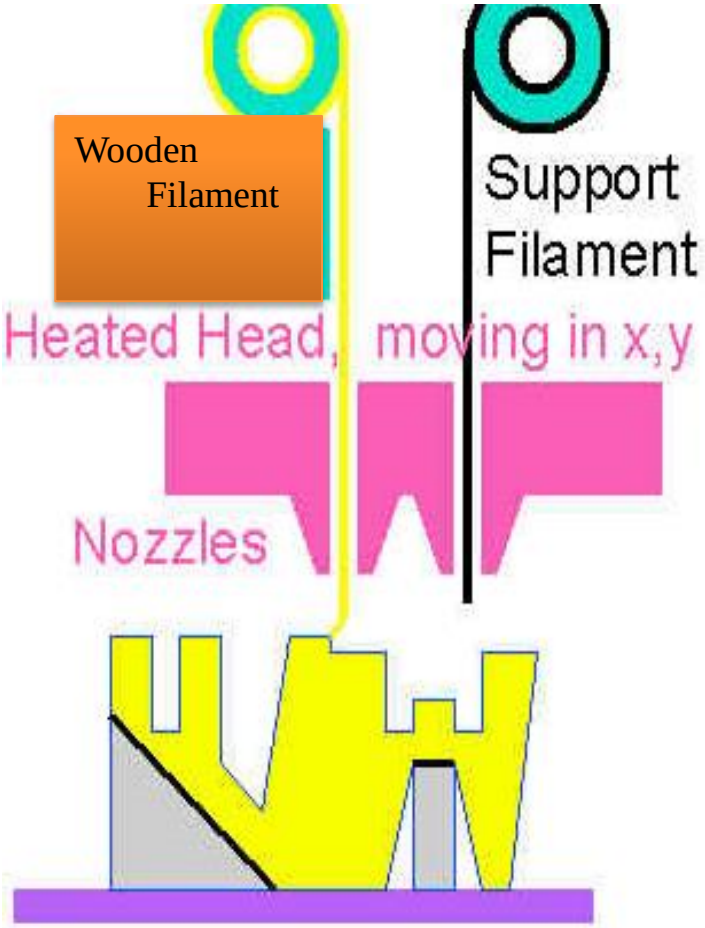
Experimental Equipments and Methodology

Preperation of wood powder and pulp :

- Primarily the wood powder of the required type of wood can be collected from the wood powder collector of any wood processing factory. The powder has to be chemically treated before using it for the RP process.
- The moisture content of the powder should be reduced by curing it in a laboratory oven up to 60^{o} C for around 6 hours.
- It has been analysed that a composite material with equal volume s of wood powder and external additive like the commercial ZP102 can be directly used in present 3D printing machine. The material is properly sieved with mesh sized about 100µm and then fed to the 3D printing machine.

- Various modified starch can be used along with the wood powder to obtain a homogeneous and isotropic material with improved viscosity and binding property to work at temperatures at which the deposition modeling process operate.
- A wood pulp of beech flour, ether starch prepared with demineralized water serves as a better feed material. It has been analysed that for a grain size of 40 µm a paste of 24.64g of beech flour and 40g of ether starch mixed with 246.46ml of water has a better stability with minimized crumpling while deposition.

Manufacturing



Final prototype analysis

- The final prototype can be checked for its mechanical properties, surface quality and accuracy.
- The prototype when tested on a 12 KN load cell of an UTM shows that increase in the proportion of wood powder above 45% in the proposed composition of wood powder and ZP102 decreases its strength and elongation.
- Furthermore the increase in proportion of the wood powder increases the hardness of the specimen but leads to a reduction in dimensional accuracy.
- The addition of wood powder in the composition decreases its surface quality which can be further improve by using a more smooth powder (below 100 μm) with more solid form instead of fibers.
- Specimens manufactured from the wood pulp prepared in combination of modified starch shows that the strength increases with more flour and less water contain.
- It should be noted that starch is sensitive to humidity and its mechanical properties decrease with increase in the moisture.