Sri Sivasubramaniya Nadar College of Engineering
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Technical Capabilities of Mechanical Engineering

Dear Sir/Madam,

This is a compilation of various activities and research interests of SSN Mechanical Engineering Department. You are requested to identify areas of interest to you and consider interactions at various levels

a. Internship for students
b. Internship for faculty
c. Sharing list of problems for students to take up their project work
d. Offering Student Innovation Competitions. Offering research problem for PhD. Scholars

Contents of this booklet are classified into several Sections for ease of use:

Section A: Products

A1: Automotive Products

A2: Advanced Welding Related Products

A3: Energy Related Products

A4: General Implements

Section B: Support and Services

B1: Manufacturing Support

B2: Processing Support

B3: Characterization Support

B4: Robotics and IoT Support

B5: Human Resources Support

AP1: Car bumper with improved energy absorbing capacity

Description of Technology:

In this technology, the impact energy absorbing capacity of the car bumper beam has been increased by incorporating hollow aluminium tubes filled with Aluminium honeycomb panels. Both lab scale and full-scale testing (at ARAI-Pune) was carried out to develop the proof of concept

Status of Development

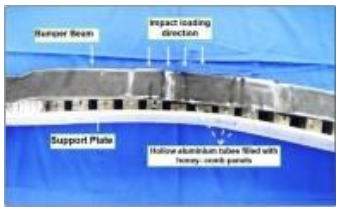
Developed the prototype and patent has been filed. Patent application no is 201841010364. Can be developed further for customization

Possible area of usage:

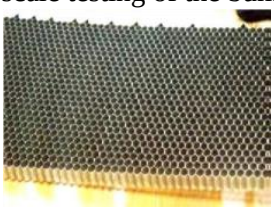
The concept is suitable for all the existing cars which need additional impact energy absorbing capacity. In particular, the idea will be suitable for all brands of Light Commercial Vehicles.

Images with Description:

In general, bumper in automobiles is considered as the front-most and rear most part designed to withstand damage to the vehicle's safety systems. In this concept, impact energy absorbing capability of car "bumper beam" portion has been enhanced by incorporating "hollow Aluminium tubes filled with aluminium cellular structure". Number of hollow tubes were arranged along the bumper beam to improve their crash behaviour. Both lab scale and full scale testing of the bumper have been conducted.



(a)Bumper beam with hollow aluminium tube



(b) Aluminium honey comb panel

(c) full scale bumper testing facility

Figure 1: Concept of full-scale bumper model with testing facility

In order to understand the service performance of the bumper, three bumper beam models were developed. Bumper beam model-1 was unfilled with other elements. In model-2, series of aluminium hollow tubes filled with aluminium cellular structures was implanted. The hollow aluminium tubes comprise of deformation triggering mechanism which will accelerate the plastic deformation within a short period of time. In model3, only aluminium cellular structure was embedded. The models were tested at authorized test centers of automobiles ARAI for about 15 km/hr speed. The test details are tabulated.

Sl.No	Bumper Model	Crush time	Velocity	Peak acceleration	Energy absorbed
		milli-second	(m/s)	m/s^2	J
1	Model-1	36	-0.8	117.3	6595.0
2	Model-2	45	-1.6	118.0	12954.3
3	Model-3	43	-4.3	104.5	21080.5

It was observed that, by using aluminium cellular structure as filler material of bumper beam, three times higher (3 times) impact energy can be absorbed compared to unfilled model.

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AP2: Hybrid bumper system

Description of Technology:

A hybrid bumper system is proposed, comprising of a primary stage pneumatic spring loaded piston and a secondary stage hydraulic fluid loaded piston of varying cross sections built in a single cylinder acting as a unitary unit to absorb the energy from low and high speed impact collisions of any moving vehicle. The hybrid system used unitarily or in multiples, can be attached to the front, rear and sides or any part of a moving vehicle to provide all-round safety to the vehicle and its occupants by absorbing the impact from any direction.

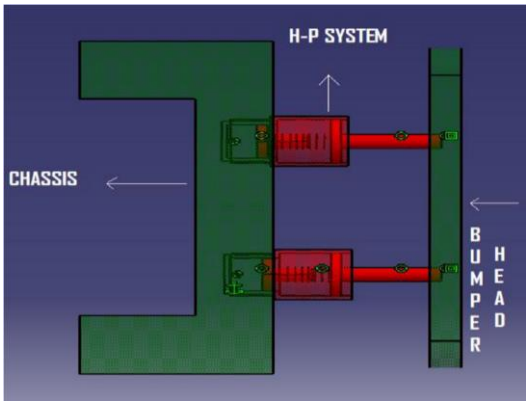
Status of Development

Patent filed - Patent ref Number- 6062 /CHE/2014

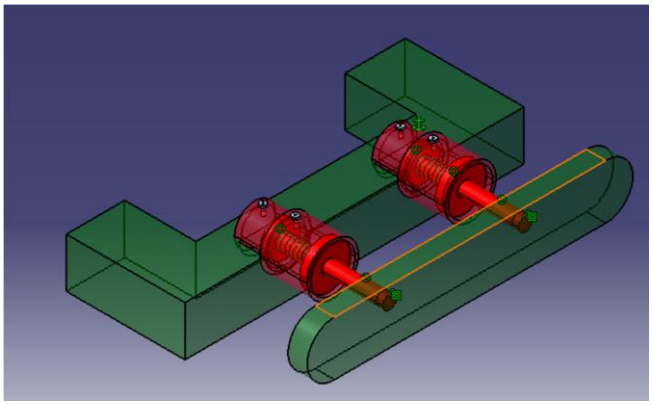
Possible area of usage:

Can be fitted to automobiles along any direction, to strengthen their bumper systems , enhancing the capability to absorb more impact.

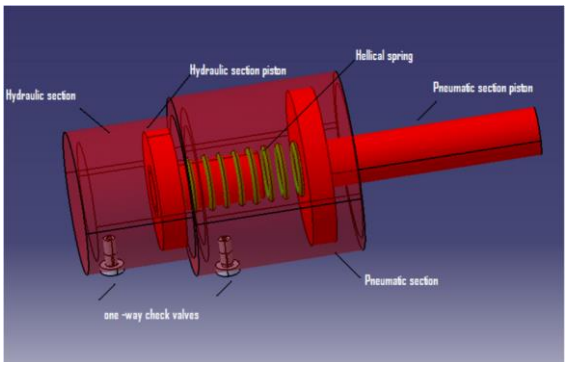
Images with Description:



(a) Top view of the bumper system



(b) Front view of the bumper system



(c) Detailed view of the single bumper system

Figure 2: (a) shows the 3D model top view of the bumper system showing the method of fitting two bumper systems to the head bumper. (b) shows the 3D model front view of the bumper system. (c) shows the 3D model detailed view of a single bumper system with the pneumatic spring loaded part and the hydraulic fluid loaded part

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AP3: Escape provision for car during drowning

Description of Technology:

In this concept, a novel mechanism has been developed to enhance the escape-worthiness of car occupants.

Status of Development

A patent has been filed for this concept. (Ref No. 201841030306)

Possible area of usage:

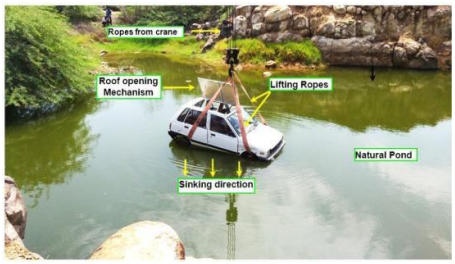
The concept can be implemented in all the existing cars with little modifications. Especially the idea is suitable for Light Commercial Vehicles

Images with Description:

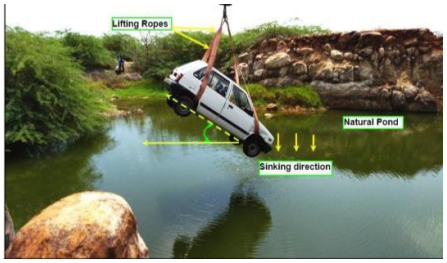
In this innovation, an attempt has been made to improve the escape worthiness of car occupants when the car is under drowning condition. It has been achieved by a novel mechanism which will open the roof of the car, the moment the car starts to sink. Various possible car sinking mechanisms and flow behaviour were studied to optimize the design parameters of the mechanism. Both prototypes and full scale models were tested to validate the functioning of the present mechanism and it showed a good response even under critical orientation of car drowning. Care has been taken while designing a mechanism in such a way that, it should not function during normal raining condition, it could also be triggered manually, and it should not reduce the air-conditioning comfort of the passenger. Furthermore, the present innovation will help the occupants to escape from a car when the car doors get jammed due to road accidents. The Concept of the mechanism and full scale testing images are shown in figure.

(a) Concept of escape worthiness

(b) roof opening Mechanism



(c) Full scale testing of car _orientation1



(d) Full scale testing of car _orientation 2

Figure 3: Concept of escape worthiness and full scale test facility

The main advantages are

a. The death toll of the occupants due to car drowning can be minimized to a greater extent
b. The mechanism is less in cost, easy to be incorporated and ensures maximum safety against critical situations such as sinking, fire accidents and jammed doors.

The innovation reduces the human (including kids) effort and injuries while escaping from a drowning vehicle.

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AP4: Seats with improved Thermal comfort

Description of Technology:

The thermal comfort of occupant in seats has become more important due to their increasing mobility, leading to more time spent by people over a particular position in seats.

Our project discusses the thermal comfort of human being when subjected to sitting in a chair/seat, for a prolonged period of time. Seats, in general, hinder the heat and moisture transport from the human, back to the environment, bringing thermal discomfort for a seated person. So people may feel uncomfortable due to the heat buildup. This heat will produce various ergonomics problem to a seated person. So evaluating the "thermal discomfort" of the seated person is very much important in order to prevent him/her from suffering ergonomics problem. In this work, we developed a Sensing system integrated with Car Seat to trigger the Thermal Comfort System developed with Peltier module to create a cooling environment between the seated person and car seat.

Status of Development

Prototype made; currently in the process of Optimizing the Algorithm's. Patent to be filed

Possible area of usage:

Automobile Sector - OEM Companies for Auto Sector

Images with Description:

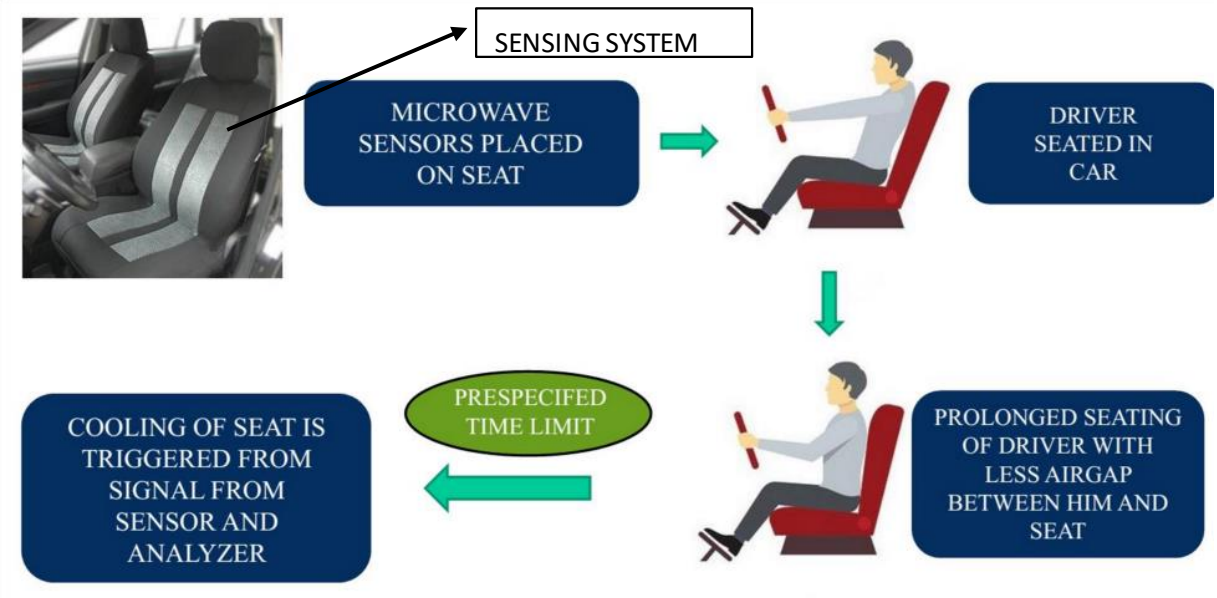

Figure 4: Seats with improved thermal comfort

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AP5: Slow-release clutch mechanism

Description of Technology:

The present invention is related to a clutch manipulating mechanism in an automobile. More specifically, it describes about the design of slow-release clutch mechanism to assist the drivers in moving the vehicle from standstill without getting the engine-off by releasing the actuated clutch pedal gradually after the gear shift. This clutch operating assistance will find utility mostly for the learner drivers until they learn proper driving in an automobile

Status of Development

Patent Application number 201741034676 . Status -Published

Possible area of usage:

For all automobile driving learners to practice driving.

Images with Description:

An additional spring loaded gear moving on a guided circular rack ensures slow release of the clutch. The mechanism is arranged such that it can be either engaged or disengaged when not required.

Figure 5: Slow release clutch mechanism

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AP6: Adjustable wheel wrench

Description of Technology:

A method of designing an adjustable wheel wrench that is capable of loosening and tightening of more than two lug nuts arranged in any pitch circle diameter of a light motor vehicle at the same time, comprising of

a. a double universal coupling to connect gears with lug nuts
b. the wrench which comprises of square shaped recess cut into the gear into which the double universal coupling can be inserted.
c. a spur gear train to transfer power from a central shaft to multiple parallel shafts.
d. a flexible shaft , keyed to the gears whereas this flexibility allows to adjust the shaft to match pitch circle diameters (PCD) of various wheels.
e. a double universal coupling that provides necessary degree of flexibility to remove wheels with 'n' number of nuts arranged in a square pattern.

Status of Development

Equipment available. Patent applied . Patent number 201641009930

Possible area of usage:

Can be used for wheel removal in light vehicles.

Images with Description:

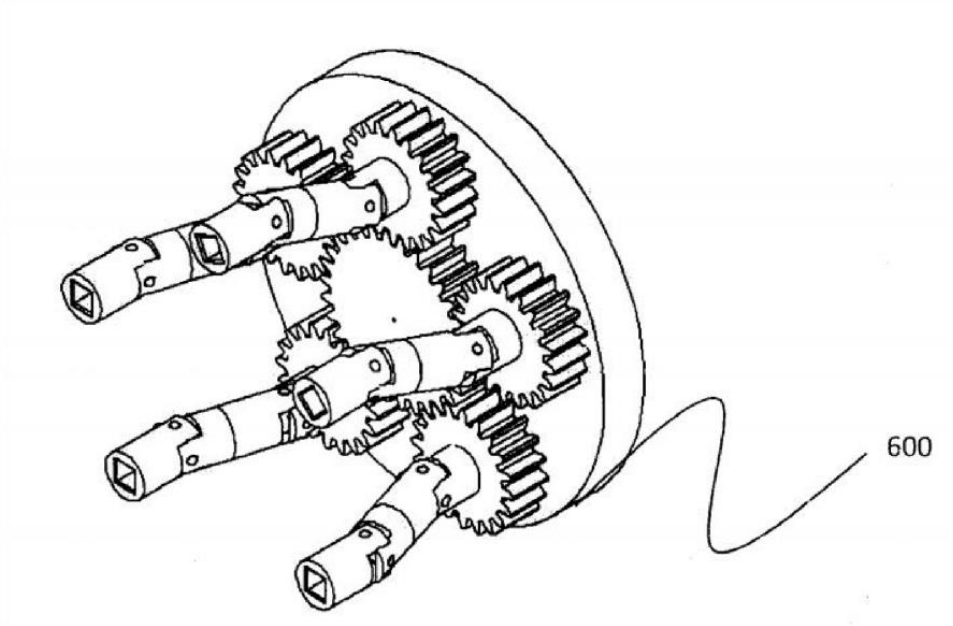

Figure 6: Adjustable wheel wrench

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AP7: Retractable wheels based Dynamic stabilizing attachment for Motorcycle

Description of Technology:

The present invention relates to an attachment which will assist the rider to balance the two-wheeler under life-threatening road environments

Status of Development

A patent has been filed for this concept. (Ref.No.: 201741003692)

Possible area of usage:

This concept can be implemented to all the two wheelers where the rider safety becomes most important. The idea can be best used for Motorbikes.

Images with Description:

Motor cycle riding on city streets under dense traffic is becoming difficult and tedious. It is necessary for the rider to frequently stop and start, while balancing the bike with one foot on the ground.

This difficulty has become more pronounced as the weight of motor cycles has increased in recent years. Some of the larger bikes are very difficult to manage in crowded ares. In order to overcome this, a dynamic balancing attachment for a motorcycle is proposed.

Primarily , the attachment consists of a curved main arm in which the auxiliary wheels are mounted. The arm can be fixed to the central frame of the motorcycle (between the front and rear wheels) without causing any modifications in the motorcycle. The frame can be actuated by a motorized control which can be triggered by the rider.

The dynamic balancing apparatus assists the rider at the time of tricky situations caused at the road surfaces and small impact received from neighboring vehicles. In addition, the innovation reduces the effort required to balance the vehicle even under static condition of the motorcycle. Figure shows the top and side views of the proposed mechanism.

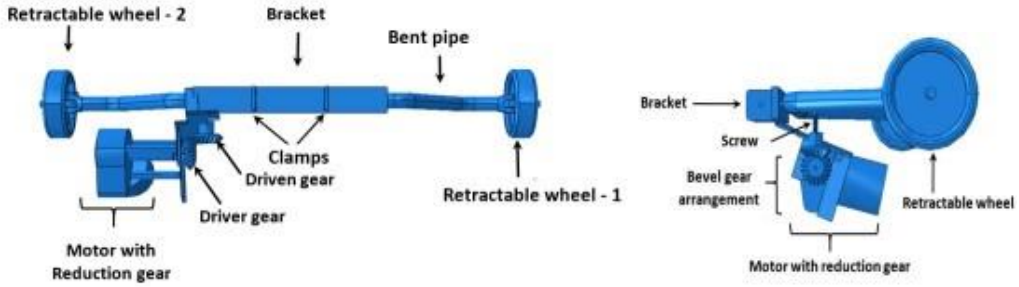

Figure 7: Concept of dynamic stabilizing mechanism for two wheeler rider.

The following are the important advantages:

- The proposed innovation completely replaces the center stand as the wheels can be locked to the floor.
- The present location of the mechanism will not affect the sitting comfort of rear passenger.
- The frequent activation and deactivation of the mechanism will not hurt the rear passenger.
- No major modifications of the motor cycle is required as the attachment is directly attached to the central frame

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AW1: Aluminium / copper cold plate (Fabricated by Friction Stir Welding)

Description of Technology:

An attempt is made to design and fabricate a cold plate with aluminium-copper dissimilar interface joined by friction stir welding. Optimum welding conditions for obtaining sound-quality corner and T joints with an aluminium-copper interface were established. Welded cross sections of the friction stir welded cold plate were analyzed to understand the bonding characteristics. Computational fluid dynamics (CFD) was used to evaluate the fluid-flow characteristics and thermal resistance of friction stir welded cold plate and the resulted are compared with the conventional bolted cold plate configuration. For CFD modeling of a cold plate with a dissimilar interface, a new methodology is proposed. From the CFD analysis and experimental results, it is observed that friction stir welded cold plate offered better thermal performance compared to the bolted cold plate and it is due to the metallurgical bonding at the aluminium, copper interface with the dispersion of copper particles. Welding without consumables, non-polluting and non-fuming. Metals are joined by Plastic deformation by a moving/ rotating tool, using frictional heat.

Status of Development

Product developed and tested to be better than bolted cold plates. Can be scaled up, based on need.

Possible area of usage:

Can be attempted as an environmentally friendly alternate to bolted cold plates of any configuration, with enhanced thermal performance.

Images with Description:

Figure 8: Cold Plate or Heat Sink

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AW2: Recycling of Magnesium chips into tubes (by Friction Stir Extrusion)

Description of Technology:

Friction stir back extrusion (FSBE) is a method of fabricating lightweight tubes with refined microstructure, based on the principle of Friction Stir Welding (FSW). Present process is to convert magnesium chips into tubes, by the novel process of FSBE. Machined chips are consolidated by Plastic deformation by a moving/ rotating tool, using frictional heat and extruded as a wire or tube.

Status of Development

Process successfully developed for magnesium chips. Can be studied on other soft ductile material chips also.

Possible area of usage:

Can be attempted to fabricate Magnesium wires from chips, which can be used for welding and repair work on magnesium alloy components, Mg wires for additive manufacturing, Mg tubes for biomedical applications.

Images with Description:

Figure 9: Recycling of Magnesium Chips using Friction Extrusion

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AW3: Micro tubes by friction stir back extrusion

Description of Technology:

Friction stir back extrusion (FSBE) is a method of fabricating lightweight tubes with refined microstructure, based on the principle of FSW. This involves fabrication of Magnesium Wire and Tubes using solid state recycling of machined chips or rods. These are consolidated by Plastic deformation by a moving/ rotating tool, using frictional heat and extruded as a wire or tube.

Status of Development

Process being researched for making micro tubes from rods.

Possible area of usage:

Can be attempted to fabricate magnesium pipes for structural applications, heat pipe fabrication and Magnesium tubes for biomedical applications.

Images with Description:

Figure 10: Friction stir back extrusion of ZE41 magnesium alloy

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AW4: Tube to plate welding (by Friction Stir Welding)

Description of Technology:

Welding tubes onto plates, without consumables, by a non-polluting and non-fuming process. Metals are joined by plastic deformation by a moving/ rotating tool, using frictional heat.

Status of Development

Process established for aluminium , magnesium, copper and soft alloys . Process being researched for hard materials (steels).

Possible area of usage:

Can be attempted as an environmentally friendly alternate to any welding process, in automotive industries. Process can be developed for any specific welding requirement.

Images with Description:

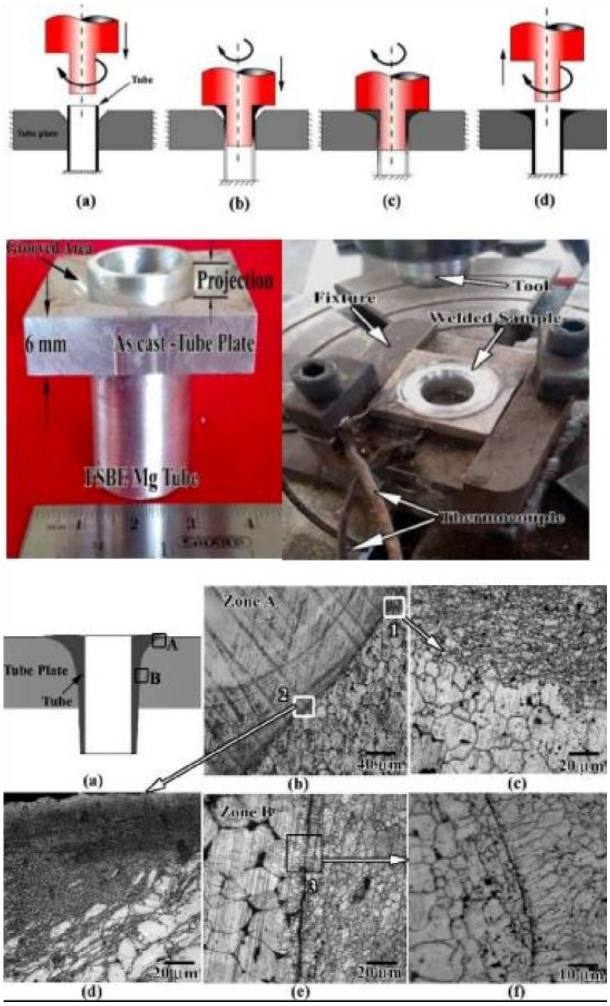

Figure 11: Tube to plate welding (by Friction Stir Welding)

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EP1: Air-inlet mechanism for compressed air driven engines

Description of Technology:

Mechanism to admit compressed air to run a piston-cylinder arrangement.

Status of Development

Prototype made. Patent filed. Patent ref Number- 4646/CHE/2012

Possible area of usage:

To run any existing or new two stroke or four stroke engine.

Images with Description:

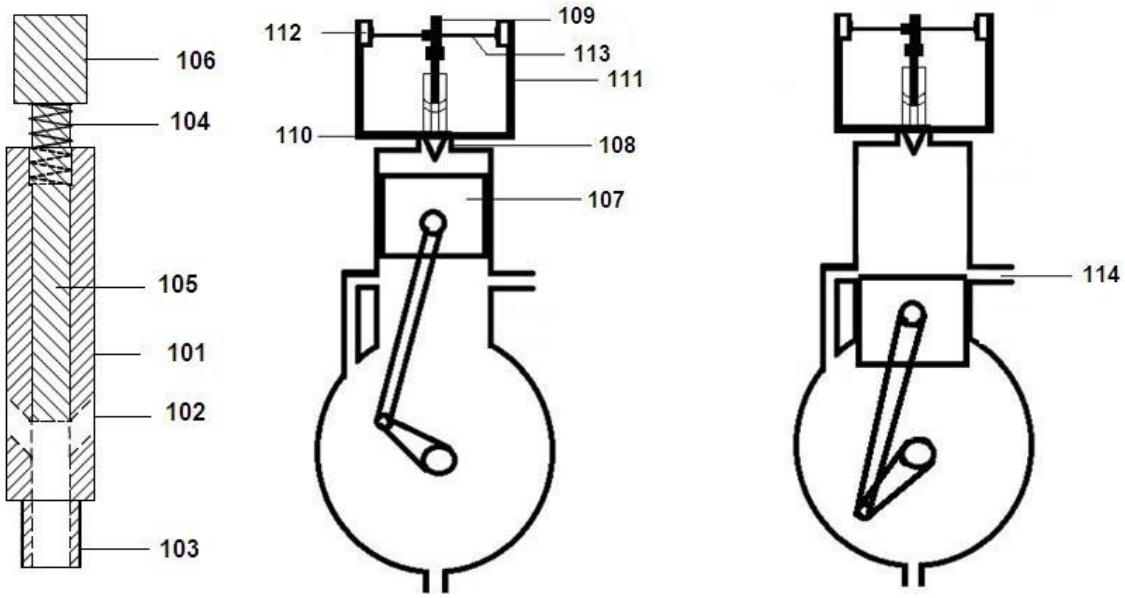

Figure 12: Mechanism to admit compressed air to run a piston-cylinder arrangement.

Figure shows the inlet mechanism is a hollow cylindrical piece (101) with angular inlet nozzles for compressed air, in which the plunger (105) reciprocates. Angular drills (102) are provided for the arms to direct the flow of compressed air into the engine. The spark plug used in the engine is replaced by the threaded head (103) of the inlet. The engine head has a threaded internal bore (108), to accommodate the spark plug, which has now been replaced by the inlet mechanism. A spring (104) is used to enable return motion of the plunger. The inlet mechanism has a plunger (105) which reciprocates in the bore (108), to control the flow of air into the cylinder. The plunger (105) is actuated by a cam (109). The cam (109) is designed such that inlet of compressed air is allowed into the cylinder only when the piston (107) is near the top dead center. When the exhaust port (114) begins to open, the plunger (105) shuts off the supply of compressed air into the cylinder. Spring force is used to push the plunger (105) back to continue the cycle. The feed for the cam (109) shaft is obtained from the crank shaft itself, by means of a chain drive. Figure 2 shows the inlet support mechanism which is fitted to the top of the engine head. It consists of a base plate (110), which is attached to the engine head to support the inlet mechanism. Two vertical plates (111) are welded to a base plate (110) in order to accommodate the bearings (112) which are used to support the cam shaft (113) which is coupled to the crank shaft by means of a chain drive.

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EP2: Vortex tube cooler

Description of Technology:

It is a mechanical device that separates compressed gas into cold and hot streams. It can find its applications in the cooling of machine tools. The cold end of the vortex tube shall be kept in the coolant tank and cold air shall be bubbled through the liquid coolant. Due to this arrangement, the coolant is cooled by sensible cooling due to cold air from vortex tube as well as evaporative cooling due to mixing of cold air with coolant.

Benefits: Flexible, can be easily moved from one machine to another machine, Compact size, No moving parts, low cost, maintenance free, will improve tool life and the overall production.

Status of Development

Equipment is available. Process is established. Can be offered for customer requirements based on specific applications.

Possible area of usage:

Can be used to i) cool grinding wheels in grinding machines, ii) cool cutting tools in lathes, milling machines and CNC machines during machining operations. This cooler was tested in an industry manufacturing grinding wheels. 10 litres of coolant (which is used for grinding application), was cooled from 33°C to 25°C (8°C reduction in temperature) in 1 hour.

Images with Description:

This concept was presented at IMTEX 2017 (Indian Metal cutting Machine Tool Exhibition), Bangalore as part of the exhibition of academia projects during January 26 – February 1, 2017 and was awarded second prize with cash award of Rs. 12,500/-.

Figure 13: Vortex Tube Cooler

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GP1: Stretchable Wheelchair

Description of Technology:
Newly designed structure functions as bed, stretcher and wheelchair.

Status of Development
Prototype made. Can be developed further for customization.

Possible area of usage:
Will be useful as an aid for people who are admitted in the hospitals.

Images with Description:

Figure 14: Stretchable Wheelchair

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GP2: Air conditioner cum auxiliary cooler with evaporative condenser

Description of Technology:

An improved air conditioning system that utilizes the condensate water from evaporator to enhance the cooling of the condenser coils, thereby increasing the cooling effect. It integrates conventional air conditioning unit and a condenser cooling mechanism along with an auxiliary cooling set up that provides natural evaporative cooling to a small storage space.

Status of Development

Prototype made and tested

Possible area of usage:

An integrated AC cum vegetable/fruit storage unit.
Will be useful to meet domestic cooling requirements

Images with Description:

Figure 15: (LEFT) Evaporator side of the unit, (RIGHT) Condenser side of the unit with condensate water spray arrangement

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MS1: CAD / CAM / 3D Printing facility

Description of Technology:

2D and 3D Designs of structures/ automobile parts/ can be developed and optimized using CREO, SOLID WORKS and CATIA Software.

Structural/ Thermal / Vibration simulation and analysis of the components and systems can be performed using ANSYS /ABAQUS, thus helping in design validation, before the prototype can be produced.

Prototypes made of PLA/ABS/composites can be printed.

MATLAB tools can be used for design optimization.

Status of Development

3D Printer: 500 x 500 x 500 mm printing range with PLA, ABS, Composites.

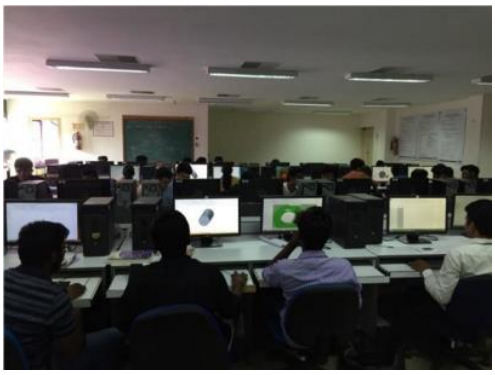
Software capability: CREO / SOLID WORKS/ ANSYS/ CATIA/ MATLAB/ ABAQUS

Possible area of usage:

Automobile, Aerospace, consumer based industries and those who extensively work on product development, prototyping and design validation can benefit from the facilities and expertise available at the centre.

Images with Description:

3D Printer



CAD/CAM/CAE Lab

Figure 16: 3D printer and CAD/CAM/CAE Lab facilities

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MS2: Ultrasonic assisted stir casting setup (for fabricating Al and Mg based Nanocomposites).

Description of Technology:

This setup uses hybrid concept (combination of mechanical stirring and ultrasonic assisted stirring) to cast Al and Mg based nanocomposites.

Status of Development

Machine installation is over. Sample castings have been made using Al alloy and hBN nanoparticles. Ready to use for any desired combination of metal and particulate materials.

Possible area of usage:

This setup is better alternative than mechanical stirring to disperse nanoparticles in Al/Mg metal matrices.

Images with Description:

Figure 17: Ultrasonic assisted stir casting setup

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MS3: Wire cut EDM facility

Description of Technology:
Unconventional machining equipment that can create various profiles.

Status of Development
Machine installed and ready for use

Possible area of usage:
This setup is better alternative for profile cutting, especially for tensile specimen, taper cutting, tool and die cutting and cutting complex profiles

Images with Description:

Figure 18: Wire cut EDM facility

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MS4: Magnetic Moulding

Description of Technology:

Moulding sand replaced with steel shots (Small size steel balls). No pollution due to binders. High production rate due to less solidification time. Mould material can be re-used any number of times.

Status of Development

Process established for Aluminium cylindrical composites. Process being researched for complex shapes.

Possible area of usage:

Can be used for casting of components of small dimensions. (Size of the moulding cylinder – Diameter 100 mm and height 150 mm). Process can be developed for any casting requirement.

Images with Description:

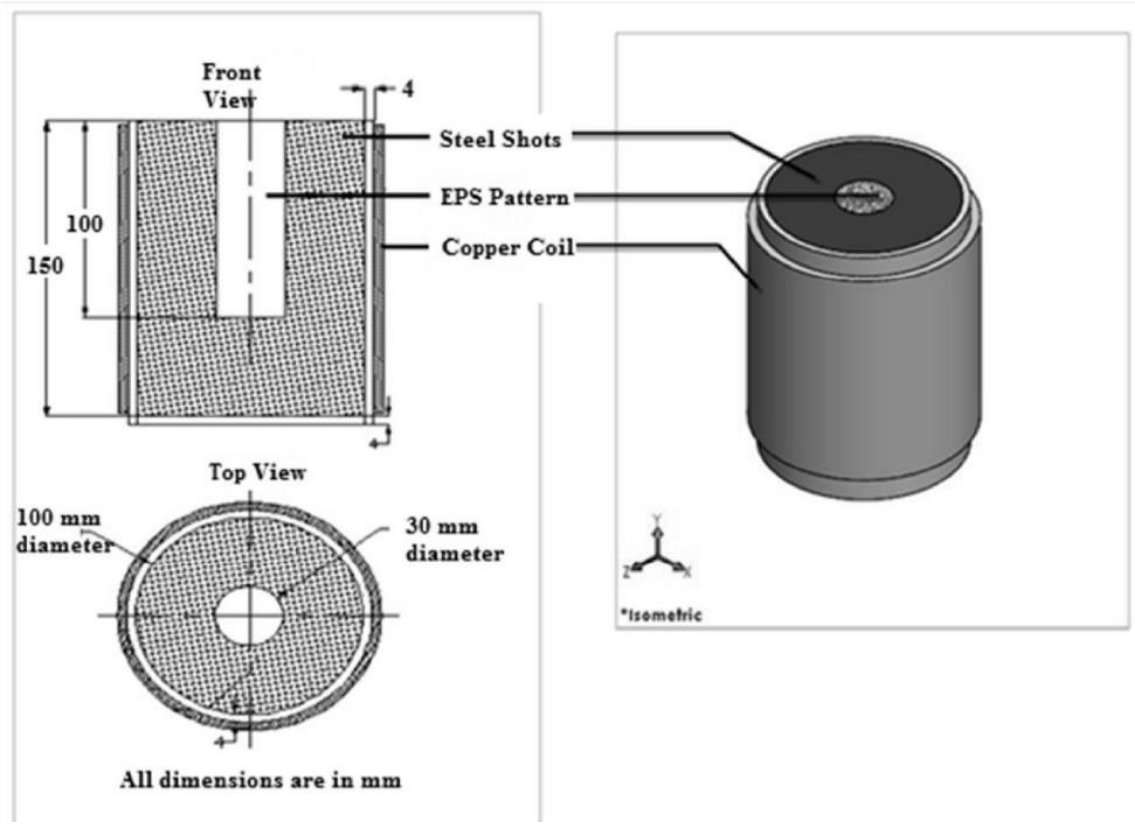

Figure 19: Magnetic Moulding setup

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MS5: Coated Abrasive Disc Manufacturing Unit

Description of Technology:

Resin coating head, electrical grain propulsion unit, flexing unit, curing ovens and performance evaluation machine

Status of Development

Equipment commissioned. Process established. Can be offered for customer requirements.

Possible area of usage:

Any abrasive manufacturer can use this facility for trying out small quantities of new product formulations in Coated abrasive discs.

Images with Description:

Figure 20: Coated Abrasive Disc Manufacturing Unit

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MS6: Polymer composite fabrication facility

Description of Technology:

Equipment for manufacturing composites by Hand layup technique. Process comprises of stacking alternative layer of fibers, sprayed with resin, one over the other and subjecting to consolidation. A compression load of 5 kN is used for the composite fabrication.

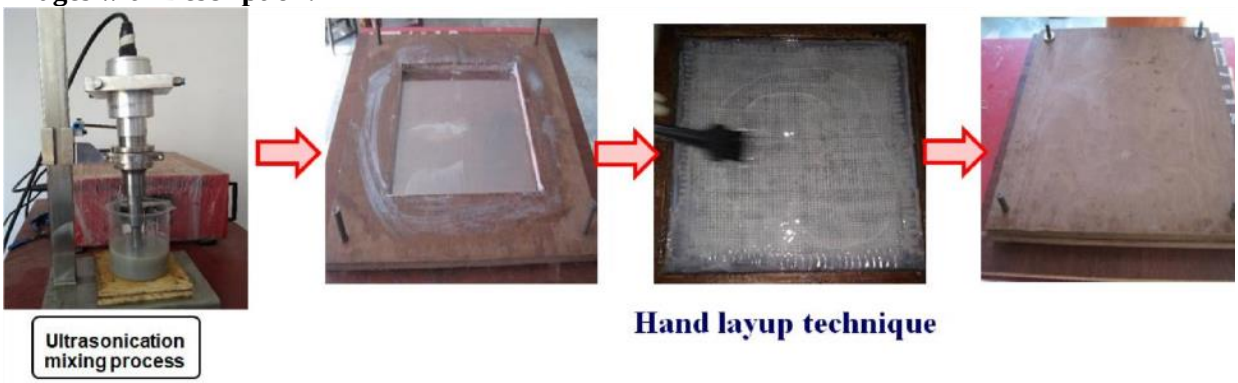
Status of Development

Process established. Can be offered for customer requirements on laminate basis. 300 mm x 300 mm size, thickness 4 to 6 mm

Possible area of usage:

Can be used to prepare hybrid and natural polymer composite samples in polymer matrix like-epoxy, vinyl ester and polyester. This technology is very useful for the development of new polymeric materials by using natural fibers and fillers as reinforcement materials.

Images with Description:



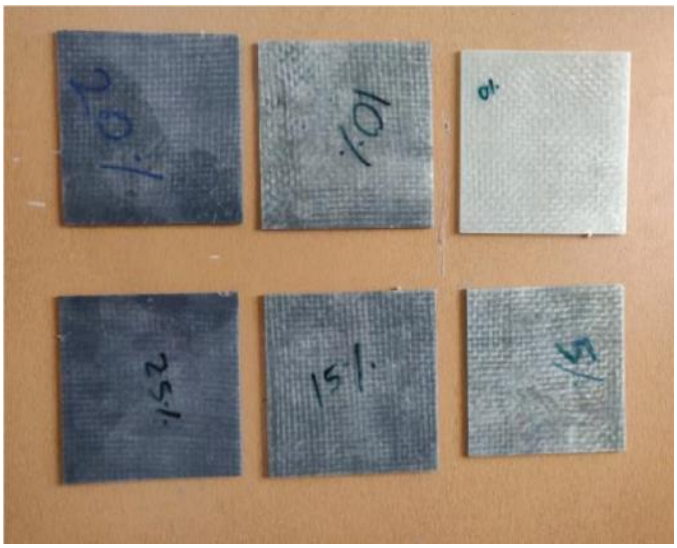


Figure 21: (TOP) Methodology for composite fabrication (BOTTOM) Composite slabs

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PS1: Cryogenic cooling unit – for hard to cut materials

Description of Technology:

The liquid nitrogen jet has been used mainly to target the heat generation zones and to protect the wear of the cutting tool which enable better tool life and quality surface.

Status of Development

Process established for machining of hard-to-cut materials.

Possible area of usage:

Cryogenic cooling with its excellent cooling abilities and environment friendliness is used to reduce cutting zone temperature in machining of hard-to-cut materials and thereby improve the machinability characteristics. Can be attempted for machining of any difficult to machine materials.

Images with Description:

Figure 22: Cryogenic cooling unit for hard to cut materials.

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PS2: Thermal Storage Employing Phase Change Materials

Description of Technology:

The system developed is basically a heat exchanger capable of storing heat or cold energy through the cyclic melting/freezing of materials called Phase Change Materials (PCMs). PCMs are available at different melting temperatures. Hence, the system can be customized to operate under any required temperature in the range minus 40 to 800 deg C. Ice, Water, Inorganic salts, Organics like paraffins, eutectic mixtures and fatty acids are best examples of PCMs.

Status of Development

Three prototypes have been built and tested successfully in the department for thermal storage. The potential to scale up for real time industrial applications is high.

Possible area of usage:

Can be deployed as Waste heat recovery systems in industries, process heating, thermal management in utilities, electronic cooling, building cooling, energy storage, cold storage in Refrigeration and Air conditioning applications, etc.

Images with Description:

Figure 23: Thermal Storage using Phase Change Materials

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PS3: Quenching in Carbonaceous Medium (CNT/Graphene Nanofluids)

Description of Technology:

Quenching is done using nanofluids (fluids suspended with nanoparticles at very low concentration). This leads to enhanced heat transfer rates.

- Higher hardness can be achieved.
- Quenched parts get thin coating (few microns) of carbon. • Better wear properties can be expected.

Status of Development

Heat transfer rates with nano fluids can be estimated for any given product – heat treatment cycle. Heat transfer rates during quenching in CNT and Graphene nanofluids have been estimated through inverse heat conduction method with the experimentally measured time-temperature data as input. The highest peak heat flux values observed for 0.25wt% Graphene nanofluid is 5.89 MW/m^2. This is 83% higher than that in 0.5wt% CNT nanofluid and 126% higher than that in water.

Possible area of usage:

Manufacturing industries involved in production of Gears, Sprockets and other such power transmission parts, can re-set their quenching process by attempting CNT nanofuids.

Images with Description:

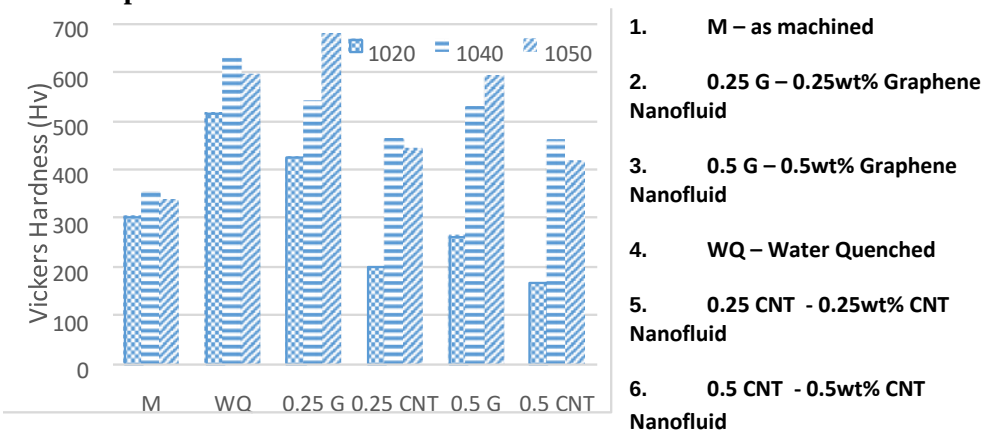

Figure 24: Effect of Quenching in Carbonaceous Medium

As compared with WQ, the hardness of 1020 steel decreased in case of 0.25G followed by 0.5G. Similar trend can be seen in cases of 0.25 CNT followed by 0.5 CNT. Compared to CNT cases, quenching cases of G are better, but still lower than water quenching. But with AISI 1040 steel, the hardness values of 0.25G or 0.5G are slightly lower than that of WQ. The hardness values of 0.25CNT or 0.5CNT are much lower than that of WQ or G cases of quenching. However, there is an increase in the hardness of 1050 quenched in 0.25G or 0.5G cases as compared to WQ

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PS4: Finite Element Analysis of the Machining of Metals, Alloys and Composites

Description of Technology:

In depth finite element analysis of turning, drilling and milling process with metals, alloys and composites can be done.

Status of Development

Process well established for studying the machinability, cutting forces, tool wear, friction and flow stress in the turning, drilling and milling of AISI 1045, AA6082 - T6, Ti6Al4V, AISI 316 L, Inconel 718, Al 2024 T 351, hastelloy, A356/SiCp, A359/SiCp, GFRP, CFRP. Studies ongoing in Titanium and Magnesium based Metal Matrix Composites. Both experimental as well as finite element analysis have been well established and several finite element models have been optimized for the analysis. The developed Finite element model doubles up as an excellent prediction tool for advanced cutting conditions

Possible area of usage:

Finite element analysis is a cost friendly and time effective process that Industries can leverage to analyse the machining characteristics of a wide range of material groups for a wide range of cutting conditions. This robust tool reduces the design cycle time and manufacturing lead time, thereby bringing the product to market faster.

Images with Description:

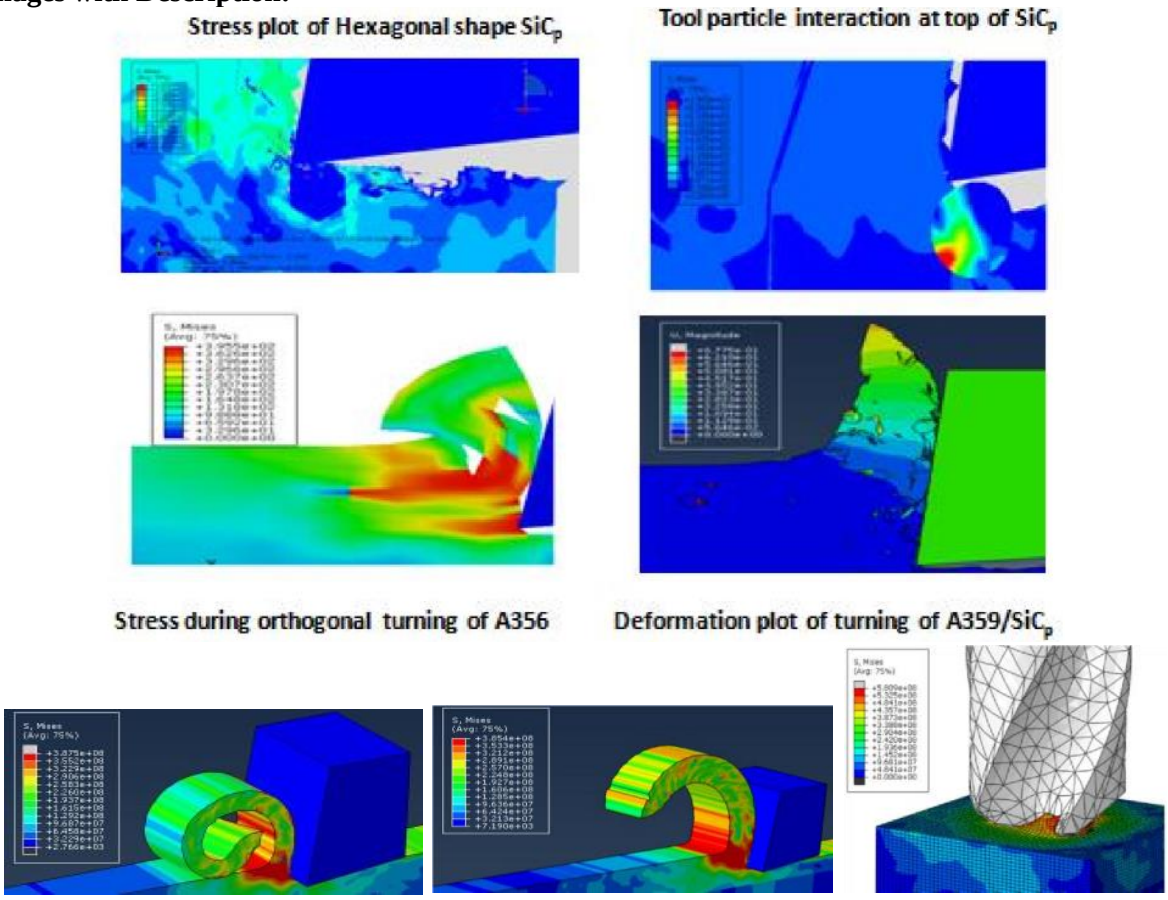

Figure 25: 3D FE stress distributions for various materials

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PS5: Reclamation of abrasive grains from spent grinding wheels

Description of Technology:

One third of the grinding wheel, which is used for clamping, is wasted as scrap. Due to exposure to high temperature during grinding wheel manufacture, these grains get toughened and hence can be used as value added material in Resinoid and Coated applications, in place of BFRPL (Blue fired grains). Centre for Product Development at SSN College of Engineering has developed technology to optimize grain regeneration and to use it beneficially in Coated / Resinoid products.

Status of Development

Process established. Grains recovered and used successfully in Coated and resinoid grinding wheel products as value added product.

Possible area of usage:

Any user industry can consider generating abrasive grains from their used grinding wheels. It is possible to develop applications for internal consumption of these recycled grains.

Images with Description:

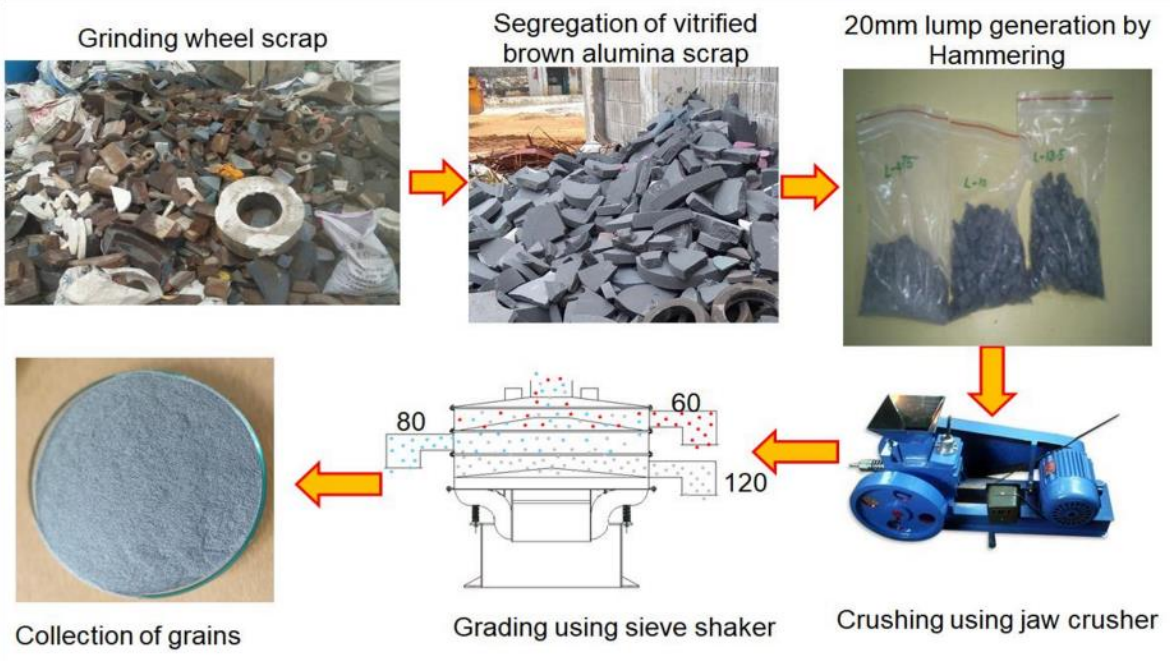

Figure 26: Process of grain recovery

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PS6: Size conversion of used coated abrasive discs.

Description of Technology:

Coated Abrasive discs of fibre backing are mostly used at the edges. The discs are disposed of, even if the inner portion has fresh unused grains. The fibre backing is vulcanized and hence creates pollution issues. By trimming the used disc and removing the outer used edge, the remaining disc of lesser diameter (next usable diameter) can be generated. This will solve pollution problem by extended life of disc. It also saves cost by enabling using the unused grains of the inner portion of the disc. Because of the size and the presence of abrasives, normal punching does not work effectively. The new developed process ensures proper cutting without edge fraying.

Status of Development

Centre for Product Development at SSN College of Engineering has developed technology and a simple machine that can be used for size conversion of used discs. Any number of used discs can be converted to next usable diameter.

Possible area of usage:

User industries can get their used discs converted to next usable diameter and save cost / reduce pollution.

Images with Description:

The used disc, the relieved portion and the next usable diameter disc.

Figure 27: Figure showing original disc, recovered disc and trimmed edge

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CS1: C-RING TYPE STRESS CORROSION CRACKING SETUP

Description of Technology:

It consists of

- Proof Ring made up of EN-24 material hardened to 40 RC values. (range 1 ton)
- Load Cell (range 1 ton)
- Displacement transducer (range 0-10 mm)
- Digital Load and LVDT indicator (range 1 ton) and
- Corrodent container made of Perspex.

The container has holes at the bottom surface of the container for the entry of specimen grippers. 'O' ring is provided for water sealing. The specimen is fitted inside the container. The specimen holder passes from the bottom of the container. Two No's of 3/8 inches brass nipples plated is provided for circulation of Corrodent solution

Status of Development

Equipment established and ready to use.

Possible area of usage:

- Can be used to study the stress corrosion cracking behaviour of metals.
- To quantify the conditions under which environmentally assisted crack extension can occur in terms of the threshold stress intensity for SCC, KISCC and Kinetics of crack growth.
- The experimental data obtained can be used for design of life prediction purposes in order to ensure either that the stress within large structures are insufficient to promote the initiation of SCC at whatever pre-existing defects that may by present or the amount of crack growth which would occur within the design life or inspection periods can be tolerated without risk of unstable failure.

Images with Description:

Figure 28: Stress Corrosion Cracking Setup

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CS2: Intergranular corrosion test rig

Description of Technology:

In accordance with ASTM standards of corrosion testing.

Status of Development

Equipment available. Process established. Can be offered for customer requirements on need basis.

Possible area of usage:

Can be used to carry out intergranular corrosion tests in dissimilar and similar GTAW,GMAW and solid state weldments.

Images with Description:

Experimental setup for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

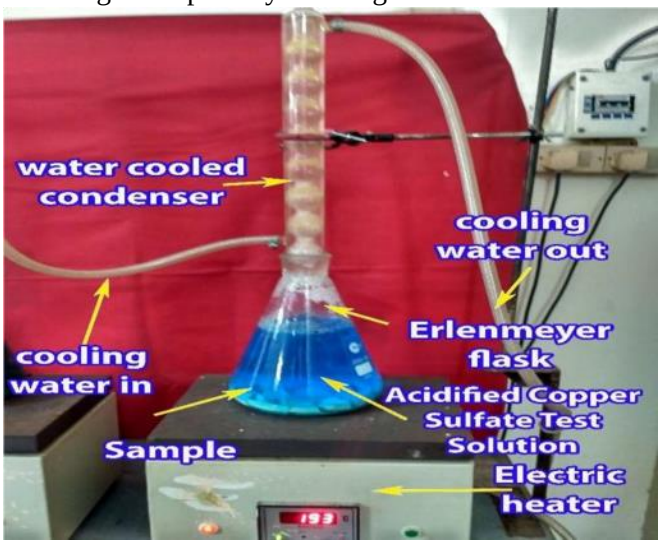

Figure 29: Intergranular Corrosion Test Rig

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CS3: Noise and Vibration testing

Description of Technology:

Equipment consists of Triaxial Accelerometer, Vibration Analyser with DAQ, Vibration exciter, Noise Measurement and force transducer. The sensors can be mounted on the desired testing place. Noise, Vibration and Harshness levels and characteristics can be analysed.

Status of Development

Equipment available. Process established. Can be offered for customer requirements on need basis.

Possible area of usage:

Can be used in Static and Dynamic systems to identify Natural frequency, Mode Frequency, Damping, force exerted and noise level. Suitable for Automotive industry, Power plant, rotary and dynamic applications, for understanding and minimizing vibrations.

Images with Description:

Figure 30: Mixer being tested for vibrations

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CS4: Ballistic impact testing set up

Description of Technology:

The equipment can be used to measure the impact energy absorbing capability of thin plates (metal sheets and composite targets)

Status of Development

Both inlet and exit velocity of the projectile can be measured. The exit velocity of the projectile will be measured by using "Caldwell Ballistic Precision Chronograph".

Possible area of usage:

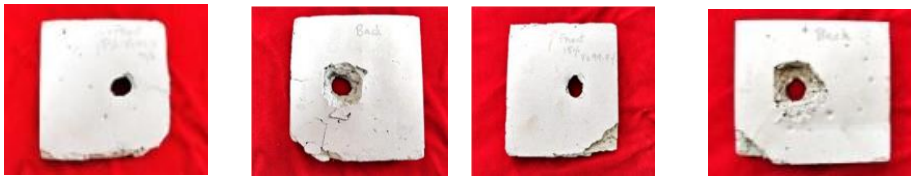
The facility can be used by all Auto Manufacturers to measure the low velocity ballistic impact of car floor and glass materials.

Images with Description:

The gas gun set up shown in Left and middle of figure below consists of air compressor, gun barrel, target holder and a velocity measurement system. The compressed air is used to trigger the projectile. The projectile penetrates the target and the exit velocity of the projectile is measured. In addition depth of penetration of the projectile on to the target can also be measured. Metal and composite samples of thickness less than 3 mm can be tested up to a projectile speed of 100m/s. The exit velocity of the projectile can be measured using ballistic chronograph device as shown on the right in the figure below.

Figure 31: (LEFT) Gas Gun Setup with compressor (MIDDLE) Gas Gun Setup (RIGHT) Ballistic Chronograph

Using the setup, several attempts have been made to determine the ballistic impact behaviour of Aluminium metal foam targets. The variation of inlet and exit velocity of the projectile provides the ballistic performance of the targets. The tested samples are shown below.



5 % porosity: front face 5 % porosity:rear face 15 % porosity:front face 15 % porosity: rear face

The set up can also be used to determine the ballistic performance of light weight composite materials which are being used car bodies and floors. In addition, the set up can also be used to determine the ballistic performance of light weight body armours. Using this facility several research works are being carried out to determine the ballistic performance of nano powder (CNT and Graphene) intruded composite targets.

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CS5: Crack initiation and growth analysis of mechanical components using Extended Finite Element Method (XFEM)

Description of Technology:

In this concept, crack initiation and propagation phenomenon can be predicted using A standard Finite element method code Abaqus.

Status of Development

The concept of XFEM is ready to be used. Already the concept has been verified in a turbine blade analysis.

Possible area of usage:

The concept of XFEM can be used to predict the residual life of the turbine blade in any existing designs. In addition the concept can also be used in automotive industries to predict the residual life of automotive components.

Images with Description:

In general extended finite element method (XFEM) is a numerical method that enables a local enrichment of approximation spaces. The enrichment is realized through the partition of unity concept. The method is useful for the approximation of solutions with pronounced non-smooth characteristics in small parts of the computational domain, for example near discontinuities and singularities. In these cases, standard numerical methods such as the FEM or FVM often exhibit poor accuracy. The XFEM offers significant advantages by enabling optimal convergence rates for these applications. In the present concept, XFEM has been used to predict the crack initiation and propagation life of the turbine blade has been carried out. The modeling and meshed images of the turbine blade are shown in the following figures. The major steps in XFEM crack analysis are specification of crack domain, crack propagation initial crack location, definition of enrichment radius, contact interaction property, damage initiation and analysis procedure.

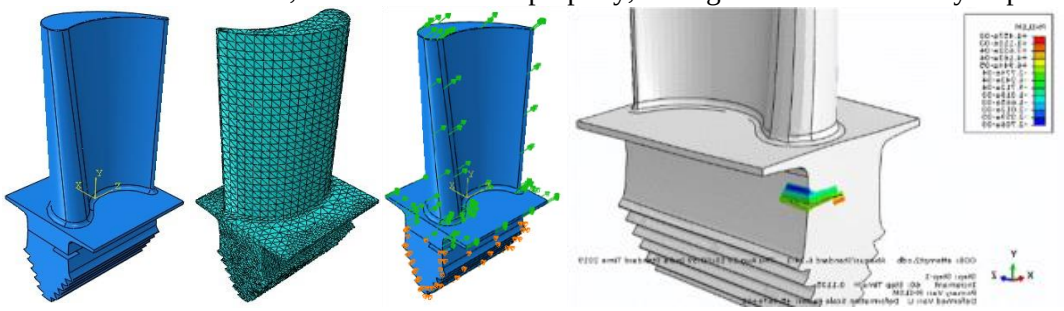

Figure 32: XFEM Crack Initiation and propagation studies on gas turbine blade model

In addition, the concept can also be used to determine the number of defects in a structure when subjected to static and dynamic loading. Based on the defects, the residual life of the components can be determined. The other approaches to predict the fracture behaviour are contour integral approach and Elastic Plastic Fracture Mechanics approach. This XFEM approach of defect initiation and propagation can be used in a better way for automobile components and aero engine components.

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RS1: TurtleBot3 Waffle Pi with Intel AAEON UP Board & Real sense tracking camera T265

Description of Technology:

Sturdy despite its small size, TurtleBot3 Waffle differs from its Turtlebot3 "Burger" cousin in its flattened format making it look like a waffle, as its name indicates. You can upgrade it with just about everything you can imagine: a robotic arm, servos, an embedded computer. The TurtleBot3 Waffle can move a payload of up to 30 kg (versus 15 kg for the Burger version) at a slightly faster translational velocity. Above all, it is equipped with the 3D Intel® Realsense™ R200 camera module, on top of all the items already found in the TurtleBot3 Burger

Status of Development

Equipment available and could be offered for customer requirements on hourly basis.

Possible area of usage:

Mobile robotics, navigation, path planning, obstacle avoidance, SLAM

Images with Description:

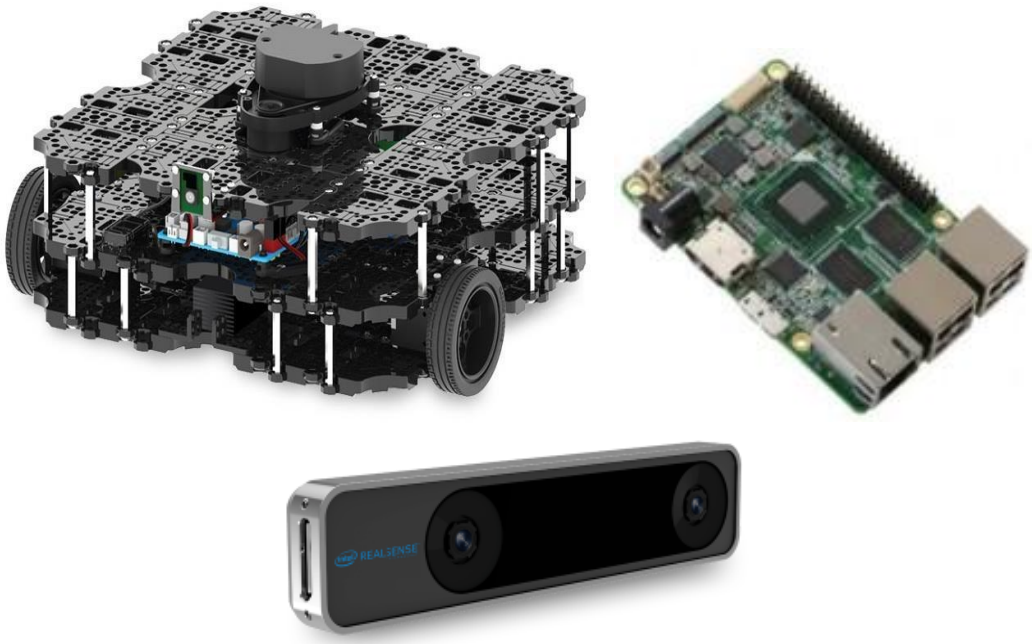

Figure 33: TurtleBot3 Waffle Pi with Intel AAEON Up Board and tracking camera

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RS2: TurtleBot3 Burger with RM-X52-TNM & Real sense depth camera D435i

Description of Technology:

The TurtleBot3 platform is modular, compact, open-source and completely customizable developed in collaboration with OpenRobotics and Intel. RM-X52-TNM is a compact version of OpenManipulator based on ROS. It has a high payload as DYNAMIXEL XM-430 model is applied. Easy to use with PC or mobile platform such as TurtleBot3 Burger/Waffle-Pi with provided source code and development environment. You can freely select and use either a PC or Controller e.g. OpenCR

Status of Development

Equipment available and could be offered for customer requirements on hourly basis.

Possible area of usage:

Mobile robotics, navigation, path planning, obstacle avoidance, SLAM

Images with Description:

Figure 34: TurtleBot3 Burger with Depth Camera

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RS3: e-puck v2.0

Description of Technology:

e-puck2 is the latest mini mobile robot developed in 2018. This is an evolution of the successful e-puck robot used in many research and educational institutes. Now with WiFi and USB link & charge. e-puck2 is compatible with its predecessor but is powered by an STM32F4 microcontroller and features a larger number of sensors: IR proximity, sound I/O, 9x IMU, ToF distance sensor, camera, USD storage. The robot is a full system with USB hub, debugger/programmer, WiFi module.

Status of Development

Equipment available and could be offered for customer requirements on hourly basis.

Possible area of usage:

Mobile robotics, navigation, path planning, obstacle avoidance, SLAM

Images with Description:

Figure 35: e-puck v2.0

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RS4: NI myRIO with Pitsco TETRIX PRIME bundle

Description of Technology:

NI myRIO robotics bundle with battery, charger & USB Camera for performing experiments on mobile robots of various configurations.

Status of Development

Equipment available and could be offered for customer requirements on hourly basis.

Possible area of usage:

Mobile robotics, navigation, path planning, obstacle avoidance, SLAM

Images with Description:

Figure 36: Ni myRIO

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HRS1: Skills and Areas of Expertise of Faculty

Product Design:

- Designing and developing robots for specific applications. (Dr.G.Satheeshkumar)
- Analysing the vibration in equipment and enabling redesign for ergonomics. (Dr.M.S.Alphin)
- Analysing forces on digital models of material handling structures. (Dr.S.Sureshkumar)
- Machining of complex shapes by wire cut EDM (Dr.G.Selvakumar)

Energy

- Identifying energy saving opportunities in industrial processes. (Dr.N.Lakshmi Narasimhan)
- Designing , selecting and developing cooling systems based on specific requirements of air conditioning /cold storage. (Dr.M.Suresh)
- Checking engine performance at various load conditions . (Dr.S.Rajkumar)

Process Improvements:

- Studying any industrial welding process for improvement / defect reduction, optimization / conversion to non-polluting Friction Stir Welding. (Dr.S.Koteswara Rao)
- Evaluating materials for their corrosion properties. (Dr.A.K.Lakshminarayanan)
- Developing composites suitable for specific applications.(Dr.K.Rajkumar)
- Investigations on Machining of Composite Materials using FEM (Dr.K.S.Vijaysekar) • Estimating the crack initiation propagation behavior in materials and components (Dr.S.Sureshkumar)
- Scientific analysis of waste and identifying opportunities for recycling / value addition (Dr.V.E.Annamalai)

Faculty with Industry Experience:

- Dr.V.E.Annamalai: 16.5 years as Head - R&D in Murugappa Group (VP Technology). Was in charge of product development, quality and process improvements. Has an overall picture of approaching process improvements in industry. Experienced in Waste Reduction / Waste Management Strategies.
- Dr.M.Suresh – around 7 years in refrigeration and air conditioning industry. Awarded Diploma in Carrier System Design Course for Packaged Air conditioning Equipment by United Technologies, Carrier-Asia Pacific Operations. Worked in various positions as R&D manager, lead engineer and job engineer in the following projects executed by ELGI, John Brown, Dalal and IDEA:
  - Design, Development of oil free air screw compressors at ELGI equipment ltd., Coimbatore
  - Additional Compressor Module at HRC process platform, Mumbai
  - BHN process platform revamp project, Mumbai
  - Diesel hydro 45esulphurization project (DHDS), Vizag.
  - Offsite and utilities plant, Dubai
  - Water treatment chemical plant, Bangalore
  - Maleic anhydride plant, Malaysia
  - Neemazal plant, Cuddalore
  - 12.8 MW WHR power plant, Durg, Madya Pradesh
  - PE II Plant, Hazira
- Dr. Anirudh V. K.: 3 years doing engineering simulations and analysis for the oil and gas industry at FMC Technologies India Pvt. Ltd. (Now TechnipFMC). Was in charge of carrying out structural and thermal simulations in ANSYS for the manifold and pipeline systems group based out of Houston, Texas.

For any of the above requirement, contact: vijaysekarks@ssn.edu.in or call +91 99403 16158