

वार्षिक रिपोर्ट

ANNUAL REPORT

2022-2023



Municipal Solid Waste
Disposal System



Mob Control Vehicle



Mechanized Drain
Cleaning System



Council of Scientific & Industrial Research
CENTRAL MECHANICAL ENGINEERING RESEARCH INSTITUTE
DURGAPUR-713209, WEST BENGAL, INDIA

वार्षिक रिपोर्ट

ANNUAL REPORT 2022-2023

With Best Compliments From

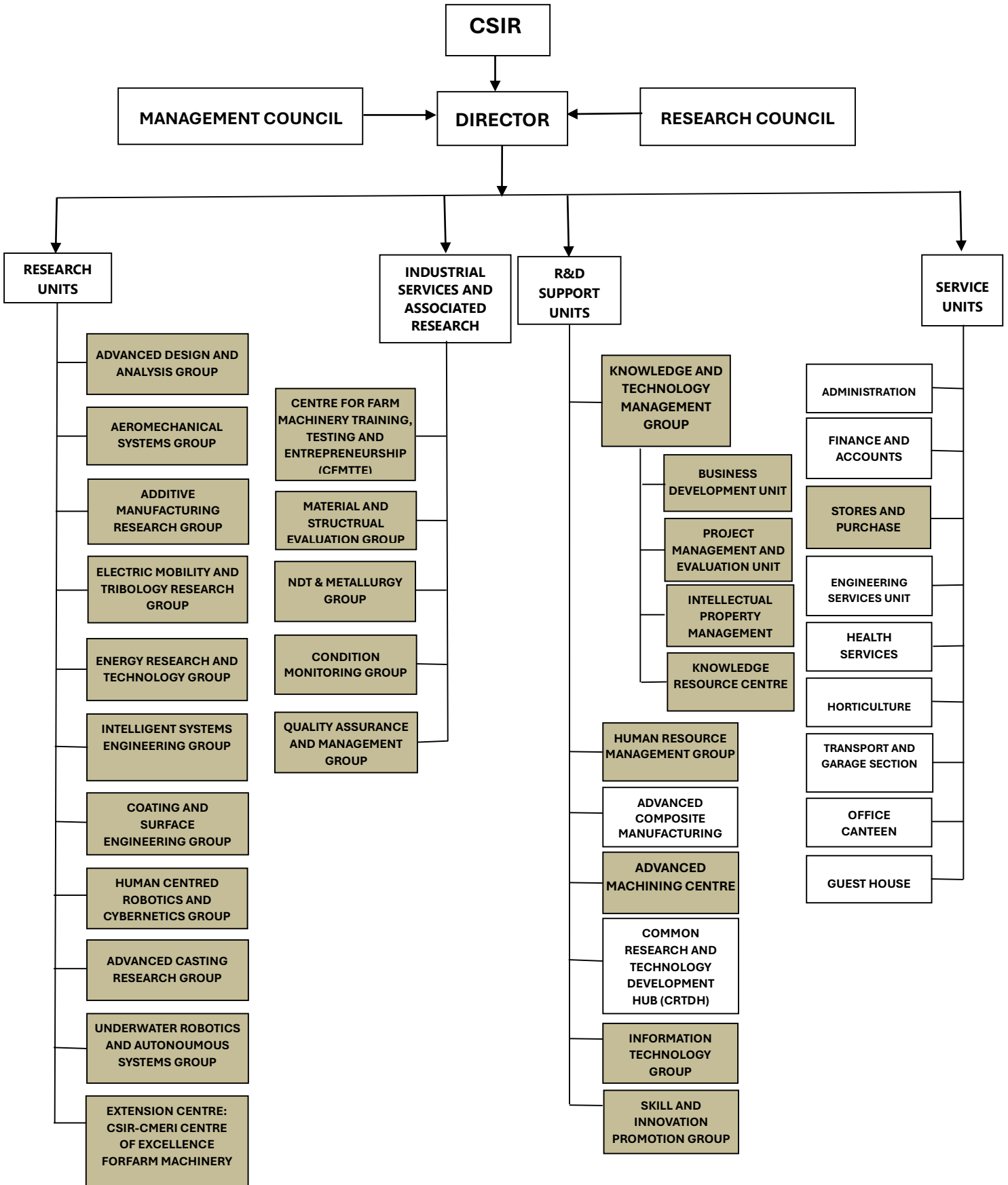
Prof. Naresh Chandra Murmu
Director

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सीएसआईआर - केंद्रीय यांत्रिक अभियांत्रिकी अनुसंधान संस्थान
CSIR - Central Mechanical Engineering Research Institute

ORGANIZATION CHART



Shaded Groups / Centres / Units are under purview of ISO 9001:2015 Certification



VISION

- To emerge CSIR-CMERI as the Key Technology Provider to the Nation in Mechanical Engineering & Allied Areas by 2030 & Play central role in Innovation process in Indian Industry & Socio-Economic development of Country.



MISSION

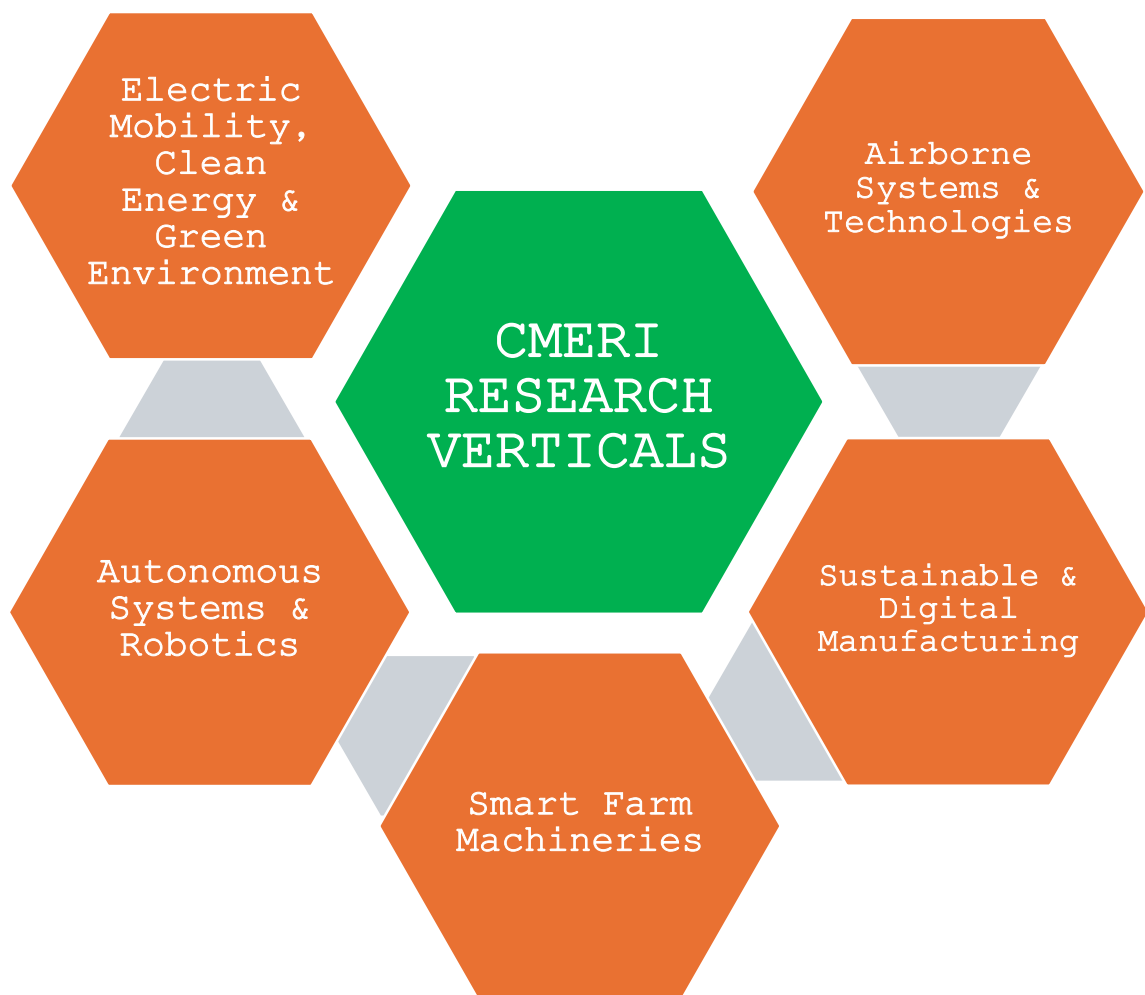
- Focusing on the applied research, creating economic value, transforming original ideas into innovation, that boost the competitiveness of Indian industry and the well-being of Indian society in a sustainable way.
- Emphasizing on the interdisciplinary research and trustworthy partnership with Industries that foster synergies and strengthen the innovative capacity with the aim for impact together with the stakeholders.
- Focusing on the professional and personal development of the Scientist, Technical Staffs & other Support Staffs who shape the future of the institute.



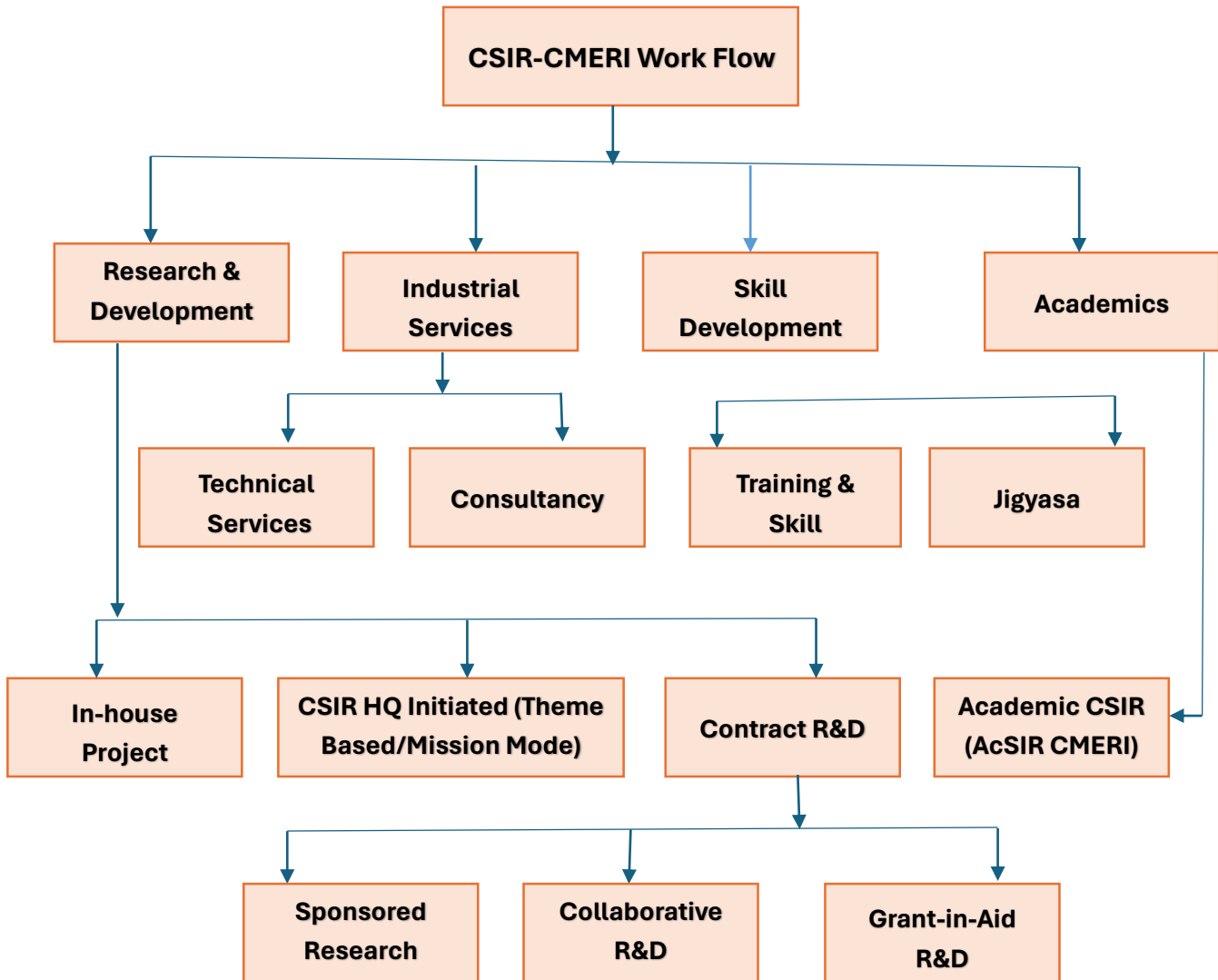
MANDATE

- Carrying out research and development in relevant areas of national priority as evolved by bodies concerned with the overall planning for science and technology in the country.
- Undertaking R&D sponsored by public/ private sector industries in consonance with national priorities.
- Undertaking R&D directed towards continuous improvement of indigenous technology.
- Undertaking R&D for evolving new technologies relevant to the country's social, economic and industrial needs in keeping with national objective of self-reliance.
- Undertaking R&D on appropriate and alternate technologies, with emphasis on the use of local resources.
- Ensuring continuous flow of finance and resources through extension of R&D services for fostering basic research at the institutional level.
- Undertaking activities focused towards fast translation of laboratory level technologies to commercial entities through proper nurturing and marketing.
- Undertaking on a routine basis effort for identification of R&D requirements of industries for rapid intervention through the extension of R&D services.

CMERI MAJOR RESEARCH VERTICALS AND CORE COMPETENCIES



CMERI ACTIVITIES PROFILE



RESEARCH COUNCIL

1	Prof. M. S. Unnikrishnan, Thermax/Indian Institute of Technology Powai, Mumbai	Chairman
2	Dr. N. Kalaiselvi Director CSIR-Central Electrochemical Research Institute Karaikudi – 623 006	Sister Laboratory
3	Dr. Suman Kumari Mishra Director CSIR-Central Mechanical Engineering Research Institute Mahatma Gandhi Avenue, Durgapur – 713 209	Member
4	Prof. B. K. Mishra Director Indian Institute of Technology Farmgudi, Ponda- 403 401, Goa	Member
5	Dr. Debasis Chakraborty Director Centre of Propulsion Technology (DRDO), IITB, Mumbai	Agency Representative
6	Dr. Leena Vachhani Associate Professor Department of Systems and Control Engineering IIT Bombay, Powai, Mumbai – 400 076	DG's Nominee
7	Shri Anoj Kumar Chadar Principal Scientist Director General Executive Directorate CSIR, Rafi Marg, New Delhi – 110 001	CSIR Hqrs. Invitee
8	Prof. Avinash Agarwal Department of Mechanical Engineering IIT, Kalyanpur, Kanpur- 208016	Member
9	Dr. Suman Chakraborty Department of Mechanical Engineering, IIT, Kharagpur- 721 302	Member
10	Dr. Srinivasan Duraiswamy Vice- President & Head New Technology Business Development Reliance Corporate, Park Building No – 8 A wing, 1st Floor CA-35 Thane Belapur Road, Ghansoli, Navi Mumbai – 400 701	Member
11	Dr. Lipika Dey Principal Scientist Tata Consultancy Services, New Delhi	Member
12	Dr. S.R. Debbarma Sr. Principal Scientist CSIR-CMERI Durgapur – 713 209	Secretary

MANAGEMENT COUNCIL

1	Dr. Suman Kumari Mishra Director CSIR-CMERI Durgapur - 713209	Chairman
2	Dr. Anjali Chatterjee Chief Scientist CSIR-CMERI Durgapur- 713209	Member
3	Dr. Biswajit Ruj Chief Scientist CSIR-CMERI Durgapur- 713209	Member
4	Dr. Arpita Mukherjee Principal Scientist CSIR-CMERI Durgapur- 713209	Member
5	Dr. Binod Kumar Saha Principal Scientist CSIR-CMERI Durgapur- 713209	Member
6	Dr. Ishita Sarkar Scientist CSIR-CMERI Durgapur- 713209	Member
7	Shri. Pranabendu Saha Sr. Technical Officer (3) CSIR-CMERI Durgapur- 713209	Member
8	Shri. Parag Patar Controller of Finance & Accounts CSIR-CMERI Durgapur- 713209	Member
9	Shri. Vinod Kumar Controller of Administration CSIR-CMERI Durgapur- 713209	Member-Secretary

MAPPING OF RESEARCH GROUPS

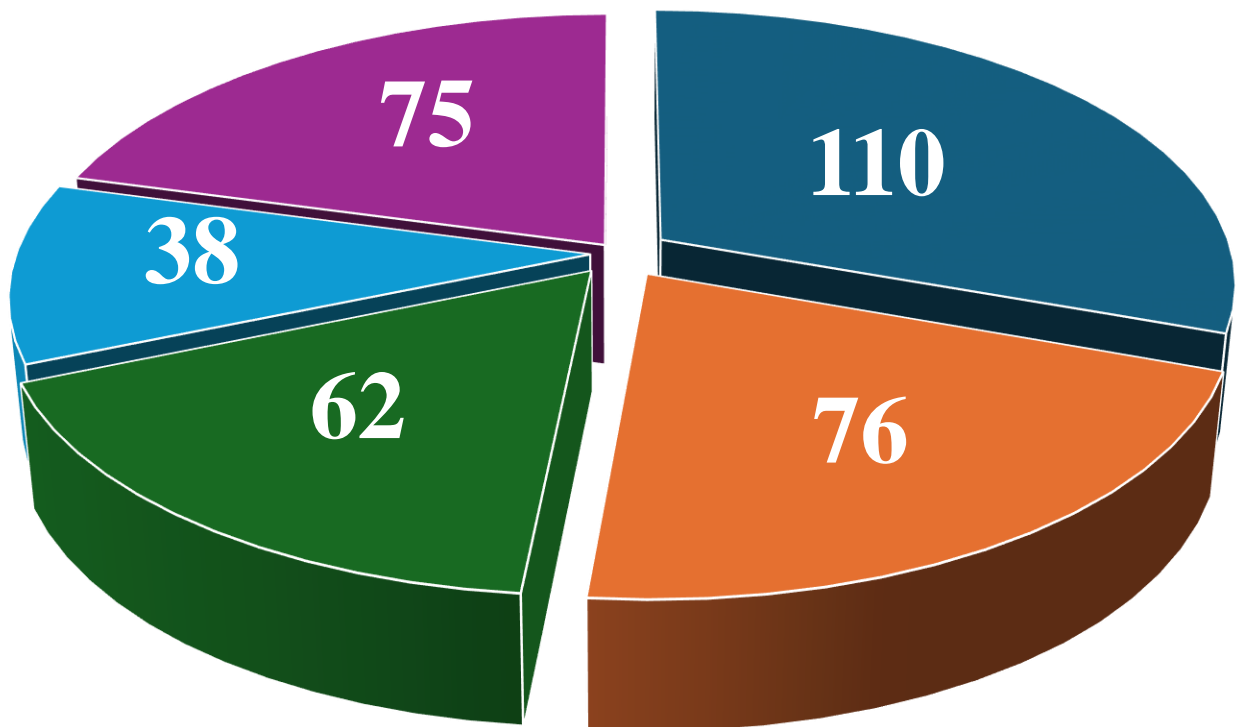
THRUST AREAS	RESEARCH GROUPS
<p>ELECTRIC MOBILITY, CLEAN ENERGY & GREEN ENVIRONMENT</p> <p>Focus: Electrification of Machines & Equipment, H₂ Compression, Storage & Dispensing, Electric Vehicles & Fuel Cell Electric Vehicles Technologies H₂ Fuelled Tractors, Waste to wealth, Carbon Sequestration</p>	<ul style="list-style-type: none"> ▪ Electric Mobility & Tribology Research Group ▪ Aeromechanical System Group ▪ Energy Research & Technology Group
<p>AIRBORNE SYSTEMS & TECHNOLOGIES</p> <p>Focus: Design and Analysis of Mechanical, Electrical & Hybrid Systems and Components for Aircrafts, UAVs, Missiles & Space Vehicles, Computational and Experimental Fluid Mechanics, Gas Dynamics, Shock and Blast Waves</p>	<ul style="list-style-type: none"> ▪ Aeromechanical System Group ▪ Advanced Casting Research Group ▪ Additive Manufacturing Research Group ▪ Electric Mobility & Tribology Research Group ▪ Coating & Surface Engineering Group

MAPPING OF RESEARCH GROUPS

THRUST AREAS	RESEARCH GROUPS
<p>SMART FARM MACHINERIES & TECHNOLOGIES</p> <p>Focus: Precision Farm Equipments, Farming Automation, Indigenous Farm Equipments/Machines</p>	<ul style="list-style-type: none"> ▪ Centre of Excellence for Farm Machinery (CoEFM), Ludhiana ▪ Advanced Design and Analysis Group
<p>AUTONOMOUS SYSTEMS AND ROBOTICS</p> <p>Focus: Underwater Robots, Autonomous Systems & Ground Vehicles, Inspection Systems, Collaborative Robots & Assistive Devices, Robotics in Healthcare</p>	<ul style="list-style-type: none"> ▪ Intelligence System Engineering Group ▪ Human Centric Robots & Cybernetics Group ▪ Underwater Robotics & Autonomous System Group
<p>SUSTAINABLE & DIGITAL MANUFACTURING</p> <p>Focus: Industry 4.0 in Foundry, Additive & Hybrid Manufacturing, Sustainable AI/ML Driven Manufacturing, Advanced Coating & Surface Engineering, Indigenous Machines</p>	<ul style="list-style-type: none"> ▪ Advanced Casting Research Group ▪ Advanced Design & Analysis Group ▪ Additive Manufacturing Research Group ▪ Coating & Surface Engineering Group



HUMAN RESOURCE INDICATORS



■ Group IV (Scientist)

■ Group II (Technical Support)

■ Administrative

■ Group III (Technical Assistant/Officer)

■ Group I (Support Staff)

MESSAGE FROM THE DIRECTOR



CSIR-CMERI Durgapur has played a pivotal role in catalyzing the Green Revolution in India, epitomized by its historic dedication CSIR-CMERI Durgapur has played a pivotal role in catalyzing the Green Revolution in India, epitomized by its historic dedication of the Swaraj Tractor, a product of indigenous innovation, to the nation. Over the years, the institute has evolved into a premier research laboratory renowned for its expertise in Mechanical Engineering and related domains. Notable breakthroughs such as the Suri-Transmission underscore its pioneering contributions to engineering. In recent times, CSIR-CMERI has made significant societal contributions by developing innovative solutions, including a Mechanised Drain Cleaning Vehicle, a robust Municipal Solid and Liquid Waste Management system, and Mob Control Vehicles. Additionally, the institute has been at the forefront of combating the COVID-19 pandemic, leveraging its expertise to develop technologies to prevent the spread of the virus and treat affected patients.

The institute's research endeavors span diverse areas, encompassing Robotics, Additive Manufacturing,

Farm Mechanization, Renewable Energy, Electric Mobility, Aeromechanical systems, Advanced design and Simulation, Tribology, Smart Foundry, NDT, and Condition monitoring. Recognizing the evolving technological landscape, CSIR-CMERI has strategically realigned its research and development orientation to stay abreast of emerging trends such as Artificial Intelligence, Machine Learning, Sustainable Engineered Materials, IoT, and 5G Technology, ensuring alignment with the nation's technological trajectory.

CSIR-CMERI is actively engaged in pioneering research in key technology domains, including Climate Change Deterrence Technologies, such as developing eco-friendly refrigerants, solar cooking solutions, and efficient Municipal Solid Waste Management systems. Moreover, the institute is leveraging artificial intelligence in robotics and automation to develop advanced systems and enhance efficiency and productivity across various sectors. Innovative Farming initiatives integrating big data, cloud computing, and IoT technologies are revolutionizing agricultural practices, while Smart Foundry initiatives are driving innovation in manufacturing processes.

Furthermore, CSIR-CMERI is at the forefront of developing import substitution technologies, ranging from ultra-fast charging Ultra Capacitors to advanced manufacturing processes like extrusion additive manufacturing and Rheo-Pressure die casting. These efforts are complemented by the institute's commitment to providing technical services to industries, skill development programs for unemployed youth, and cutting-edge research facilities for students through CMERI's AcSIR master and doctoral programs.

In addition to its focus on technology development, CSIR-CMERI is actively engaged in research on Electric Vehicles (EVs)/Fuel Cell Electric Vehicles (FCEVs) and Renewable Energy, as well as developing indigenous technologies for societal and strategic sectors. Through its multifaceted research initiatives, CSIR-CMERI continues to be a driving force in fostering innovation and technological advancement for the betterment of society. Consolidating the domestic economy is paramount, given the interconnected nature of the global economy, where any disruption can have far-reaching effects. One of the critical pillars of our national economy is bolstering the industrial landscape, and the Council of Scientific and Industrial Research (CSIR), the parent institution of CSIR-CMERI, is mandated to aid industries through technological interventions. CSIR-CMERI is deeply committed to this task, actively collaborating with various industries with vigor and enthusiasm.

Micro, Small, and Medium Enterprises (MSMEs) are the backbone of the Indian economy, contributing significantly to the national GDP. However, their frequent interactions pose challenges for CSIR-CMERI in providing crucial technological interventions. Additionally, with the depletion of fossil fuels and their detrimental impact on the environment and price volatility, carbon neutrality has become a focal point in national policy. Consequently, CSIR-CMERI has shifted its R&D focus towards cleaner and greener technologies. The vision is to develop clean,

green, and environmentally safe energy systems by 2030, utilizing indigenously sourced materials with strong entrepreneurial potential embedded within them.

Another significant research direction CSIR-CMERI aims to pursue is enhancing national energy security, mainly through the development of Type IV Hydrogen Storage Systems. Breakthroughs in hydrogen storage technology could have manifold implications for the national and global economy. These initiatives collectively are envisioned to substantially impact the Atma Nirbhar Bharat campaign by boosting import substitution and export promotion and significantly improving GDP and international trade.

Furthermore, CSIR-CMERI intends to inspire its Scientific Human Resources to contribute tirelessly towards fortifying the institute's Intellectual Property Portfolio. This can only be achieved through the dedication of scientists to enhance the average impact factor for every accepted publication from the institute. Moreover, expanding awareness of CSIR-CMERI's cutting-edge activities through interactions with industry members, entrepreneurs, and youth is crucial. Enhanced lab visits, interactions with scientists, and a strengthened knowledge dissemination mechanism utilizing digital and social media platforms, seminars, and conferences will further bolster the institute's outreach efforts.

In conclusion, the vibrant CSIR-CMERI community, comprising scientists, technical and administrative staff, students, and other contractual staff, is called upon to uphold the eminence of the institution. With the support of its young and dynamic workforce, CSIR-CMERI is poised to emerge as a key technology provider in Mechanical & Allied Areas by 2030. It will play a central role in the innovation process, driving industrial and socio-economic development in the country. The vision is to establish "Brand CMERI," synonymous with reliability, efficiency, performance, and novelty, aligning with the Hon'ble Prime Minister of India's vision of 'Make in India! Make for the World!'

**- Prof. Naresh Chandra Murmu
Director, CSIR-CMERI**

RESEARCH HIGHLIGHTS

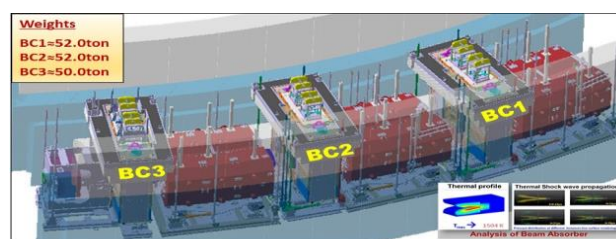
The CSIR-CMERI Durgapur has developed three innovative mob control vehicles (MCV) to provide modern technical support to paramilitary forces deployed in maintaining law and order and internal security operations. They are categorized as tractor-based, medium, and heavy and are claimed to be the first-of-its-kind advanced indigenous designs manufactured in the country. All three categories of MCVs were demonstrated to the Ministry of Home Affairs (MHA) Committee members twice at CRPF-campus Gurugram in December 2021 and 103 Bn CRPF-RAF campus in January 2022.

The tractor-based MCV is built on a 90 HP industrial tractor. It has an SS 304 wire mesh shield, a PTZ camera, and an LED flood light. Medium Category MCV has a payload capacity of 2.5 tons with 8+2 troop carrying capacity. It has 7 Core technology modules. The heavy Category MCV has a payload capacity of 7.5 tons with 8+2 troop carrying capacity. It has a maximum of 9 Core technology modules.



The heavy Category MCV has height adjustable front shovel, retractable protective front shield, all-round irritant spray system, foam spray system and tear smoke munitions system, cabin pressurization system, retractable multi-barrel tear gas launcher with appropriate electronic vision systems, wide-angle surveillance, multi-channel video transmission system, GPS tracker and GPS navigator.

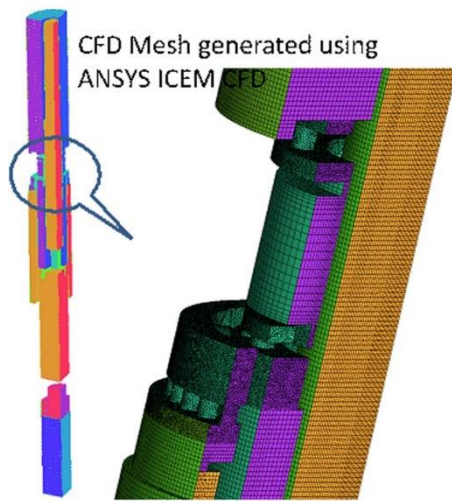
CSIR-CMERI was involved in the Design of Beam Stoppers for Super-FRS in the FAIR project, one of the significant In-kind contributions from Govt. of India to FAIR (Facility for Antiproton and Ion Research), which is coming up at GSI, Darmstadt, Germany. Indigenous development of such high-power beam dumps (stoppers) will enhance the field of accelerator technology and empower Indian manufacturers to compete globally in this field to cater to the requirements for Global mega-science projects.



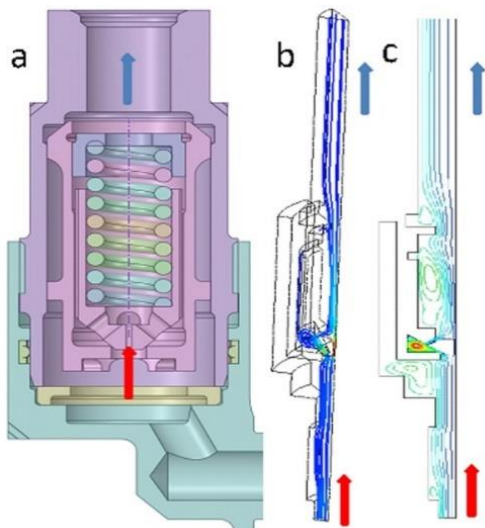
Landing gears play a crucial role in the dynamic stability of any aircraft. The nose wheels of the landing gear (NLG) are subjected to strong ground forces during take-off, taxiing, and landing, which can cause unstable coupled oscillations (shimmy). When an aircraft reaches the critical velocity, small motions may become unstable and grow in amplitude due to a certain combination of parameters such as inertia, elastic properties, damping, geometry, speed, excitation forces, and nonlinearities due to friction and backlash.

The shimmy phenomenon is common in nose wheel steering (NWS; two free-running wheels mounted co-axially on both sides of the strut) systems. However, the problem is prone to growing larger, causing discomfort and unsafe to passengers if left unattended. The solution to the problem is attainable through an extensive analysis of the system comprising many structural elements, Linkages, Gears, hydraulics, and Electro-hydraulic servo Controls using modern analytical software

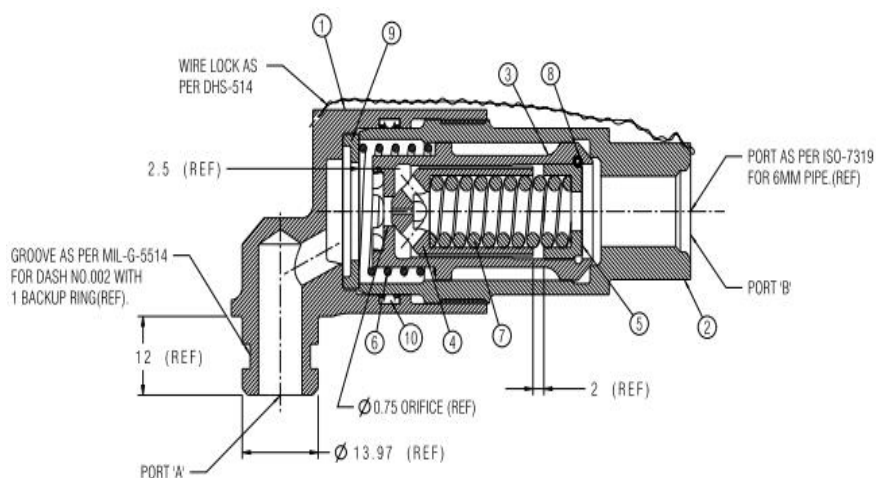
techniques. The modeling of such systems is highly complex, challenging, and time-consuming.



The CSIR-CMERI performed the stability analysis of the Light Combat Aircraft (LCA) NLG System with associated hydraulics by building an analytical model of the various subsystems, including the hydraulics, and simulating the working of the systems using advanced software. This model can exhibit the hydraulic system's behavior, including the rack & pinion set and its linkages. The effect of various free play levels on the pressures has been quantified, as well as the effects of change of strut ID, piston OD, and variations in the cam profile. The generated hybrid CFD mesh of ole pneumatic strut using ANSYS ICEM CFD software, the sectional view of the shimmy valve (a), Three dimensional (b), and 2D axisymmetric CFD models (c) are shown above.



The Shimmy valve is line-mounted, with two co-axial spring-loaded poppets in opposed configuration (anti-parallel), as shown below. Each poppet sits on its seat and opens during oil flow in one direction. The housing is split into two halves to facilitate assembly, connected by a threaded joint and sealed by a radial seal. An orifice is provided in the center of the inner poppet. Modeling the Shimmy valve is essential to determine its static and dynamic characteristics. These characteristics directly influence the Shimmy effect.



The flow of hydraulic oil through the shimmy valve takes place via three flow paths, namely, orifice, Pressure Relief Valve (PRV), and Non-Return Valve (NRV). An integrated model of the whole system has been developed using LMS Amesim software to examine the stability characteristics. It was found that the static model of the oleo strut closely matches findings from an HAL report, indicating accuracy in the modeling process. The derived rotational viscous damping of the oleo strut from CFD analysis of the shimmy valve highlights behavior under different valve configurations. The Identified negative pressure loss gradient in the Pressure Relief Valve (PRV) suggests potential instability once the valve opens. A high-pressure loss is noticed in the NRV path, suggesting geometry modifications to enhance performance and reduce negative impacts on hydraulic oil properties.

Government oil companies distribute bottled LPG cylinders at subsidized rates to individual houses for domestic cooking. However, often, the cylinders fitted with a Self-Closing Valve (SCV) are amenable to unauthorized liquid LPG pilferage at some point in the supply chain network. It results in the loss of taxpayers' money through a subsidy. It could have been better utilized to deliver subsidized LPG cylinders to a wider section of the society targeted by the government.



The SCV fitted on domestic cylinders needs design modifications to stop pilferage of liquid LPG at any orientation of the filled-up LPG cylinders. However, all other essential functions available with SCV have to be ensured. An Anti-Pilfer Self-Closing Valve (APSCV) is simply described as a Self-Closing Valve (SCV) with the added feature of anti-pilfer capability against the outflow of liquid LPG from a filled-in cylinder.

CSIR-CMERI has designed and developed an APSCV for LPG cylinders utilizing the Knowledge gained through three five-year plans on the design & development of some special-purpose aircraft valves with actuators and their allied test rigs. The developed APSCV has three sub-systems, as shown above. One sub-system is almost similar to the earlier SCV. The second sub-system is the Non-Return Valve (NRV) positioned immediately after the SCV, which functions only during cylinder filling. The third subsystem is a ball valve designed below the NRV and allows only LPG vapor to pass through it when the cylinder is upright. The subsystem-level performance was validated in the laboratory and at the bottling plant.



The prototype of APSCV was tested in the laboratory environment using compressed air. The NRV in the APSCV must open with minimal differential pressure and impart flow resistance similar to SCV. This function was validated with the compressed airflow. The air outflow rate through the ball valve subsystem was checked at

various differential pressures through experiments and compared with the numerical results.



The following are the major conclusions derived from the laboratory and relevant environment testing of prototypes.

- Both APSCV and SCV allow almost equal flow rates when fitted with DPR.
- The performance of the APSCVs is satisfactory compared to the original SCV.
- Two cylinders fitted with APSCVs are filled with LPG using the normal filling procedure at the HPCL LPG bottling plant, Panagarh.
- Cylinders filled up with 14.2 kg of LPG within the acceptable time. This ensures normal production of filled-up LPG cylinders at the plant
- The cylinders were successfully decanted up to 0.5 kg of LPG, and the maximum amount of overfilled LPG was evacuated at the existing decanting facility at the plant.
- Trained HPCL personnel tested the above cylinders for any liquid LPG pilferage, as shown in the above image. Newly developed APSCVs successfully prevented the flow of liquid LPG at any orientation of the cylinders and fulfilled the major requirement of APSCV development.
- Cylinders were tested successfully with gas ovens in the canteen kitchen at the bottling plant, both for room and outdoor temperatures, as shown below. This ensured the primary function of APSCV

- Finally, the above cylinders were evacuated at the plant and filled up with 200 g of LPG. The above tests were repeated a few times and found that ovens lit up perfectly for more than 30 minutes. This ensured that leftover LPG in the cylinder at the end was much less than 200g, the maximum allowable weight.



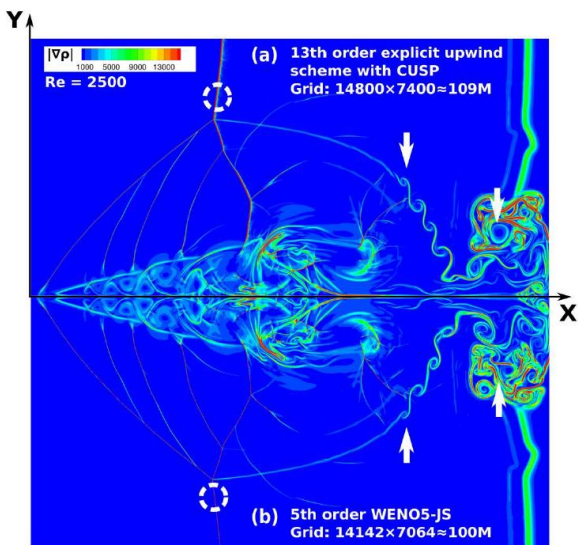
Measurement of aerodynamic forces and moments of grid fins



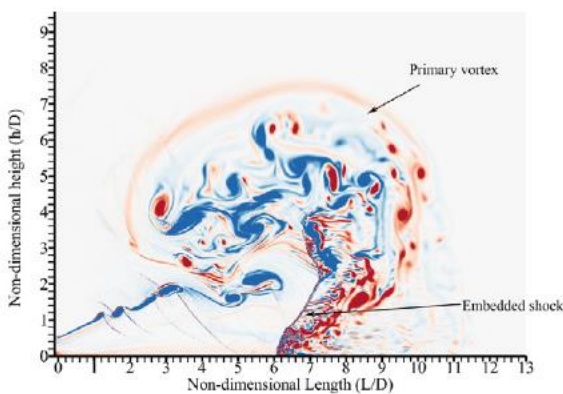
Measurement of vertical velocity close to the wall using PIV



Observation of off-bottom suspension of gypsum particles



Comparison of higher-order scheme developed by CSIR-CMERI with 5th order WENO scheme



Simulation of high peak overpressure blast wave (11) emanating from shock tube exit

Besides the above activities of design and analysis of pneumatic and hydraulic systems, experimental and numerical studies on aerodynamics, shock, and blast wave attenuation and mitigation, scale-down model testing of aerodynamic surfaces, and flue gas desulfurization (FGD) plants, and testing of valves are performed at CSIR-CMERI. The above figures show the low-speed wind tunnel testing of grid fins, particle image velocimetry study of the jet bubble reactor tank of the FGD plant, and CFD simulations performed at the high-performance computational facility.

One of the critical enablers to progress the transportation sector towards zero gas emission is on-board hydrogen (H_2) storage. H_2 has the potential to be a clean and environmentally friendly energy carrier if it is stored safely and compactly. H_2 in ambient conditions has a very low energy density by volume. To be used as fuel to run the vehicles, it must be pressurized to range from 35 to 70 MPa. The colossal storage tanks required for compressed hydrogen gas diminish the fuel economy of the onboard vehicles. The storage of H_2 gas at elevated pressure in a light yet robust vessel is the need of the hour to commercialize the H_2 -based fuel.

Heavy steel/aluminum cylinders are no longer a viable method to store the gaseous H_2 . The most thriving technological product that has surfaced in the past decades in this regard is composite pressure vessels. The optimal design configuration of such high-pressure storage tanks includes an inner liner used as a gas permeation barrier, geometrically optimized domes, inlet/outlet valves with minimum stress concentrations, and directionally tailored exterior reinforcement for high strength and stiffness.

The existing technology extensively used to store gaseous H_2 is composite pressure vessels with metallic liners (Type III pressure vessels) overwrapped with composite. As the pressure vessel's operating pressure determines the vehicle's driving range, one can obtain a better driving range by increasing the H_2 gas pressure. This enhances the

pressure vessel's weight, further increasing the manufacturing cost.

To fabricate lightweight high-pressure hydrogen storage vessels to accelerate the commercialization of hydrogen in the automotive industry, type IV high-pressure storage vessels have received much attention. The CSIR-CMERI is working towards the development of Type IV H₂ storage tanks.

At first, the structural carbon fiber/epoxy layers using high-density polyethylene (HDPE) liners are fabricated. The HDPE liners can be manufactured either by Roto-molding or blow-molding manufacturing methods. Next, a shielding envelope using either glass fiber/epoxy or glass fiber/vinyl ester is incorporated into the layers. Carbon fibers wrap these liners after dipping them in an epoxy resin matrix. The design of a hydrogen storage tank with composites contributes to system weight and parts-count reductions. It provides the manufacturer with the facility to mold the system easily according to the requirement.



Due to the absence of a metallic structure, the type IV tanks are characterized by extremely low mass, and an operating pressure of 70 MPa can be easily achieved. The absence of rigid metallic liners increases the durability of the cylinders against repeated hydrogen charging. Therefore, a prodigious scale of research and development is

solicited to reduce costs and improve the volumetric performance, reliability, and durability of Type IV composite pressure vessels for onboard hydrogen storage applications. The above figure shows a prototype of a Type-IV cylinder manufactured at CSIR-CMERI for H₂ storage.

The vehicle-mounted mechanized drain cleaning machine is indigenously developed with a noble intention to eradicate the manual scavenging process and provide a point solution for all sewer-related problems like sewer choking, overflowing manholes, damaged sewer pipelines, etc. The machine is equipped with many cutting-edge technologies and innovative ideas that make it stand out from other similar types of equipment available on the market. It has a creative mechanical slurry water filtration system, re-using of filtered slurry water for the jetting process, a three-way gearbox unit to utilize the engine power for the system's operation, an automated hose reel guiding and disinfectant facility, an inbuilt feedback system and underwater camera based post drain cleaning inspection system. These features make the machine most effective and user-friendly in negotiating many drain cleaning-related challenges with ease and comfort.

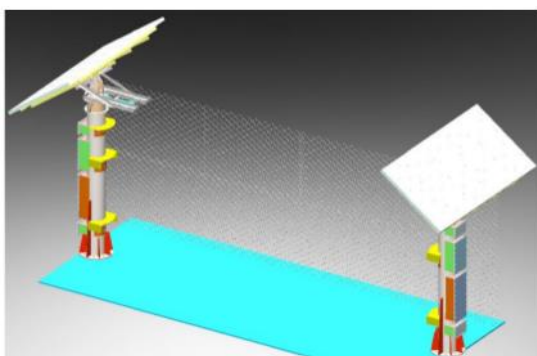


This vehicle serves urban and local bodies with a population of 10000 and cleans the chockage up to 600 mm sewer line. It has a slurry dispensing unit for sludge collection, a multistage mechanical filtration, a high-pressure jetting system, a D silting mechanism, and a post-cleaning inspection unit. It

is mounted in the BS-VI chassis and operated pneumatically to make the operations easy and safe.

It has the following main features:

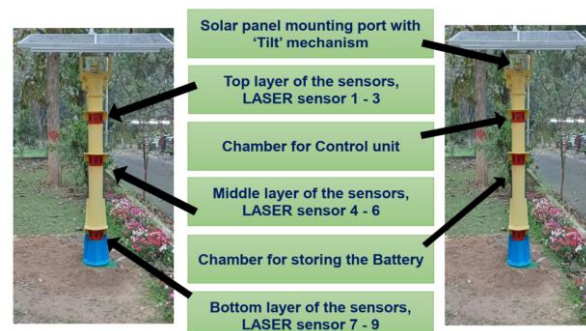
- Indigenously developed, vehicle-mounted, self-powered integral system.
- Vehicle-mounted mechanical filtration unit for filtration of grey (slurry) water to be utilized in the high-pressure jetting process, saving a large amount of freshwater. Uninterrupted execution of drain cleaning process without using fresh water for jetting operation.
- The entire system gets power from the vehicle's engine, which makes the system self-adequate and can be deployed anywhere.
- Automated hose reel guiding mechanism with disinfectant unit to provide the operator with a safe & comfortable working environment.
- A state-of-the-art in-cabin, on-time feedback display system empowers the system controller from the vehicle's cabin to monitor the system's functioning and make effective decisions based on the situation.
- Underwater camera-based post-drain cleaning inspection system provides a complete evaluative report about the effectiveness of the sewer cleaning process, including inside health analysis of underground sewer pipelines such as any cracks/damages, etc.



Perimeter surveillance of border areas is pivotal in ensuring national security and sovereignty. These

areas are often vast, diverse, and challenging to monitor effectively. With the increasing complexities of global security threats, robust perimeter surveillance becomes paramount to prevent unauthorized entry, smuggling, terrorism, and other illicit activities.

Effective surveillance helps detect and deter potential threats such as illegal immigration, drug trafficking, and human smuggling, safeguarding the nation's security and integrity. Thus, sophisticated electronic surveillance systems are strongly needed for reliable perimeter surveillance. Considering the importance of reliable perimeter surveillance, CSIR- CMERI Durgapur has developed a range of laser fence-based intrusion detection systems and seismic sensor intrusion detection systems, each with a range of 100 m.

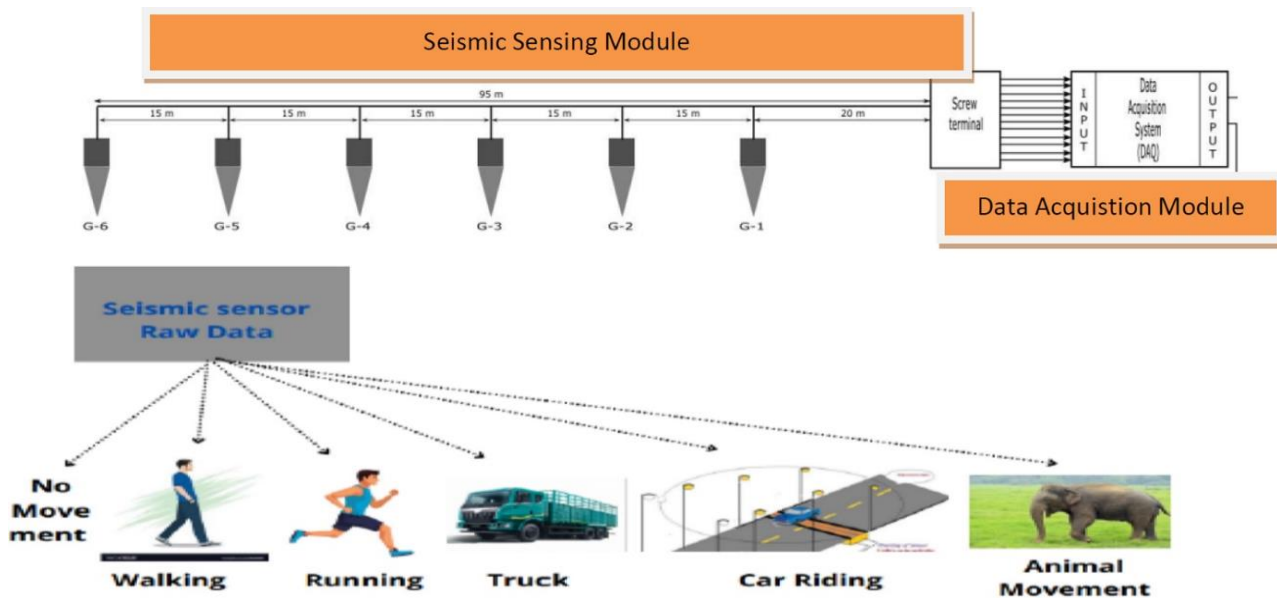


To accomplish the range-finding array-based perimeter surveillance, a "Laser Range Wall" is deployed, which comprises Laser Ranging Devices along the perimeter of 100 m. A single pillar housing multiple laser beams pointing in various directions is designed and developed at CSIR-CMERI Durgapur to accomplish intrusion detection over a range of 100 meters, as shown below.

Here, lasers were arranged as shown above, and a network of sensors and a data acquisition system were used for intrusion detection. The range detection sensors update the intrusion status at intervals of 100 milliseconds to a monitoring system inside the control room. In the present architecture, an RS-485 to Ethernet Converter with each Pole is used, which connects to the Ethernet Hub inside the control room.

In the Seismic Sensor-based Intrusion Detection System, a setup including buried seismic sensors and a data acquisition system is designed and developed at CSIR-CMERI Durgapur. Here, the

“marsh string” comprises six seismic sensors in series along the perimeter, which detect intrusion within a distance of one meter and are deployed as shown in the following figure.



Here, the intrusion (as shown above) is detected with the help of a machine learning algorithm designed to detect and classify intrusion. The intrusion detection is processed by a monitoring system (Data acquisition and processing module) placed inside the control room. The system's reliability is tested at different seasons and various geographical locations, and a few images of testing are shown below.



A Farm Machinery Training and Testing Centre is established at CSIR-CMERI, Durgapur, to reduce the high waiting period (~ more than one year) at the Central Farm Machinery Training and Testing Institute (FMTTI), Tractor Nagar, Budni-466445, Hissar, Haryana. Further, it helps conduct skill development programs for prospective farmers and entrepreneurs. Here, all tests on different types of machinery are performed as per BIS norms.

Commercial tests are performed to ascertain the performance characteristics of agricultural machines and equipment in use or ready for commercial launching. The following types of commercial tests are being undertaken:

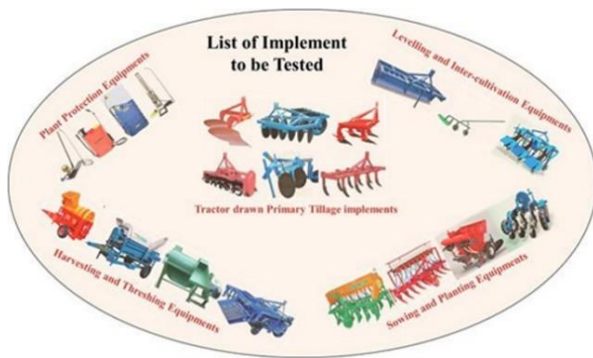
- Initial commercial tests on indigenous or imported prototype machines
- Batch test on machines that have already undergone initial commercial tests and are manufactured commercially in the country.
- Test following the Organisation for Economic Co-operation and Development (OECD) Standard Test Code for machines exclusively for export purposes.

- Confidential tests are carried out to provide confidential information on the performance of machines, or to provide any special data that may be required by the manufacturer/applicant.

This center provides commercial and confidential testing of the following machinery:

- All types of agricultural machinery, equipment, and implements operated by tractors and power tillers.
- All types of manually operated agricultural machinery, equipment, and implements.
- All types of plant protection equipment, i.e., Sprayers, Dusters, blowers, etc.

The spectrum of implements tested at our center is shown below,



The regulated environment is essential to fulfill the demand for high-quality planting material required for large-scale cultivation. CSIR-CMERI has also designed and developed a Retractable –Roof Poly-House which has improvements to the current poly-house design, integrating a retractable roof feature tailored to safeguard crops against adverse climate conditions. This innovation amalgamates the advantages of climate optimization, natural conditions, and crop protection. The retractable-roof poly-house features a roof that can be opened and closed, either partially or fully, allowing growers to automate roof adjustments based on favorable weather conditions for plant growth or the need for crop protection.

When the roof is opened, the poly-house facilitates increased light levels and fresh air for plants. It can serve as a nursery for open-field plantations. Additional benefits include reduced disease incidence due to enhanced ventilation, decreased reliance on irrigation thanks to natural rainfall, and improved temperature control. The retractable roof's motion will be facilitated by a PLC automated, direct drive system. The following figures show the installed retractable roof poly-house.

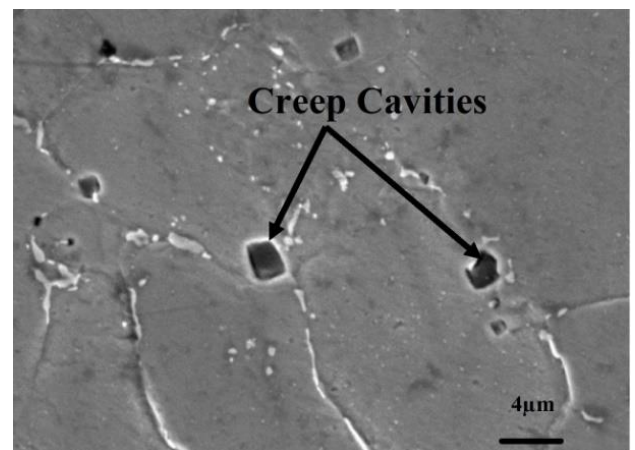
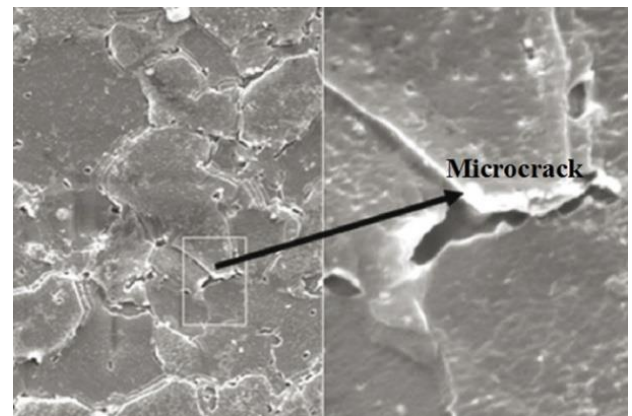


Compared to conventional poly-houses, the developed Retractable Roof Poly-House offers the following advantages:

1. Enhanced yield and firmer, longer shelf-life produce compared to conventional open fields, tunnels, and naturally ventilated poly-house.
2. The retractable roof fosters optimal indoor microclimates, promoting the growth of vigorous crops.
3. It prevents crop overheating by minimizing infrared radiation, thereby encouraging better yield and quality due to enhanced photosynthetic activity.
4. It retains more heat or utilizes soil as a heat sink during low night temperatures.
5. Precise control of indoor humidity through adjustable vents ensures uniformity.
6. Consistent air and CO₂ exchange throughout the poly-house optimize plant vegetative growth.
7. Manipulating humidity and light results in superior plant development.
8. The design is conducive to supporting bees and other natural pollinators.

9. It offers a more viable technology for organic cultivation.
10. Direct sunlight accessibility enables higher plant density compared to other conventional systems.

CSIR- CMERI has expertise in the field of damage assessment, Component integrity, and failure studies of Industrial Components, especially the power, process, steel, Petrochemical, and refinery sectors such as NTPC, DVC, WBSEB, CESC, TVNL, Haldia Petrochem, Chennai Petrochem DSP, ISP, Jindal Thermal power, and many other Industries. Apart from these activities. The group also carried out some R&D services for Defence Projects funded by GTRE/ DRDO in the area of Material Characterization.



The non-destructive metallographic test is also carried out in in-situ conditions over the damage-prone areas of different high-temperature components to assess the damage at the microstructure level. The following figures show the oriented creep cavities and micro-cracks in the grain boundaries.



DETAILS OF SKILL DEVELOPMENT PROGRAMMES CONDUCTED IN 2022-23

Sl. NO.	TITLE OF THE PROGRAM	DURATION	NO OF PARTICIPANTS
1	Finite Element Analysis of Structural Components	April 25-29, 2022	11
2	Analytical Techniques and Instrumentation for Water Quality Assessment	Apr. 27-29, 2022; June 28-30, 2022; Aug 03-05, 2022; Nov 09-11, 2022; Nov 14-16, 2022	136
3	Automation, Control, and Maintenance of Electrical System	May 10-20, 2022	11
4	Industrial Training on Farm Machinery Design	Apr-May, 2022	10
5	Summer Research Fellowship for Science Academy students	May - August 2022	12
6	Summer Internship	May - August 2022	31
7	Industrial Training on Farm Machinery Design	June 01-30, 2022	13
8	Hands-on Training in Real-Time Embedded System Design	June 01-07, 2022, July 18-29, 2022	52
9	High-end Workshop on Present and Future Trends of Electric Vehicle Technologies;	Sep 07-13, 2022	25
10	Municipal Solid Waste Management	Sep 13-15, 2022; Feb 01-10, 2023	58

11	Plastic Waste Disposal and Fuel Recovery - Characterization through Gas Chromatography	Sep 21-23, 2022; Nov 22-24, 2022; Jan 16-22, 2023	54
12	Dimension, Mass, Volume, Density and Pressure Metrology	Nov 02-03, 2022; Nov 15-17, 2022	08
13	High-end Workshop on AI & ML in Robotics	Jan 06-13, 2023	25
14	High-end Workshop on AI & Data Science for Industrial Applications	Jan 16-22, 2023	25
15	Renewable Energy Systems	Feb 07-10, 2023	11
16	MSME Advanced Entrepreneurship and Skill Development Programme (E-SDP) on 'Modern Agricultural Machines and Techniques	Feb 13-17, 2023; Feb 20-24, 2023	52
17	Embedded System Design for Real-Time Control	June 01-07, 2022; Jan 17-30, 2023	29
18	Hands-on training on Robot Building	July 01-15, 2022	21
19	Hands-on training on CNC Machining and Programming	04-09 July, 2022	59
20	10 weeks of Industrial Training for B. Tech. Agriculture students	04 July - 09 Sep, 2022	23
21	SDP on AI & ML	July 19-29, 2022; 17 Aug to 02 Sep, 2022	5
22	Hands-on Training on High-End Scientific Equipment towards Design, Development, and Testing of Agricultural Machinery	July 22-28, 2022	25
23	Internet of Things	25 Jul - 05 Aug, 2022; Mar 13-28, 2023	40
24	Hands-on Training on Python Programming with Applications in Robotics	Aug 03-07, 2022	32
25	Farm Machinery Design	05 Aug-03 Sep 2022; 08 Aug -30 Sep, 2022	57

LIST OF TECHNOLOGIES TRANSFERRED & TECHNOLOGY COMMERCIALIZED IN THE YEAR 2022-23

A total of 11 technologies were transferred to various industries, and 2 technologies were commercialized. The following table shows the details

TECHNOLOGIES TRANSFERRED:

SL. NO	NAME OF TECHNOLOGY TRANSFERRED	NAME OF INDUSTRY	LICENSE FEE (RS. IN LAKHS)
1	Vehicle-mounted Drain Cleaning System with 3 modules, namely Recycled Slurry Water Unit, Closed Loop Feed Back System, and Post-Cleaning Inspection Unit.	M/s Kam Avida Enviro Engineers Pvt. Ltd., Mulshi, Dist.Pune-411057, Maharashtra	12.98
2	Retractable Roof Poly-house (CoEFM, Ludhiana)	M/s Blue Stallion Equipments (P) Ltd., Ludhiana-141003, Punjab	3.54
3	AC-powered, intelligent, remote-controlled UVC-LED Sterilizer Unit	M/s A.R. INFOTECH Madhyamgram, North 24PGN-700129, WB	0.236
4	Inter-row rotary cultivator (from CoEFM, Ludhiana)	M/s DAJI Industries Pvt.Ltd., Sangli, Maharashtra-416403	3.0
5	Water Canon System of MCV	M/s Himatsingka Agencies Pvt.Ltd., Dumka-814101, Jharkhand	17.70
6	Front Shovel of MCV	M/s Himatsingka Agencies Pvt.Ltd., Dumka-814101, Jharkhand	3.54
7	Multi Barrel Tear Shell Launching System of MCV	M/s Himatsingka Agencies Pvt.Ltd., Dumka-814101, Jharkhand	8.26
8	Front Shovel of MCV	M/s Vijay Fire Vehicles and Pumps Ltd, Umbergaon-396171, Dist.Valsad, Gujarat	3.54
9	Multi Barrel Tear Shell Launching System of MCV	M/s Vijay Fire Vehicles and Pumps Ltd., Umbergaon-396171, Dist.Valsad, Gujarat	8.26
10	Wide Angle Video through Video Stitching of MCV	M/s Himatsingka Agencies Pvt.Ltd., Bhagalpur Road, Dumka-814101, Jharkhand	9.44
11	PTZ Camera with Telescopic Mast of MCV	M/s Himatsingka Agencies Pvt.Ltd., Bhagalpur Road, Dumka-814101, Jharkhand	8.26

TECHNOLOGIES COMMERCIALIZED:

SL. NO	NAME OF TECHNOLOGY TRANSFERRED	NAME OF INDUSTRY	ROYALTY EARNING (RS. IN LAKHS)
1	Extension of Assignment Deed for 35-60 hp Tractor w.e.f. 12/7/2022 to 11/7/2032 for 10 years. Rs.35.40 Lakh received on 30/6/2022	International Tractors Limited Vill. Chak Gurjran, P.O. Piplanwala , Jalandhar road, Hoshiarpur, Punjab, (India) 146022.	35.40
2	Royalty Earning on the selling of High flow rate iron removal filter technology (01 unit)	M/s Mission Minimise LLP, Flat No.503-B, Bailey Green Apartment, Priyadarshi Nagar, Bailey Road, Danapur, Patna-801503, Bihar	0.118

LIST OF MOU/AGREEMENT/NDA SIGNED WITH CSIR-CMERI DURING 2022-23

LIST OF LICENSE AGREEMENTS

SL. NO	NAME OF PARTY	SUBJECT	SIGN ON
01.	M/s International Tractors Limited, 283, Sonalika House, AGCR Enclave, Karkardooma, Delhi-110 092	Extension of Assignment Deed of 35-60 HP Tractor for a further period of 10 years w. e. f. 12/07/2022 up to 11/07/2032.	16/07/2022
02	M/s International Tractors Limited, 283, Sonalika House, AGCR Enclave, Karkardooma, Delhi-110 092	Extension of Assignment Deed of 20 HP Tractor for a further period of 10 years w. e. f. 12/07/2022 up to 11/07/2032.	29/07/2022
03	M/s KAM AVIDA ENVIRO ENGINEERS PVT.LTD., Plot No.2, Survey No.255/1, Hinjewadi, Tal: Mulshi, Dist.Pune-411057,	License Agreement signed on technology transfer of Vehicle mounted drain cleaning System	22/04/2022
04	M/s Blue Stallion Equipments (P) Ltd., Ludhiana-141003, Punjab	License Agreement signed on technology transfer of Retractable Roof Poly-house	05/08/2022
05	M/s A.R.I NFOTECH 286, Bankimpally East Madhyamgram, North 24PGN-700129, WB	License Agreement signed on technology transfer of AC-powered, intelligent, remote-controlled UVC LED Sterilizer Unit	10/08/2022
06	M/s DAJI Industries Pvt.Ltd., Sangli, Maharashtra-416403	License Agreement signed on technology transfer of Inter-row rotary cultivator	12/09/2022
07	M/s Himatsingka Agencies Pvt.Ltd., Bhagalpur Road, Dumka-814101, Jharkhand	License Agreement signed on technology transfer of Water Canon System of MCV	29/11/2022
08	M/s Himatsingka Agencies Pvt.Ltd., Bhagalpur Road, Dumka-814101, Jharkhand	License Agreement signed on technology transfer of Front Shovel of MCV	04/01/2023
09	M/s Himatsingka Agencies Pvt.Ltd., Bhagalpur Road, Dumka-814101, Jharkhand	License Agreement signed on technology transfer of Multi Barrel Tear Shell Lunching System of MCV	04/01/2023
10	M/s Vijay Fire Vehicles and Pumps Ltd., Plot No.232, GIDC Ind.Estate, Umbergaon-396171, Dist.Valsad, Gujarat	License Agreement signed on technology transfer of Front Shovel of MCV	22/02/2023
11	M/s Vijay Fire Vehicles and Pumps Ltd., Plot No.232, GIDC Ind.Estate, Umbergaon-396171, Dist.Valsad, Gujarat	License Agreement signed on technology transfer of Multi Barrel Tear Shell Lunching System of MCV	22/02/2023
12	M/s Himatsingka Agencies Pvt.Ltd., Bhagalpur Road, Dumka-814101, Jharkhand	License Agreement signed on technology transfer of Wide Angle Video through Video Stitching for MCV	24/03/2023
13	M/s Himatsingka Agencies Pvt.Ltd., Bhagalpur Road, Dumka-814101, Jharkhand	License Agreement signed on technology transfer of PTZ Camera with Telescopic Mast for MCV	24/03/2023

MEMORANDUM OF UNDERSTANDING (MOU) SIGNED

SL. NO	NAME OF PARTY	SUBJECT	SIGN ON
1.	Indian Institute of Technology, Technology Innovation and Development Foundation (IITG TI&DF), Guwahati-781039, Assam	MoU signed to collaborate for investment in research and development of the innovation being developed by the students, faculty, scientists, start-ups, etc. (Collaborating in a mutually beneficial agreement)	06/07/2022
2.	Sonalika Industries, Jalandhar Road, Village Chak Gujran, PO. Piplanwala-146022, Punjab	MoU signed for testing of agricultural implements of SI from CSIR-CMERI-CoEFM, Ludhiana, from time to time	16/07/2022
3.	Indian Council of Agricultural Research, ICAR-Central Research Institute for Jute & Allied Fibres, Barrackpur-700021, WB	MoU signed for execution of Joint Project on Science Technology and Innovation (STI) HUB (R&D on smart and embedded technology)	31/10/2022
4.	<ul style="list-style-type: none"> • National Institute of Technology Calicut (NITC), Kazhikode-673601, • Additive 3D (A3D), Chennai-600 051 AND • Tequity Engg.(P) Ltd., Goregaon East, Mumbai-400065 	MoU signed for execution of Project titled 'Development of low-cost Induction Melted Liquid Metal Additive Manufacturing Machine (IMMAMM) with Numerical and Experimental Investigations.	31/01/2023

NON-DISCLOSURE AGREEMENT SIGNED

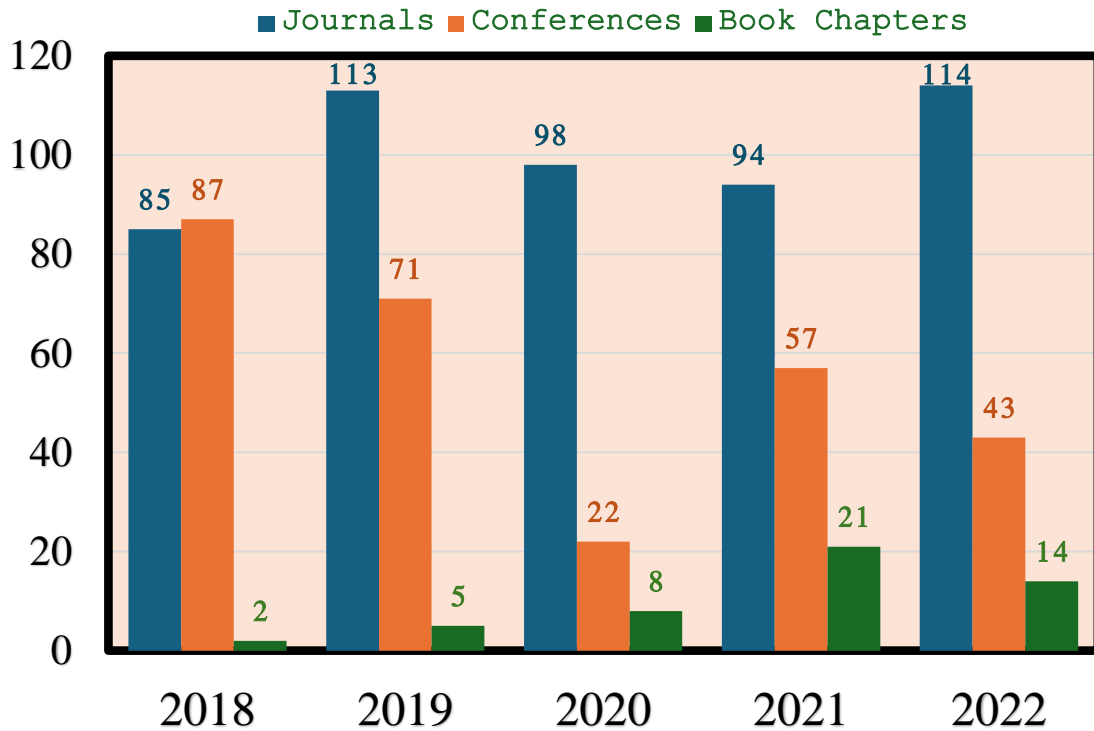
SL. NO	NAME OF PARTY	SUBJECT	SIGN ON
1.	Central Manufacturing Technology Institute (CMTI), Bangalore-560022	A non-disclosure agreement was signed on manufacturing different components/ sub-assemblies suitable for aerospace applications using different engineering and aviation-grade materials.	30/05/2022
2.	Sunrise Enterprise, Ayodhya Chowk, 150 Ring Road, Rajkot-360006, Gujarat	NDA signed for manufacturing different components/sub-assemblies suitable for 10-15 hp e-Tractor	10/11/2022 02 Years
3.	Bose Institute, Kolkata & Trident Auto Components Pvt.Ltd., Kanpur	NDA signed to protect confidential information received by Trident Auto Components (P) Ltd, which enables the development, fabrication, manufacture, test, and supply of Beam Stopper for Super FRS in FAIR Project at FAIR, GSI and Germany	07/12/2022
4.	TEQUITY ENGG.PVT.LTD. Goregaon East, Mumbai-400065	NDA signed for protection and safeguarding of confidential information of Deployment and feedback generation of hybrid manufacturing machine and its controller.	24/12/2022

5.	M/s Azista Composites Pvt. Ltd. C-Wing, Madhupur, Hyderabad, Telangana-500 081	NDA signed for exchange of information on the Development of High Pressure (350 Bar & 700 Bar) Hydrogen Storage Tank of Type-IV	29/12/2022
6.	Bharat Heavy Electricals Ltd. (BHEL), Ranipur, Haridwar-249403	NDA signed to pursue the collaborative work, which will be decided mutually	29/12/2022
7.	M/s Nextgen Plasma Pvt.Ltd., Jagadishpur, Biswaspara, Howrah-711115, WB	NDA signed for a project titled 'Development of concept and manufacturing design of mechanically operated machine/system for different arc welding applications and tooling and jig fixtures required for robotic welding and wire arc additive manufacturing applications.'	03/02/2023
8.	Optimized Solutions Limited Vastrapur, Ahmedabad, Gujarat-380015	NDA signed for the Development & Manufacturing of Control Circuits, Hardware for MCU, Actuator Drivers, Operator Panel and Interfacing MCU with proximity sensors, IMU/GNSS, Motor Drivers, Actuator Drivers, Cameras, and other Accessories for the existing 6x6 UGV Platform for Remote Control (Wireless).	01/03/2023
9.	Bevywise Networks LLP, Maharaja Nagar, Tirunelveli-27011, Tamilnadu	NDA signed for formulating joint project proposals, collaborative development of indigenous IoT and allied products, both software & hardware, IPR sharing, technology transfer, commercialization, marketing, and revenue generated out of such commercialized technologies	01/03/2023
10.	TIH Foundation for IoT and IoE, Indian Institute of Technology, Bombay, A. S. Marg, Powai, Mumbai-400076, Maharashtra and Bevywise LLP, Thiyagaraja Nagar, Tirunelveli, Tamilnadu-627011	NDA signed for a project related to 'Framework for registration of IoT Devices and applications' funded by TIH- IoT.	27/03/2023

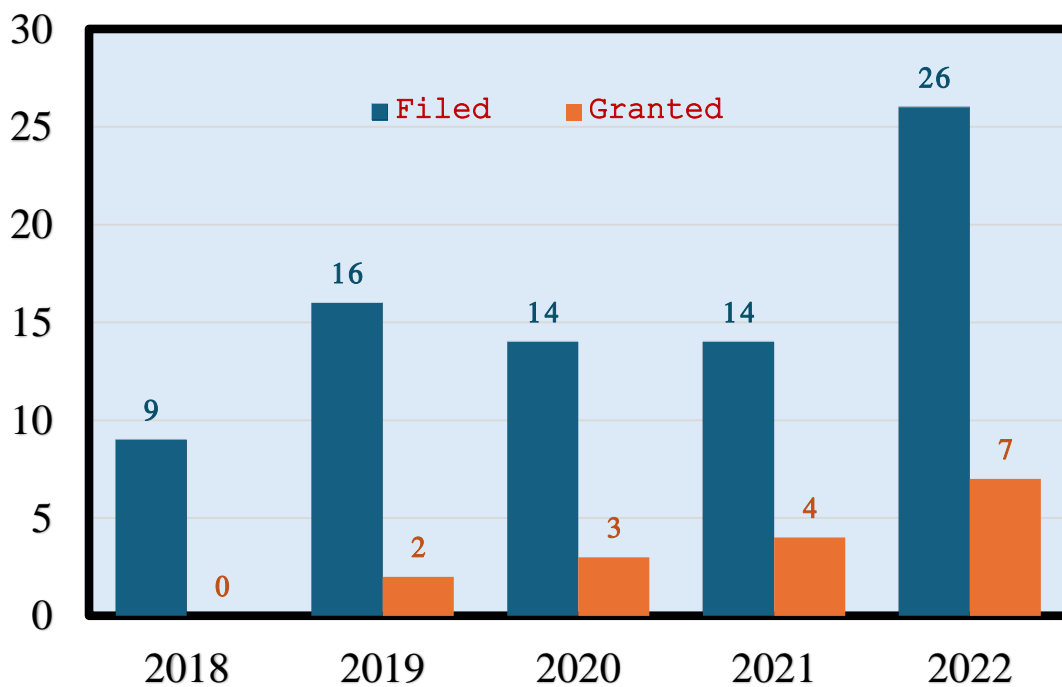


S&T Performance Indicators

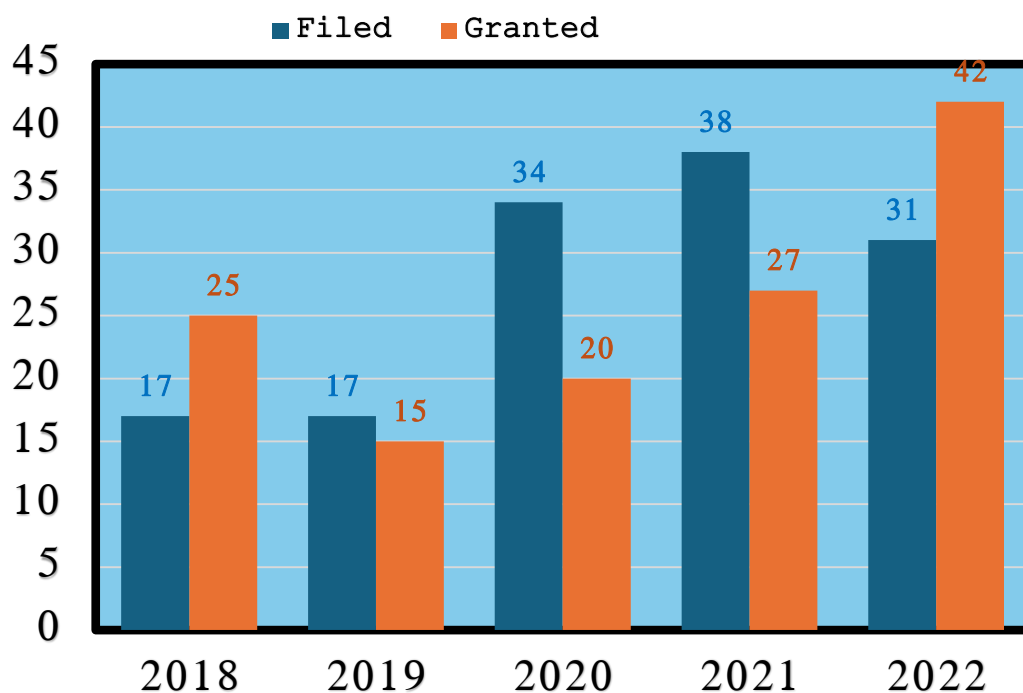
a) TRENDS IN PUBLICATIONS



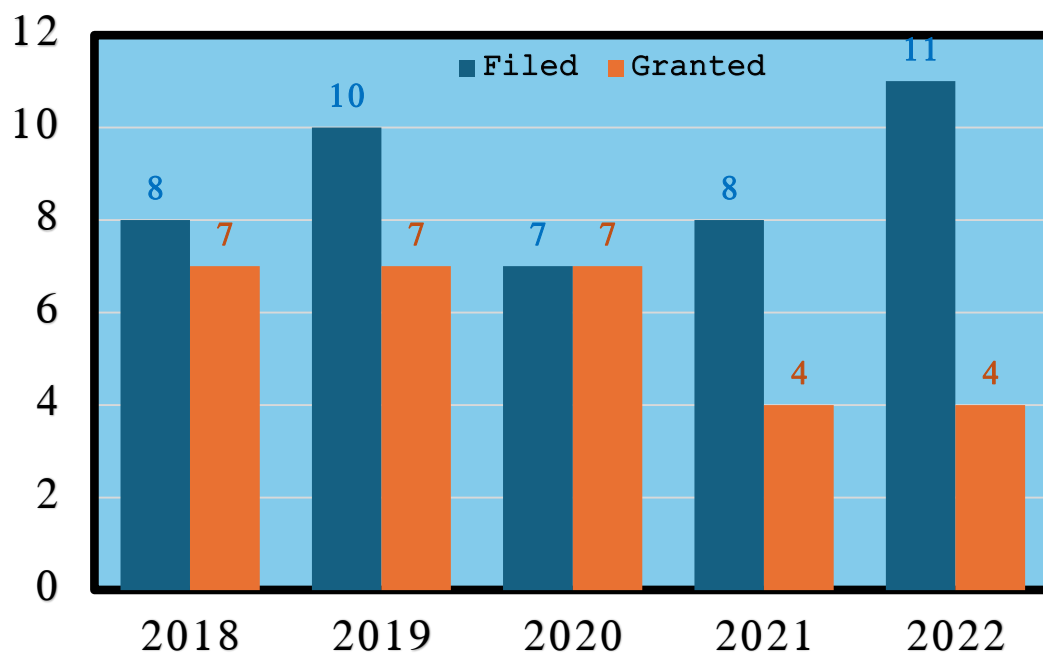
b) TRENDS IN IPR (PATENTS)



c) TRENDS IN IPR (COPYRIGHT)



d) TRENDS IN IPR (DESIGN REGISTRATION)



Programs offered in CSIR-CMERI under AcSIR

➤ PhD in Engineering

- ✓ Additive Manufacturing and Foundry
- ✓ Design and Analysis of Aeromechanical systems
- ✓ Robotics and Intelligent Systems
- ✓ Electric Mobility and Tribology
- ✓ Surface Engineering and Coating
- ✓ Energy Research & Farm Machinery
- ✓ Information Technology and Cybernetics
- ✓ Computational Solid and Fluid Mechanics

➤ Post Graduate Diploma Program (PGDP)

- ✓ Advanced Manufacturing Technology

➤ PhD in Science

- ✓ Chemical Science
- ✓ Mathematical Information Science

➤ M. Tech programs

- ✓ Mechatronics
- ✓ Design of Machinery and Equipment
- ✓ Farm Machinery and Power Engineering

➤ Integrated M Tech-PhD Program

- ✓ Mechatronics
- ✓ Machine Design

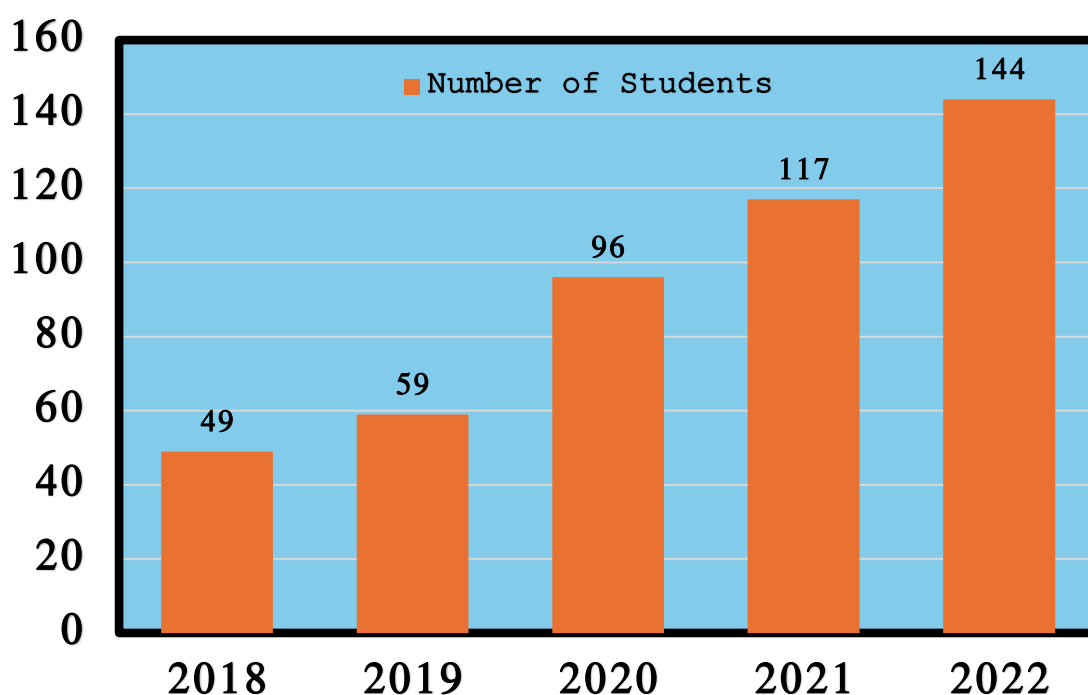
➤ Facts and Figures

- ✓ 165 PhD Students are on the roll
- ✓ 20 and 40 Students completed PGDP and PhD

➤ Strengths

- ✓ ~70 Scientists as faculties in AcSIR
- ✓ Access to cutting-edge facilities

TRENDS IN STUDENT STRENGTH (AcSIR CMERI, DURGAPUR)



SKILL DEVELOPMENT AND INDUSTRIAL SERVICES

Skill Development Activities

SSC Training Centre (TC186018)

Agriculture Skill Council (ASCI)

Capital Goods(CGSC)

Green Jobs (SCGJ)

CSIR Integrated Skill Initiative

2022-23

SERB Karyashala : 04
(Agri M/c, EV, AI & ML)

Vritika : 01

MSME E-SDP : 02

Skill Data

Skill Programs: **53**

Manpower Skilled: **982**

Total Revenue: **Rs. 57.99 Lakh**



In-situ Tests

Industrial Services

Laboratory Tests

NDT of Industrial Equipments

Condition Assessment & Stability Analysis of Industrial Structures

Failure Analysis of Industrial Structures

Vibration Analysis of Rotating Equipments

Locating and Quantifying Available Underground Water

Hydrographic and Bathymetric Survey of Rivers, Dams etc

Design & Manufacturing of Critical Components

Precision Component Manufacturing

Additive Manufacturing & 3D Printing

NABL Accredited Mechanical Testing

Metallurgical and Chemical Analysis

Destructive Testing for Material Properties

Calibration for Quality Control

Testing of Steel Ropes, Conveyor Belts

Metrological Inspection & Certifications

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