



Innovations licensed to industry



Indian Institute of Technology Bombay



Director's Message

Over the last three decades, IIT Bombay has focussed increasingly on Research and Development (R & D), in addition to its core activity of providing a high quality education to its students. The faculty of the Institute receive more than Rs. 240 crores each year in research funding from external agencies and industry. This has enabled the setting up of state-of-the-art experimental facilities for research, as well as several major research centres in which students and faculty from different Departments work together to address problems in a holistic way.

The outputs of our R & D efforts include not just publications in research journals but also patents, copyrights and designs resulting from applied research and design. The Institute has been making efforts to translate the results into use. One of the important metrics of the success of our R & D enterprise is the number of technologies licensed for commercialization. More than 100 technologies and products developed at IIT Bombay have been deployed and we are proud to present a representative set in this brochure.

Besides the technologies contained in this brochure, IIT Bombay has several more technologies that are awaiting deployment (<http://www.ircc.iitb.ac.in/>). Some of these technologies are ready for implementation, while others may need additional work to reach the deployment stage: prototyping, mass production, balancing the cost and quality of the product, providing affordable after-sales service, etc. These efforts may require collaboration between IIT Bombay and the Licensee at the initial stages.

We hope that this information in brochure is useful and we will be happy to partner with entities for translating these IPs into products.

Deploying innovations

A researcher translates an idea into a product or technology in the laboratory. With this, more often than not, the researcher deems the project to be complete. But the R&D efforts remain incomplete if the benefits of the innovation do not reach the end-user. It is at this stage that a researcher needs collaboration with an external entity that can deploy the innovation. This is especially true in Institutes such as IIT Bombay whose primary mandate is teaching and research.

Some technologies and know-hows are “ready to go” and it is relatively easier to deploy such innovations but more often than not, innovations need additional efforts to reach commercialization stage. Most R&D institutes lack a prototyping facility and the innovation hits a road-block. A perception (probably true to some extent) that prototyping involves more of logistic / managerial efforts (as opposed to intellectual efforts), coupled with the absence of facilitating mechanisms, dissuades researchers from taking steps for deployment.

Mass production that balances the cost and quality of a product and putting in place a provision for affordable after-sales service is another barrier. These efforts require hand-holding by the researcher so that the commercialization partner gets to understand the innovation and its nuances. A positive outcome of this is that relationships that are seeded by such hand-holding develop into stronger R&D partnership towards improving the technical specs of the product, generating new IP in areas that are directly related to the product as well as ancillary areas.

Most innovations come with an expiry date: if products are not deployed within a “short” duration, other indigenous or imported products that offer better specs to cost ratio make the efforts of commercialization economically unviable. Often, entities that intend to deploy innovations see this as a major deterrent.

In spite of all these constraints, IITB has been successful in licensing a number of innovations to reach the society. However, a time has come when Institutes have to proactively put in place prototyping facilities and other enabling mechanisms to see that a larger number of innovations reach the logical end point.



Green Technology



Environmental Technology



Healthcare Technology



Information and
Communication Technology



Manufacturing Technology



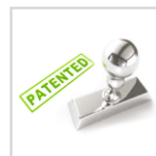
Socially Relevant
Technologies



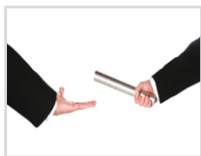
Collaboration / handholding
required for market readiness



Patent filed



Patent granted



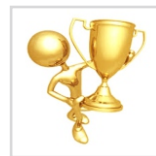
Exclusive license / transfer



Ready to go IP



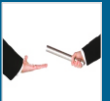
Registered Design



Awarded technology

Fuel additives

- Multifunctional solid fuel additive
- Prevents heat loss
- Reduces combustion energy generation costs
- Thermact : Coal additive for the improvement in combustion
- Thermol : Fuel oil additive for the improvement in efficiency





Heat pumps

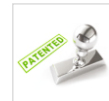
- **Tube-tube heat exchanger**
 - Low cost double vented wall heat exchanger
 - Compact and cost effective
 - Easy to modify
- **Multi-utility heat pump**
 - Integrated, easy to operate, compact design system
 - Novel tubular exchangers
 - On-demand supply of hot / cold water
 - Low operating costs



Prof. Milind V. Rane (Mechanical Engineering)

Licensed to

- Mechworld Eco Pvt. Ltd.
- Promethean Energy Pvt. Ltd.





WAYU device

Wind Augmentation and air purifying Unit

- System for diffused air pollution control
 - Low speed wind generators
 - Works on solar power
 - Thermal oxidiser for removal of carbon monoxide, hydrocarbons and volatile organic compounds
 - Appropriate size filters for long operation cycle
 - 50-60% efficiency



Prof. Rashmi S. Patil
(Centre for Environmental Science and Engineering)
Licensed to ESS Enviro Pvt. Ltd.

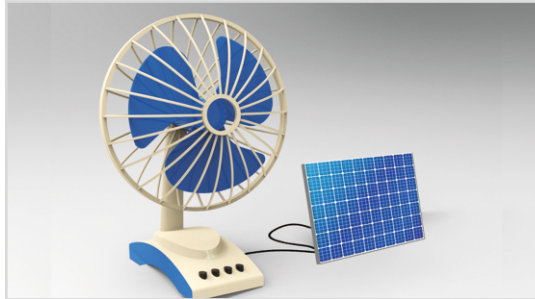




Solar photovoltaic (PV) technology



- PV Module
- PV system characterization
- Solar PV system design and integration

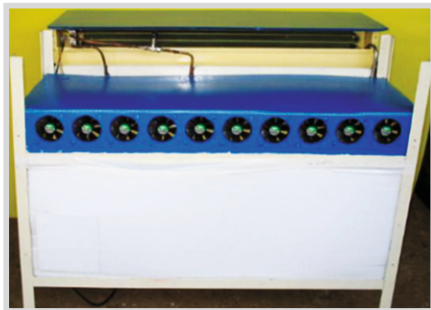


Prof. Chetan Singh Solanki
(Energy Science and Engineering)
Licensed to kWatt Solutions Pvt. Ltd. (IITB startup company)



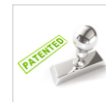


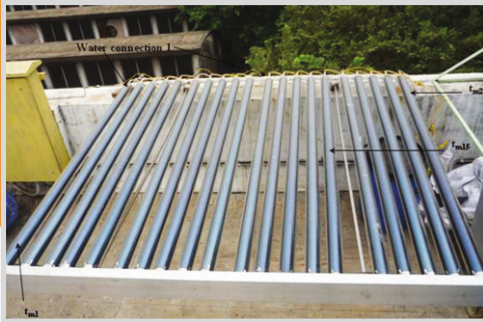
Hybrid cooling system



- Simultaneously controls air temperature and humidity using modular diabatic contacting devices
- Cooling and dehumidification of air takes place in a single compact unit
- Benefits:
 - Better indoor air quality
 - Energy efficient cooling system
 - Coefficient of performance increases by upto 45%
 - Cooling capacity increases by up to 60%
 - Operates silently since there is no splashing or spraying noise

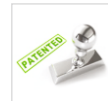
Prof. Milind V. Rane
(Mechanical Engineering)
Licensed to OPAL HVAC Engineers Pvt. Ltd.





Compact adsorption module

- **A unique adsorption module with a compact design :**
 - Can be integrated with condensers, evaporators and other component systems with different cycles
 - Gives lower cycle time and higher coefficient of performance, higher specific cooling power
 - Allows ease of fabrication and operation
- **Applications:**
 - Purification and separation of gases
 - Pressure swing adsorption
 - Removal and supply of heat to reaction chambers
 - Storage of compressed biogas or natural gas





Vermiculture Technology

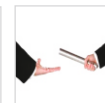
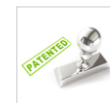
Waste water & solid waste treatment

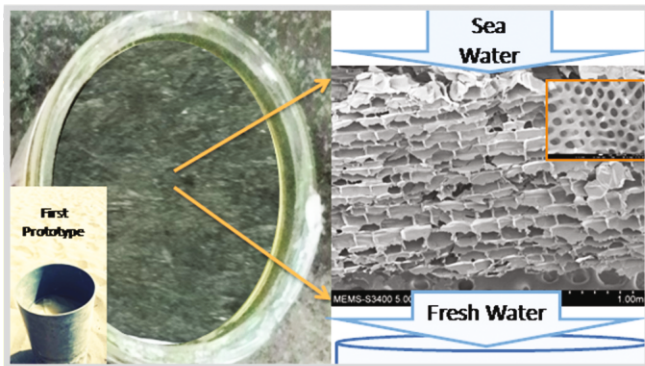
- Treatment based on a bio-conversion process
- No use of synthetic chemicals; uses natural ingredients
- Low on mechanization, hence zero down time
- No disposables or process residues
- No air or sound pollution; free from foul odour

Prof. H. S. Shankar (Chemical Engineering)

Licensed to

- Vision Earthcare Pvt. Ltd. (IITB startup company)
- Lifelink Eco Technologies Pvt. Ltd.





Water purification

- Use of carbon based membrane technology for purification and desalination of water
- Uses a dye degradation method
- Provides a solar concentrator method
- Environment friendly and cost effective





Polysensor

- Low-cost and easy method of testing impurities in water
- Can measure pH, electrical conductance, total dissolved solids, nitrate, chloride, salinity
- Small size for easy use at water site
- Convenient for application in rural areas, particularly un-electrified areas
- One instrument with one cartridge can estimate many parameters
- Fully indigenous, easy to repair





Integrated wetland technology



- A two step process for waste water treatment
 - a. Primary solid removal tank: allows 60% removal of suspended solids
 - b. Planted bed unit: works on principle of aerobic, anoxic and anaerobic environment
- Advantages:
 - High efficiency
 - No odour
 - Chemical free treatment
 - No energy required
 - No topological constraint





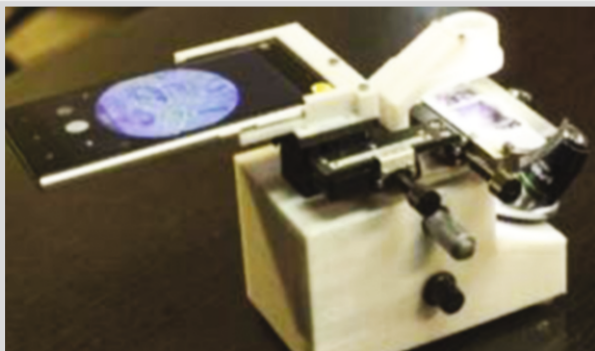
Smart phone based assay reader



- A smartphone based reader for lateral flow assays
- Has an image processing part and embedded algorithm for quantitative / semi quantitative / qualitative assessment
- Currently being developed for reading HbA1c assays
- Can be used for a variety of lateral flow assays

Prof. Rohit Srivastava (Biosciences and Bioengineering)
Collaboratively developed and licensed to
Labcare Diagnostics Pvt. Ltd.



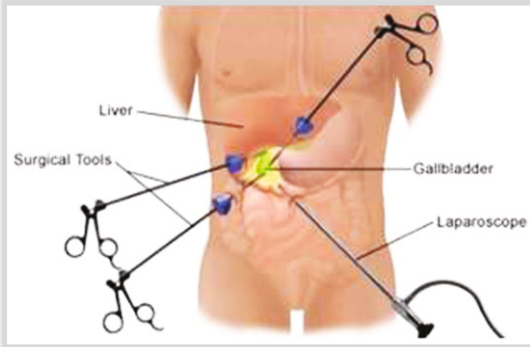


A portable microscope

- Low cost smartphone microscope
- High magnification
- Mobile phone integration provides live imaging and allows capturing of images and videos
- Monitoring cellular abnormalities and bacterial responses
- Currently used for monitoring sickle cell disease.

Prof. Debjani Paul (Biosciences and Bioengineering)
Licensed to MedPrime Pvt. Ltd. (IITB startup company)





Novel laparoscopic instrument

- Enables safe and reliable manipulation of tissue and organs
- Stress-free dexterity for surgical procedures
- Provides seven or more degrees of freedom
- Effective maneuverability; lower risk of tissue damage and surgeon fatigue.
- Maintenance of accuracy and reliability





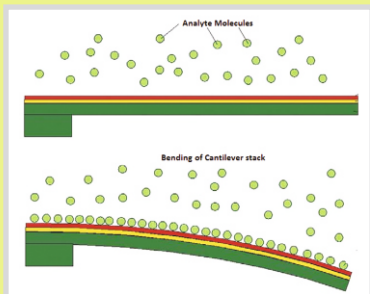
XrayTo3D

- Cloud based software platform
- Helps orthopedic surgeons to perform 3D surgery planning
- Helps in designing patient specific instruments
- Assists surgeons to take accurate surgical decisions and to order correct implant from implant manufacturers



Dr. Vikas Karade, Research Student (Mechanical Engineering)
Licensed to Algosurg Products Pvt. Ltd. (IITB startup company)





Polymer micro cantilever based system

- Diving board like structure which deflects both upwards and downwards leading to strain in the whole structure
- Piezo-resistive structure enables measurement of strain
- Capable of transducing a nano-mechanical motion into an electrical signal
- Can be functionalised as sensors for various applications

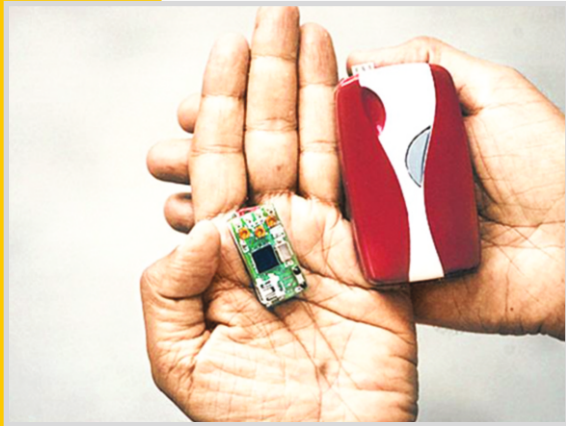
Cantilever based experimentation platform for vapour phase analysis of volatile organic compounds and gases

Prof. Ramgopal Rao (Electrical Engineering) and
Prof. Soumyo Mukherji (Biosciences and Bioengineering)
Licensed to NanoSniff Technologies Pvt. Ltd. (IITB startup company)





Silicon locket for cardiac monitoring



- A toffee-sized, low-cost ECG monitoring device
 - Optimized to acquire a three-lead simultaneous electrocardiogram
 - Can correct for motion artefacts due to physical activity of the patient
 - Stored data can be transmitted through a phone modem or GPRS network
 - Automatically informs a medical practitioner through an SMS in the event of an arrhythmia
 - Allows the practitioner to remotely login to the Locket to view a patient's ECG real-time or otherwise





Carbogen breathing apparatus

- Useful for people who work in high noise areas and experience noise-related stress
- Features :
 - Mixture of 95% oxygen and 5% carbon dioxide
 - Plays a therapeutic role for those with impaired hearing
 - Relieves stress due to noise pollution
- Tested with the Indian Navy and approved for use by personnel working in severe noise environments

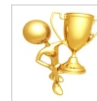




Carrier ethernet switch router



- Indigenously developed low cost technology
- Capable of solving a number of telecommunication needs in layer 1-3 networks
- A secure medium for communication
- Carrier class features; provides an ultra fast routing fabric at low energy consumption
- Supports metro transport, data centre, mobile Backhaul, carrier class transport and the metro/access market





OptiPX

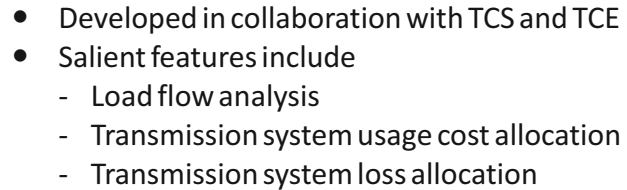
- Software for bid matching in day ahead spot electricity market
- A mixed integer linear programming (MILP) based solution
- Provides high end optimization features to the exchange based transactions
- Provides intelligent scheduling techniques

Prof. S. A. Soman (Electrical Engineering)

Licensed to

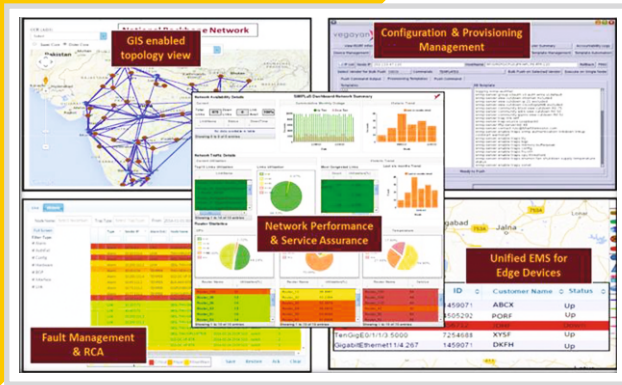
- Power Exchange India Ltd.
- Power Anser Labs Pvt. Ltd. (IITB startup company)





- National Load Despatch Centre (NLDC)

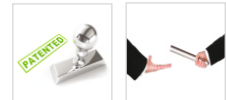




Next generation network

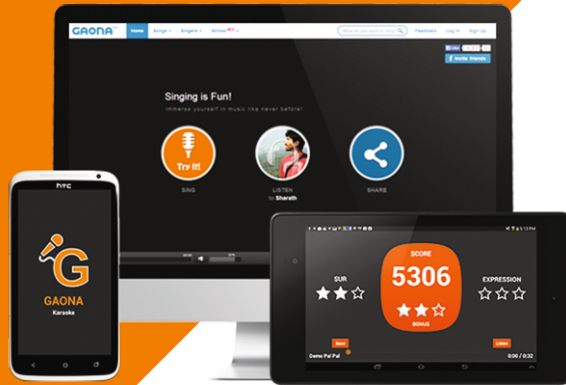
- For traffic engineering and optimization
- Enables selection of optimal route(s) in the network to satisfy quality constraints and ensure efficient resource utilisation
- Uses multi-dimensional virtual space representation
- Solution for multi-commodity-flow optimization or K-shortest-paths-first type of problems

Prof. Girish Saraph (Electrical Engineering)
Transferred to Vegayan Systems Pvt. Ltd. (IITB startup company)

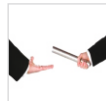
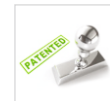




Singing scoring system

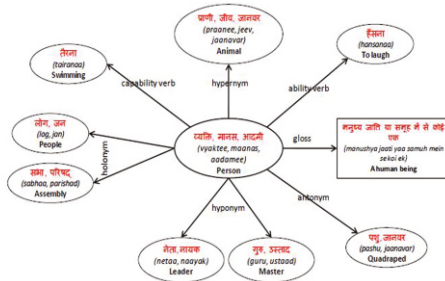


- Pitch (Sur) singing evaluation technology
- System compares a user-renderition of a song to the original singer
- Credible singing evaluation on multiple musical dimensions
 - Modulation (harkat)
 - Timing (taal)
 - Lyric pronunciation (alfaaz)
 - Falsetto/Vocal effort
 - Octave change
 - Bonus





WORDNET SUB-GRAPH: HINDI



Hindi wordnet

- A rich, complex, large and widely used electronic resource along with associated tools for an Indian language
- Features:
 - Lexical structures composed of sets of synonyms (synsets) and semantic relations
 - Crucial resources within the field of natural language processing (NLP)
 - Important during translation of and word searching among Indian languages

Prof. P. Bhattacharyya (Computer Science and Engineering)
Licensed to

- Multinational search engine company
- Many research organisations
- US based linguistic data consortium

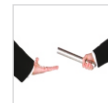
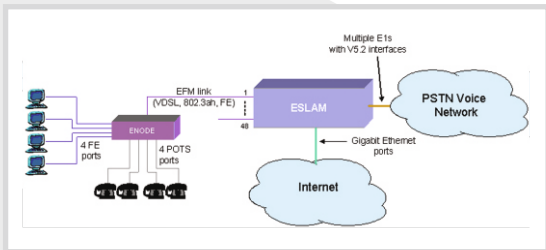




Efficient technologies for broadband access

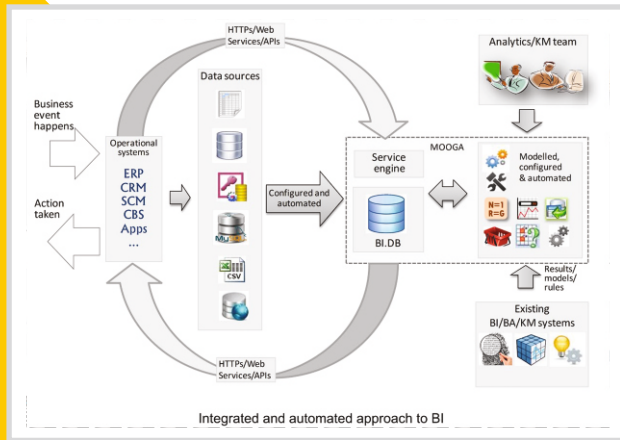


- An innovative, ethernet-based architecture called EisoAccess, for broadband access technology in the converged telecom sector
- Considerable superiority in Capex as well in Opex costs, while at the same time it is able to offer new value-added services



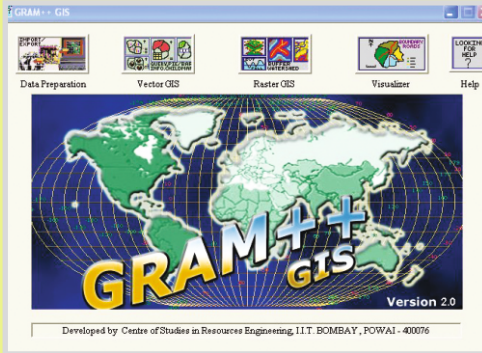


Artificial intelligence for business analytics



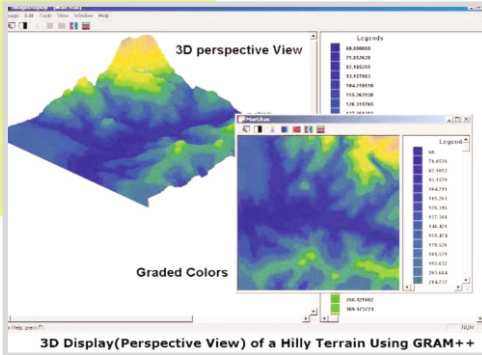
- Business intelligence and analytics framework 'Mooga' backed by the hybrid Artificial Intelligence (AI) Approach
- Facilitates integrated, automated and operational intelligence using conventional intelligent systems and relational database management systems
- Implements four basic filtering techniques and their hybrids to offer personalization and recommendation in various domains





GRAM++

- A geographic information system (GIS) software with rich functionality to support spatial database preparation by importing data in popular GIS formats
- Supports specific editing and onscreen digitisation of scanned documents
- Provides analyses using various tools
- Image processing for analysis of remotely sensed images
- Basic statistics utility and powerful map composition tools
- Easy use making it accessible to a large number of users
- Over 1000 licenses sold across the country



Prof. P. Venkatachalam
(Centre for Studies in Resources Engineering)
Licensed to Bhugol GIS Pvt. Ltd. (IITB startup company)

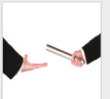




Automatic address segmentation

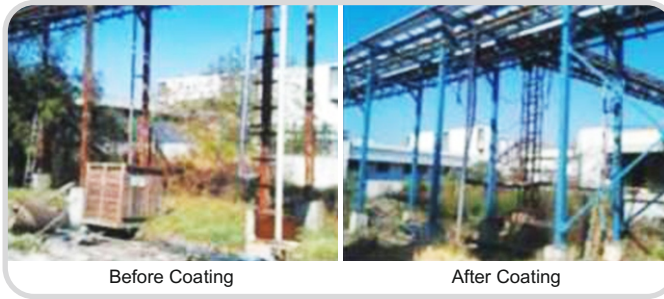
House number	Road	Area	City	Zip
36/307	S.V. Road	Goregaon (W)	Bombay	400079
<i>An example segmentation of the address string: '36/307 S.V. Road Goregaon (W), Bombay 400079'</i>				

- Software tool that can 'learn' to segment unseen addresses once trained with examples of already segmented addresses
- Handles new data robustly
- Computationally efficient
- Easy interpretation and adjusts to rectify unexpected address segmentations
- High accuracy obtained through use of actual Addresses





Protective coatings



- Nano ZnO coatings synthesized through sol-gel method
- Epoxy coatings modified with fly ash and glass flakes to improve adhesion and resistance to abrasion / chemical corrosion / UV rays
- Use in various industry applications





Underwater epoxy coating

- Fast curing corrosion resistant paint to protect structures Including those submerged under water
- Features:
 - Good corrosion and abrasion resistance
 - Ease of application, rapid drying and low moisture permeability
 - Relatively non-toxic
 - Good compatibility with existing coatings
- Applications:
 - Agricultural and food processing facilities
 - Damp and moisture prone systems, ships, tunnels and bridges





Precision linear motion system

- Inexpensive, repeatable, noiseless high-precision technique for guiding precision stages in linear motion
- Force sensing can be done in open loop for tool substrate Touch detection
- Use in high precision micromilling applications

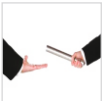




Low cost engine management system



- Supports petrol-powered engines with port fuel-injection
- Performs a variety of functions such as real-time engine control, enhancement of fuel economy, reduction of tailpipe emissions and improvement of overall durability
- Least expensive sensing configuration possible for small vehicle applications.





Steer by wire technology

- A next generation technology characterised by the absence of mechanical linkages between the hand wheel (or any other user interface) and the road wheels
- Motion is communicated to the steered-wheels through electronically-controlled actuators
- Benefits include passive safety, better drivability, better vehicle handling, ease of manufacture, better product features, space saving, weight / fuel efficient





Surface plasmon resonance detector



- Low cost, portable, semi-automated SPR instrument for Biosensing
- Can be adapted to detect various molecules by suitable surface functionalisation
- Label free detection of biomolecules and performance of real time biomolecular interaction studies
- Use of acrylic sheets for light weight





Unibody electric 3 wheeler vehicle



- 3-wheeled, single piece, light weight, single seat vehicle
- Driven by an electric hub motor fitted into the front Steering wheel
- Made of fibre reinforced plastic (FRP)
- Reduced assembly time

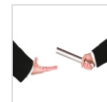


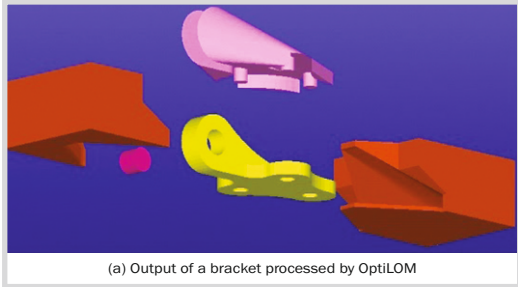


Supercritical fluid extraction technology



- A versatile technology with a varied range of applications:
 - Extraction of natural products such as essential oils and oleoresins, flavours, fragrances, food colours, preservatives, pesticides and herbal medicines
 - Production of ultrafine / nanoparticles
 - Processing and preservation of food products
 - De-cholesterolisation of food, de-caffeination of tea / coffee, de-nicotisation and removal of tar from tobacco and extraction of hops
 - Precision cleaning of electronic and optical components
 - Removal of residual solvent from solvent-extracted products





(a) Output of a bracket processed by OptiLOM



(b) Bracket made on a LOM machine after pre-processing using OptiLOM

OptiLOM software

- Laminated object manufacturing (LOM) is a rapid prototyping process used to produce less expensive and stronger prototypes.
- Features of OptiLOM:
 - Allows pre-processing of the prototype geometry before using it on the LOM machine
 - Eliminates the need for grid cutting and de-cubing
 - Does not require any change in the hardware of the LOM machine and readily adoptable
 - Additional geometries can be calculated

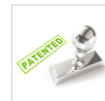




Process for making natural sweetener from stevia leaves



- An improved process for recovery of sweetener from *Stevia rebaudiana* Bertoni
- Leaves subjected to pressurized hot water
- Extraction using CO_2 at appropriate range of temperature and pressure
- No unpleasant smell and bitter after-taste in the product





Electro slag remelting technology

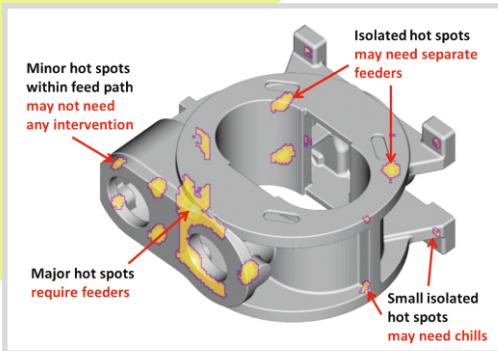
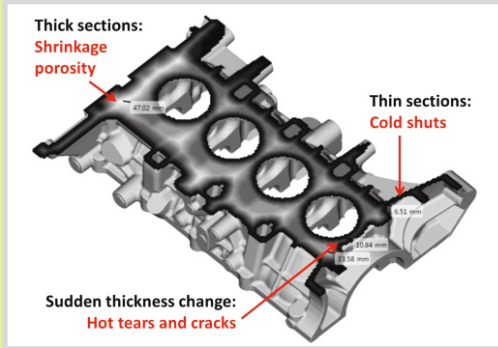
- Electro slag remelting (ESR) plant design and ESR technology for high speed steel, hot die steels, and other specialised steels
- Applications/Activities:
 - New ultra-high strength steel for rocket motor casing
 - Turn-key supply of an ESR facility to the Vikram Sarabhai Space Centre
 - Complete automatic control system for an ESR pilot plant developed and installed
 - Inoculation of ESR steel to further improve the material's properties
 - Iron-aluminides use for high temperature applications





Improved casting design and simulation

- Fast and reliable algorithms for 3D casting design, simulation and optimization
- Advanced and intelligent algorithms for automatic methods design, simulation and optimization of castings
- Implemented in the following software programs:
 - 3DHotSpot: for students and teachers
 - AutoCAST-X: for foundry engineers
 - LessMetal: for product designers



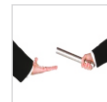


Hand held explosive detector



Beagle-Z

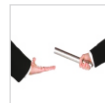
- Features
 - Hand held device
 - Light weight
 - Real-time detection
 - No radioactive source
- Applications
 - People screening: Check points, Post blast search
 - Vehicle screening
 - Building screening: Terrorists hot-spots, places of importance, crowded establishments





Patient monitoring care

- Wireless transmission of medical parameters along with 12-lead ECG with patient picture and additional comments related to patients condition.
- Simultaneous 12 Lead high resolution diagnostic ECG display Monitor
- Precision of measurement
- High speed operation
- Local storing of patient data
- Solar powered (Optional)
- Lightweight and highly durable equipment construction





Vestibulator

- Will stimulate the vestibular canals by generating vertical, horizontal and rotary motions
- These motions will stimulate the semicircular canals of the vestibular organ
- This will develop reflex actions which will enable the development of neuro-muscular coordinated responses
- Therapeutic device to stimulate vestibular system of cerebral palsy children
- Also serves the physiotherapy needs



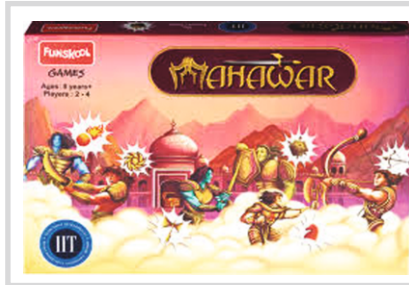


Dry sanitation system

- Stainless steel squat type toilet pan with three exclusive ports for solids, urine and washing water
- Waterless – no flush system
- No external additives like chemicals, enzymes
- Aids and accelerates natural process of decomposition
- Women friendly with help in disposing sanitation pads and diapers
- Elderly friendly with heel support
- Utilises waste to make fertiliser



Board games



Prof. U. A. Athavankar (Industrial Design Centre)

Licensed to

➤ Funskool (India) Ltd.

➤ Gakken Education Publishing Company Ltd. Japan



Computer masti



21st Century Skills + Computational Thinking

Collaboration

Communication

Creativity

Critical Thinking Skills

- Algorithmic thinking
- Problem solving skills
- Systematic information gathering
- Brain-storming

Concepts of Computer Science

Hardware, software and programming languages

Ethical and secure use of computer and internet

- Thematic integration
- Scalability
- Guided-inquiry based learning
- Higher order thinking skills
- Spiral curriculum
- Healthy computer practices
- Playfulness

Prof. Sridhar Iyer
(Computer Science and Engineering)
Transferred to Next Education India Pvt. Ltd.

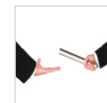




Aqua: online farmer knowledge exchange



- AQUA (almost All Questions Answered), is an online question answering website providing farm and veterinary advisory services to farmers over phone or Internet
- Provides fast access to reliable agri information
- Supports voice over phones, video over tablets and any affordable devices for maximum reach
- Provides a searchable agri knowledge database
- Supports all Indian languages

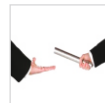




Bio-fuel processor for engines

- A processor for compression-Ignition engines to use straight vegetable oil (Karanj, Mahua, etc.) as fuel
- Sustainable technology
- Does not depend on petroleum-based products
- Does not require conversion to biodiesel
- Emissions from the engine conform to the diesel engine emission standards set by CPCB

Prof. A. Ganesh (Energy Science and Engineering)
Deployed / retrofitted on engines at Cummins India Pvt. Ltd.



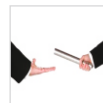


A new letterbox for india post



- Stainless steel body keeps the letters from being soiled during rains
- Red composite-plastic top with a beak-like aperture
- Rust free with maintenance-free life expectancy of 20 years
- Cap cover on top prevents seepage of rainwater into the letterbox
- Slope on the top drains water away from the slope on the top drains water away from the box

Prof. B. K. Chakravarthy (Industrial Design Centre)
Deployed at Department of Posts, Govt. of India





ASAN – a new ATM

ATM enclosure design

- A low cost, automated teller machine (ATM)
- Attractive design
- Small size makes it suitable for deployment
- Has a multi-coloured card reader and status
- Intelligent, power-saving hardware and Software
- 40-column, graphic thermal receipt printer
- Unique airflow system allows deployment at non-air conditioned sites

Prof. U. A. Athavankar (Industrial Design Centre)
Transferred to NCR for installation in various banks

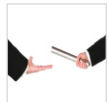




K-yan: the compact media centre



- A compact media product combining functions of a multimedia and internet-enabled PC, a large format television, a DVD/VCD/CD player and CD writer, a video-conference device, an LCD data projector and an audio system
- Facilitates shared viewing and participation by users
- Easy to use
- Has multilingual facilities
- Eliminates the need for investing in other media hardware



IITB has more than 600 patent applications filed and 140 patents granted in and outside India



Awarded the top Indian academic institution for patents; Best commercialization of patent(s) and the WIPO users trophy in 2015



Thomson Reuters India Innovation award 2014

Institute is continuously seeking potential licensees to commercialize and deploy its intellectual property for possible licensing.

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