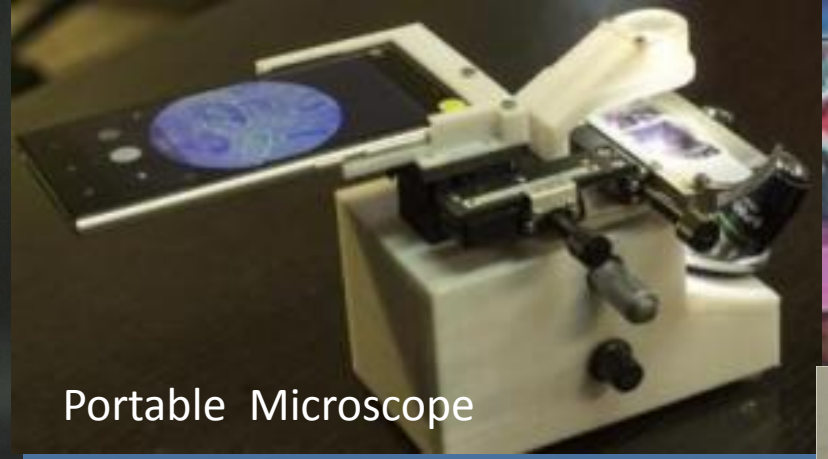

Solar Urja Lamps


Portable Microscope


Ethernet Switch Router


Coloured Cool Roof Coatings

Fuel Additives


Multi Utility Heat Pump

Indian Institute of Technology Bombay

Industrial Research & Consultancy Center

December 1, 2017

IIT Bombay at a glance

- Teaching and Research
- ~10,069 students on roll (Sept. 2017)
  3283 Bach., 895 (2) DD, 3006 (39) Masters, 2885 (22) PhD
- 130+ Post-doctoral fellows ; 1250+ Project staff (Technical)
- 27 Academic Units; 23 Research Centres
- ~630 full-time faculty ; ~50 part time (adjunct & visiting) June 2017
- External research funding (receipts in FY 2016-17) ₹ 392 crores

Academic units @ IIT Bombay

Engineering
Mechanical, Civil, Electrical, Computer science, Aerospace, Metallurgy and materials science, Chemical

Education Technology
Research and education in the area of technologies to promote the learning-teaching process.

Pure Sciences & Mathematics
Chemistry, Physics, Mathematics, Applied statistics, Biosciences

Geology & Geophysics

Entrepreneurship
Imparts a structured training to aspiring student entrepreneurs

Climate studies
Fundamental understanding and problem-centred analysis of climate change

Nanotechnology & Biomedical engineering

Systems and Control
Nonlinear control, robotics, embedded systems, coordination of autonomous vehicles, combinatorics, modelling and optimization of stochastic processes.

Industrial Engineering and Operations Research (IEOR)
A blend of theory, modelling and application, draws from traditional as well as modern areas of operations research, together with a systems view derived from long-standing principles of industrial engineering

Energy

Urban Engineering
Research, teaching and skilled manpower development with the primary mandate of improving urban quality of life

Rural Technology
Perspectives, policies, and practices pertaining to technology, development, and the interrelationship between the two in the rural context

Design
Industrial design, Visual communication, Animation, Interaction design, Mobility and vehicle design

Policy studies

Environmental Science

Geoinformatics and Natural Resources Engineering

Humanities and Social Sciences

Management

Academic units @ IIT Bombay

- Department of Aerospace Engineering
- Department of Biosciences & Bioengineering
- Department of Chemical Engineering
- Department of Chemistry
- Department of Civil Engineering
- Department of Computer Science & Engineering
- Department of Earth Sciences
- Department of Electrical Engineering
- Department of Energy Science and Engineering
- Department of Humanities and Social Sciences
- Department of Mathematics
- Department of Mechanical Engineering
- Department of Metallurgical Engg. & Materials Sci.
- Department of Physics
- Center for Environmental Science & Engineering
- Center for Policy Studies (IDP)
- Center for Research in Nanotechnology & Science
- Center for Technology Alternatives to Rural Areas
- Center for Urban Science and Engineering
- Center of Studies in Resources Engineering
- IDP in Climate Studies
- IDP in Education Technology
- IDP in Industrial Engg. & Operations Research
- IDP in Systems & Control Engineering
- IITB Desai Sethi Centre for Entrepreneurship (IDP)
- Industrial Design Center
- Shailesh J. Mehta School of Management

Academic programs and degrees

Applied Statistics & Informatics

Chemistry

Economics

Geology

Geophysics

Mathematics

Physics

Aerospace Engineering

Chemical Engineering

Civil Engineering

Electrical Engineering

Mechanical Engineering

Design

Education Technology

Entrepreneurship (minor)

Humanities & Social Sciences

Management

Policy Studies

Biomedical Engineering

Biotechnology

Climate Studies

Computer Science & Engineering

Energy Science & Engineering

Environment Science & Engineering

Geoinformatics & Natural Resources Eng.

Industrial Eng & Operations Research

Metallurgical Eng & Material Science

Nanotechnology & Science

Systems and Control Engineering

Technology & Development

Urban Science & Engineering

BTech, BDes, BS, PhD, MTech, MSc, MDes, MMgmt, MPhil,Dual degree programs (BTech+MTech, MTech+PhD, MTech+MSc, MSc+PhD,)
Minors and Honors for BTech students

Research & Development @ IIT Bombay

1982 (1374 Journals + 608 Conference proceedings)

- Number of research publications in 2016

105

- Number of companies incubated so far

834 (710 Indian + 124 Foreign)

- Number of patent applications filed upto June 2017

181 (127 Indian + 54 Foreign)

- Number of patent applications granted upto June 2017

357

- Number of PhD degrees awarded in 2017

857 Bachelors + 1398 Masters

- Number of other degrees awarded in 2017

Representative examples

Gram Marg Solution for Rural Broadband

Open source low cost hardware prototype utilising television white spectrum

- Indigenous and ingenious technology that utilises unused white space on the TV spectrum to backhaul data from village wifi clusters to provide broadband access (frugal 5G)
- Rolled out in 25 villages on a pilot basis so far
- Won Ist prize in the Mozilla Innovation Challenge

GRAM MARG
Enabling Rural India Digitally

Prof. Abhay Karandikar, Electrical Engineering

Solar Urja Lamps (SoUL)

Localization of solar energy through local assembly, sale and usage

- Provided to students in 7903 remote rural villages in Maharashtra, Madhaya Pradesh, Rajasthan and Odisha through support by the National Clean Energy Fund, MNRE

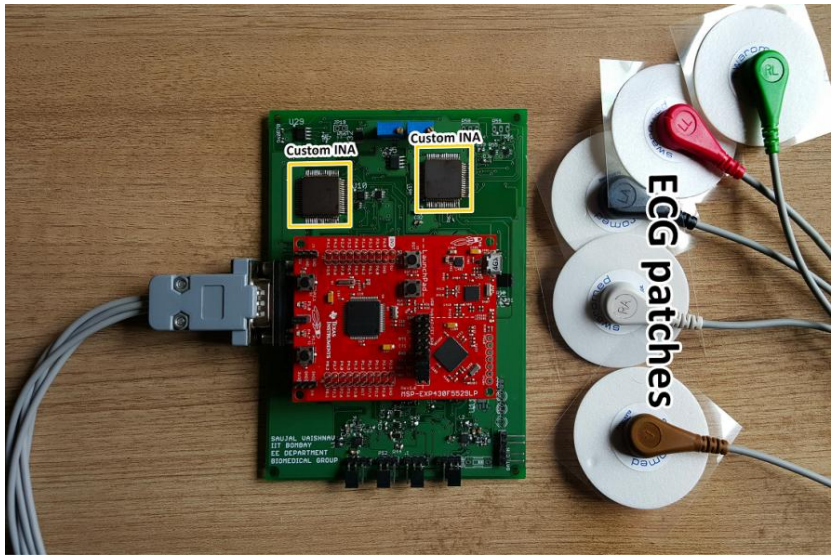
- The project as implemented by the District Collector in Dungarpur, Rajasthan received the prestigious Prime Minister's Award under the Innovation Category in April 2017

- ~40,000 lamps distributed in Dungarpur

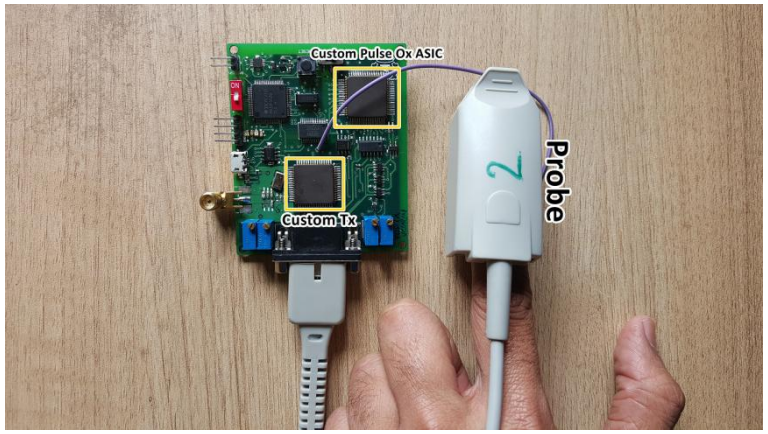
Prof. Chetan Singh Solanki, Energy Science & Engineering

Wearable Health Monitoring

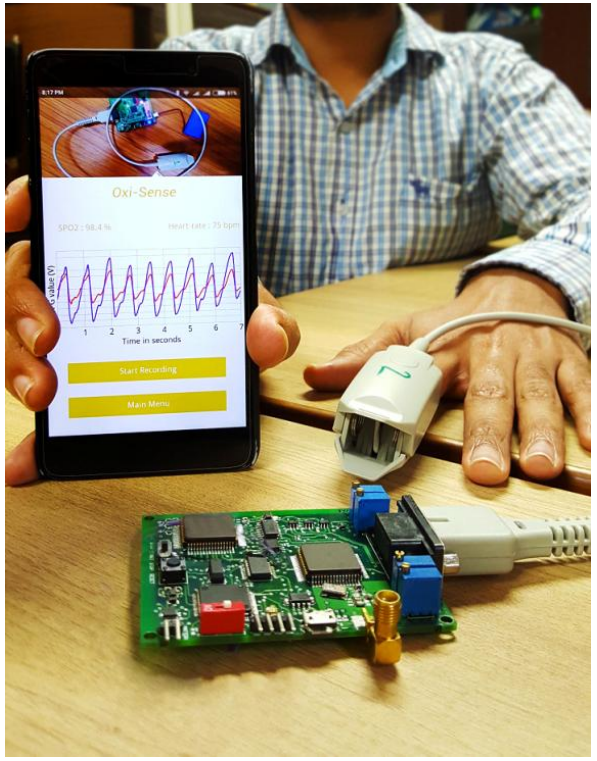
Technologies to monitor ECG, EMG, EOG and SpO_2



Heart-Sense
(Multi Channel ECG recorder)
Light weight portable device for continuous monitoring of ECG and heart rate



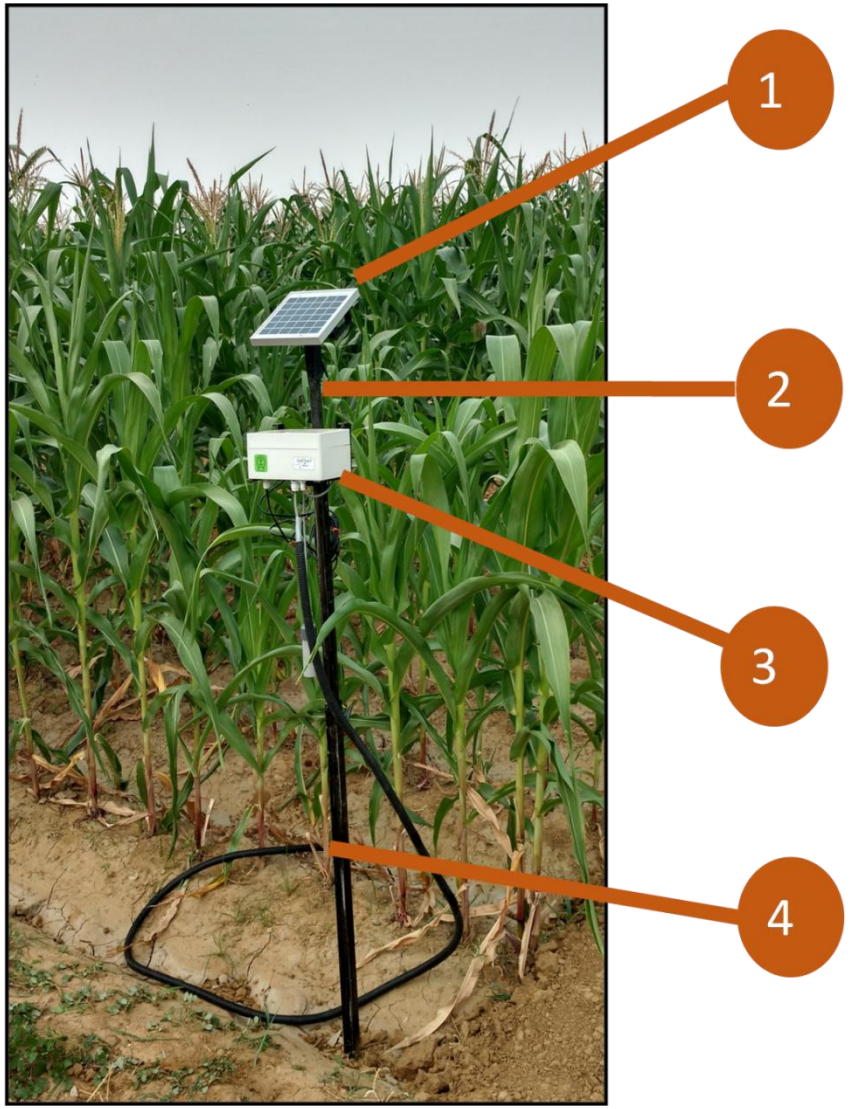
Oxi-Sense
(Pulse Oximeter)
Non-invasive, fast and accurate measurement of blood oxygen saturation level and heart rate



Life-Sense
(Android Application and Desktop GUI)
Real-time monitoring of ECG/PPG data on any Android mobile or desktop

Prof. Maryam Baghini, Electrical Engineering

Low Cost Soil Monitoring System for Irrigation Control



- Solar powered system
- Completely automated system
- System will sustain for 3-4 days without solar energy

- Modular design
- Ease for use
- Designed according to Indian farmers condition

- Low power signal processing unit
- Wireless communication
- Data displayed on mobile

- Soil moisture sensor
- Soil temperature sensor
- Ambient humidity sensor
- Ambient temperature sensor

Prof. Maryam Baghini, Electrical Engineering

Energy Conservation Systems

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

Diabetic Contacting Device

- Air humidifier
- Indirect evaporative cooler
- Evaporative condenser/ de-superheater/sub-cooler
- Fresh air dehumidifier
- Hybrid air conditioning system

Multi-Utility Heat Pump

Heating / Cooling - Air/Water/Process Fluid

Tube – Tube Heat Exchanger

Diabatic Contacting Device

Prof. M. V. Rane, Mechanical Engineering

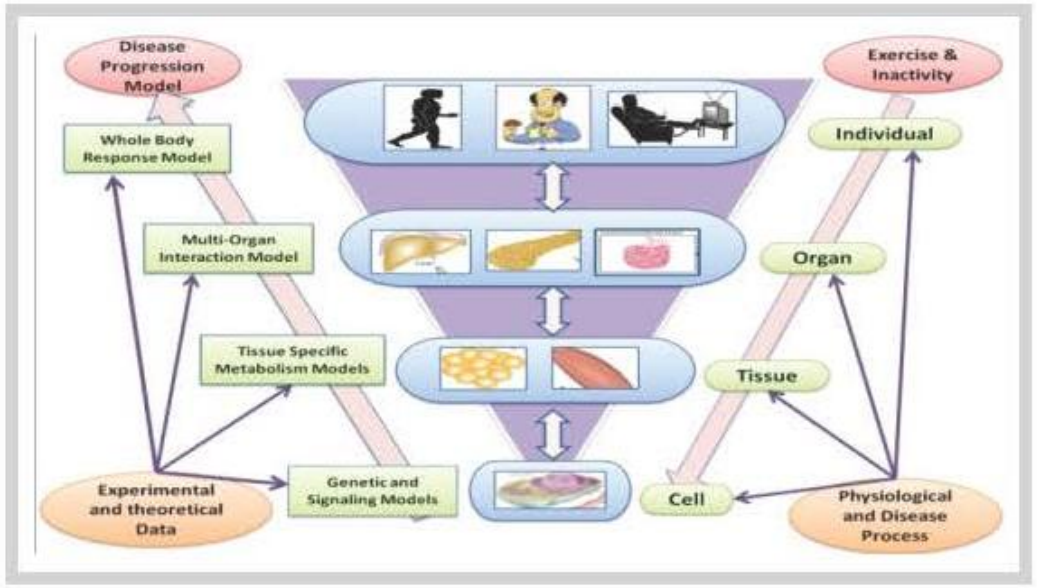
Arsenic Removal from Water

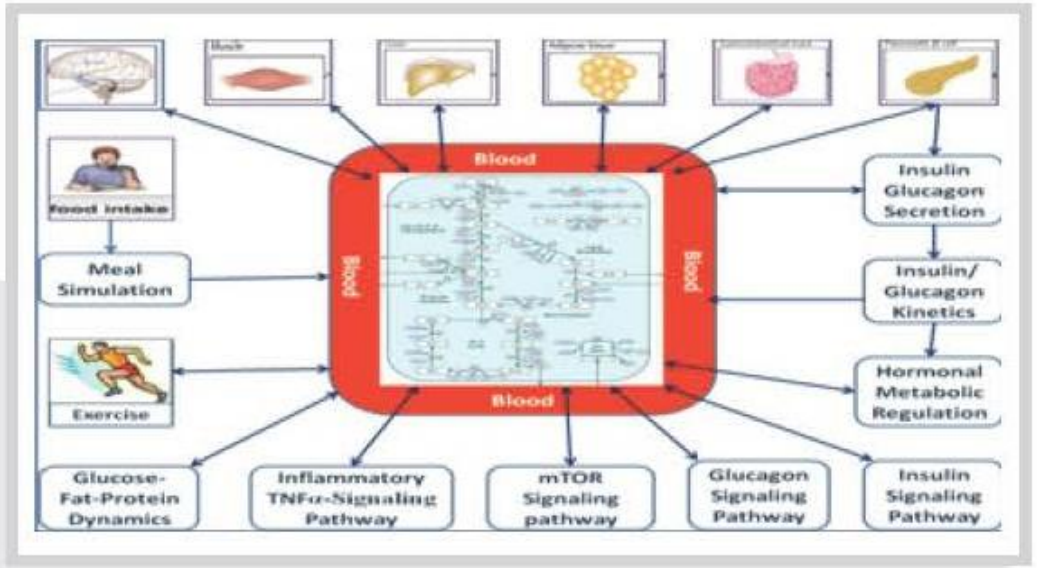
- Water treatment for removal of arsenic, pesticides, herbicides, etc.
- Hand-pump attachable filters developed using indigenous material
- Each unit caters to around 200 families

- 50+ units - Assam, Bihar, UP, West Bengal
- Each unit costs around ₹ 70K
- Low maintenance (₹ 1000/year)

Prof. Sanjeev Chaudhari, Centre for Environmental Science and Engineering (CESE)

Mathematical Model for Lifestyle Management



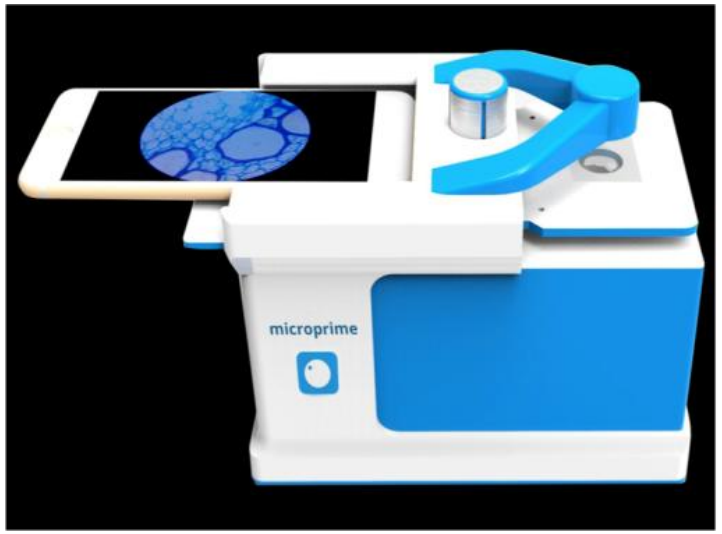


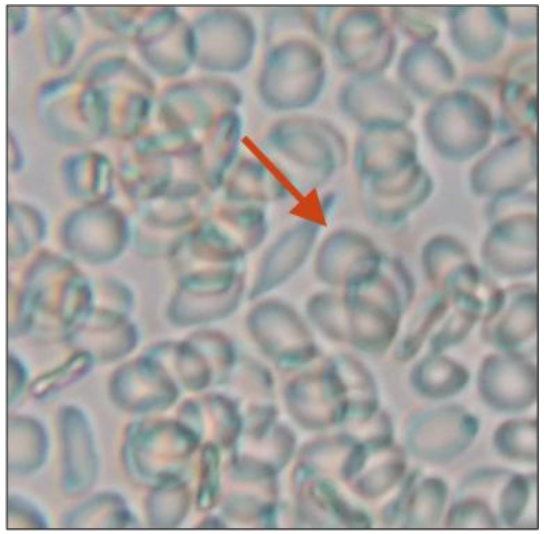
- Reliable disease diagnosis & therapeutic strategies for holistic disease management
- Hypothesis generation for various lifestyle and environmental properties
- Determining drug targets rationally
- Personalised analysis
- Toxicology & drug safety assessment
- Whole body dynamics including body weight, fat mass, plasma metabolite dynamics
- Strategies for adaptive weight loss & muscle mass gain for individuals
- Lifestyle intervention (optimal diet & physical activity chart) for reduced disease risk and management overall health

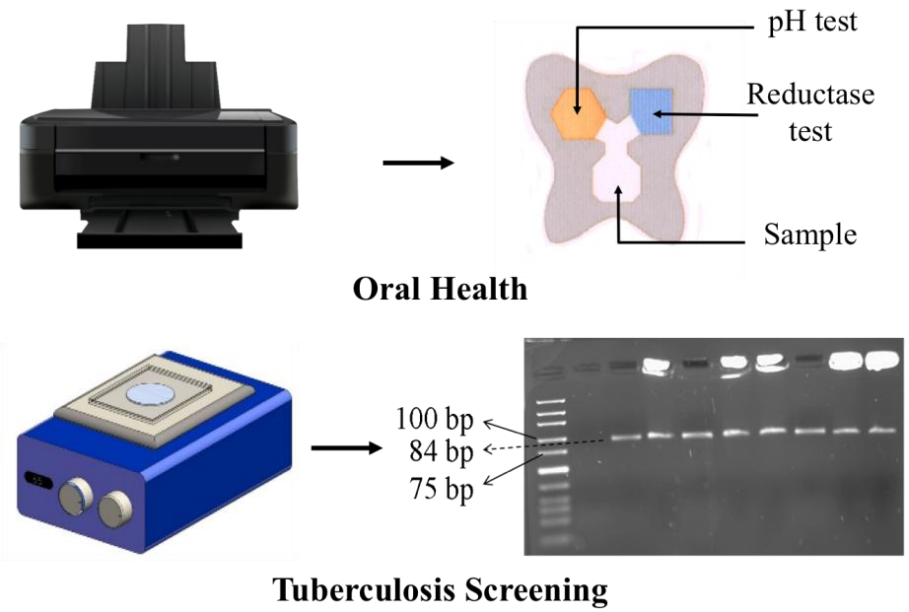
Prof. K. V. Venkatesh, Chemical Engineering

Point of care diagnostics

Detection of sickle cell disease by microscopy







Paperfluidics for affordable diagnostics

Prof. Debjani Paul, Biosciences and Bioengineering

Point of care diagnostics

UCHEK

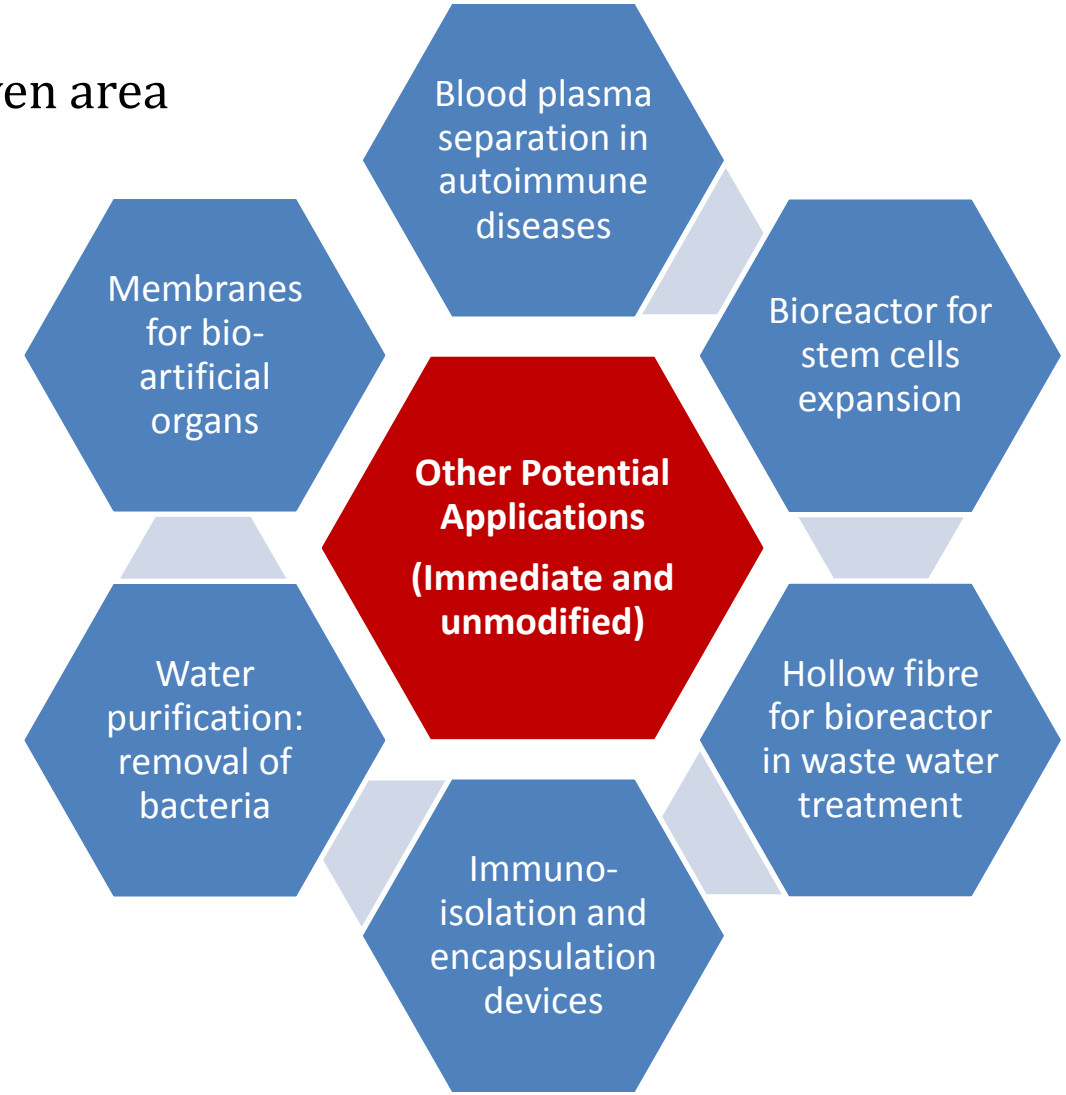
Mobile-based urine & blood glucose analyzer

SUCHEK

Low-cost blood glucometer

Hollow Fibre Membrane for Kidney Dialyses

- Economically viable technology for haemodialysers
- High performance: 10 times greater urea clearance per given area than commercial haemodialysers
- Superior bio-compatibility & improved quality of life for renal patients
- Manufacturers of haemodialysers with end users being patients, nephrologists, industry, dialysis centres and hospitals



Prof. Jayesh Bellare, Chemical Engineering

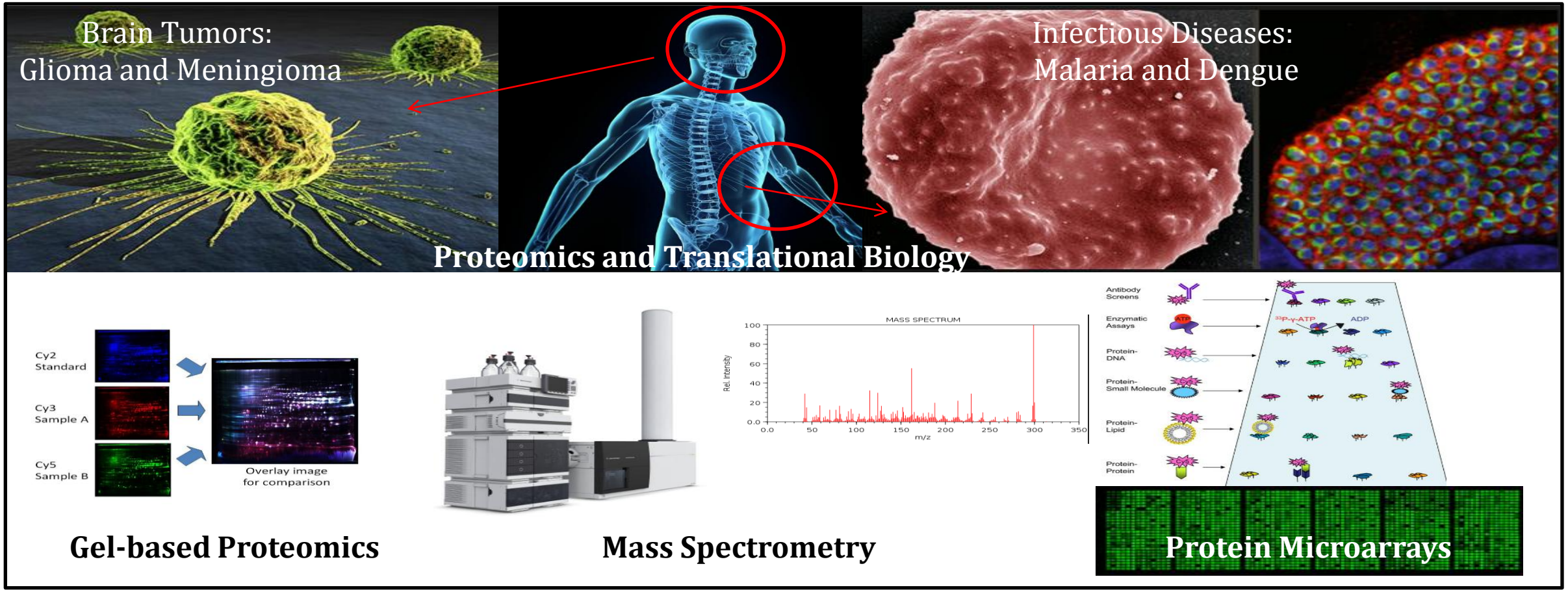
Nutrient Enriched Cosmetics

- Low-cost drug delivery system developed to deliver nutrient supplements through skin of pregnant women
- Aim: To reduce infant mortality

Prof. Rinti Banerjee, Biosciences and Bioengineering

Proteomics for Translational Research

To investigate biomarkers in brain tumours (gliomas & meningiomas) and infectious diseases like malaria & dengue



Prof. Sanjeeva Srivastava, Biosciences and Bioengineering

Biomedical Engineering and Technology (incubator) Center

- BETiC – started in 2014, a translational research center
- Catalyzes indigenous medical device innovation
- Brings together doctors, researchers and manufacturers.
- Develop a range of diagnostic devices, surgical instruments and patient aids covering medical specialties like orthopedics, internal medicine, cardiology and rehabilitation.
- Funding: RGSTC and DST
- Have developed over 100 medical devices, filed 20 Indian patents, and transferred 3 technologies to industry

Prof. B. Ravi, Mechanical Engineering

Biomedical Engineering and Technology (incubator) Center

Ideas room of BETiC

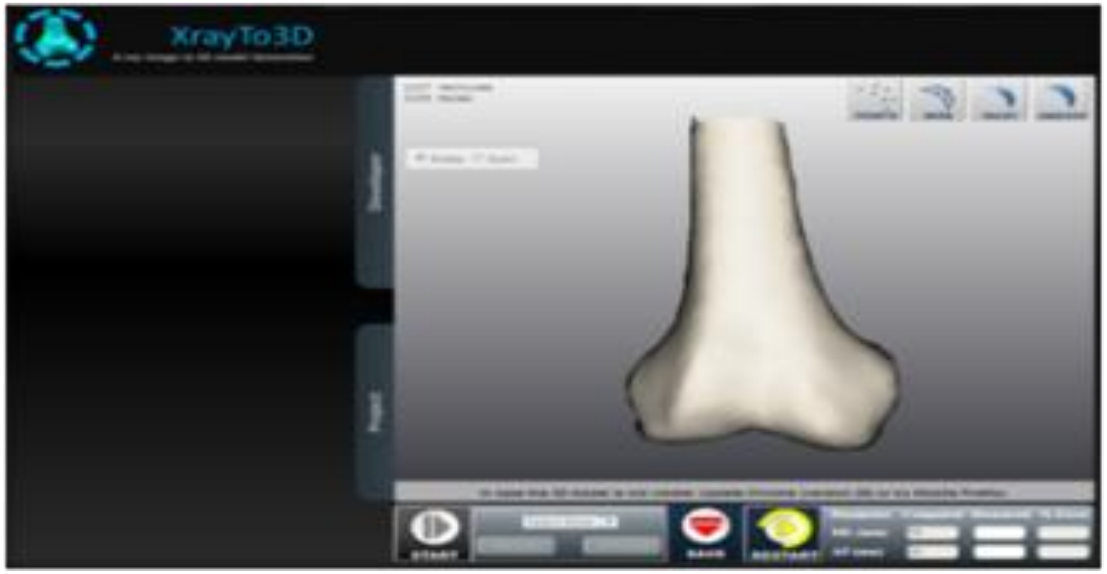
Surgeon testing laparoscopic device

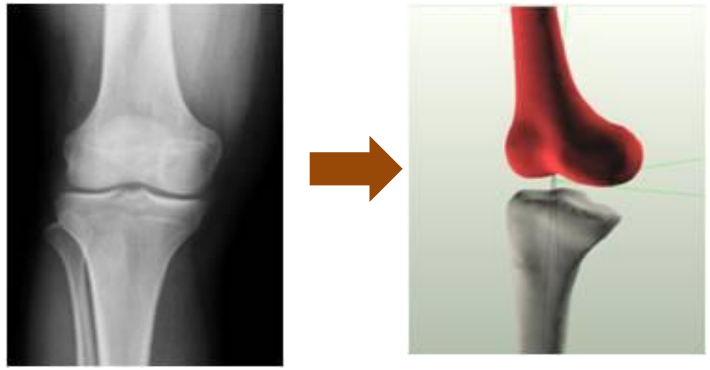
Medical Device Innovation Conclave

Indian Medical Device Exhibition in Dervan

Prof. B. Ravi, Mechanical Engineering

Xray to 3D

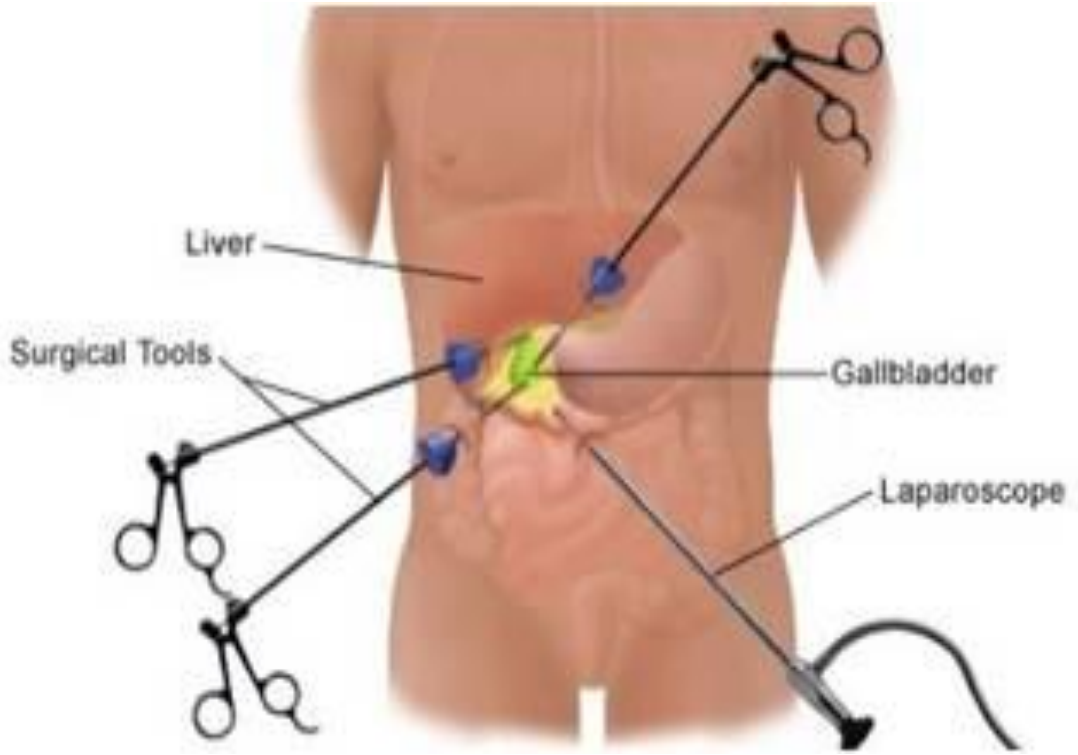




- Cloud based software platform
- To perform 3D surgery planning
- Designing patient specific instruments
- Will assist surgeon to take accurate surgical decisions and to order correct implant from implant manufacturers

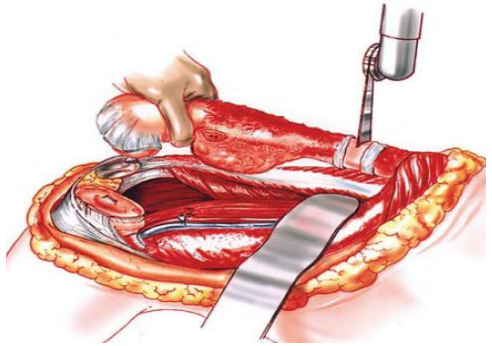
Novel laparoscopic instrument

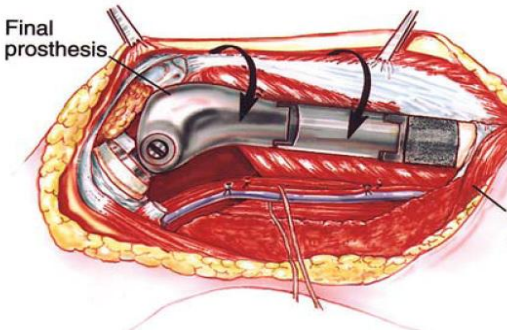
- Enables safe and reliable manipulation of tissue and organs
- Stress-free dexterity for surgical procedures
- Provides seven or more degrees of freedom,
- Additional maneuverability, thereby reducing the risk of tissue damage and surgeon fatigue.
- Accuracy and reliability are maintained



Low Cost Tumour Knee Mega Prosthesis

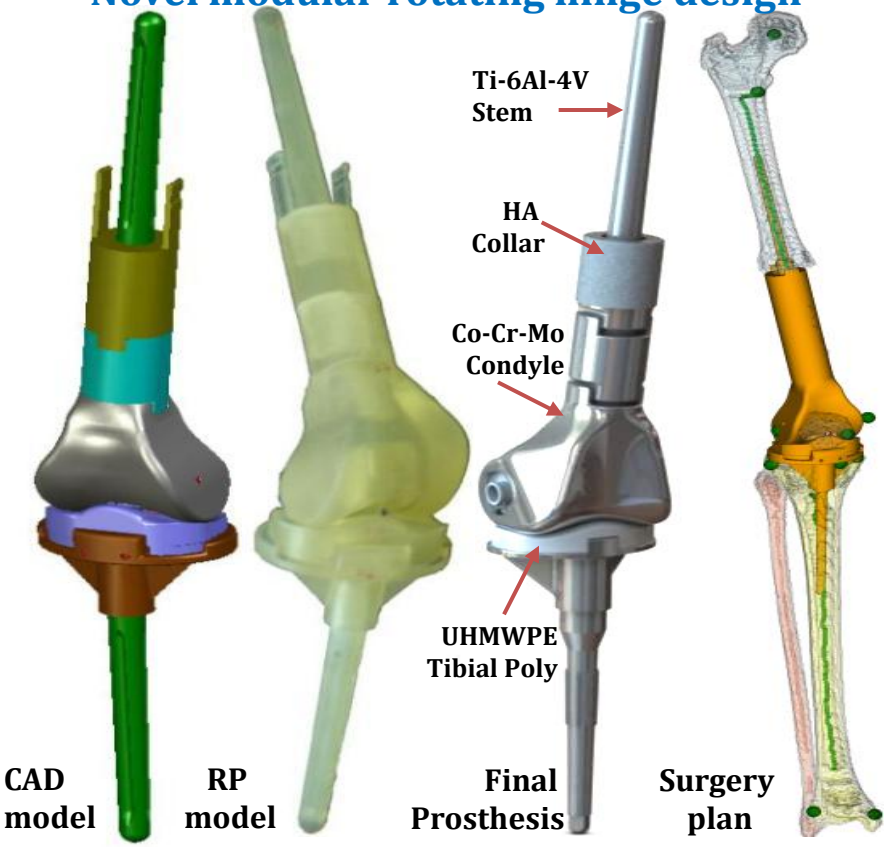
Bone tumor in children:
cancer can be treated but limb is amputated





Limb saving surgery:
Resect tumour bone, reconstruct gap using prosthesis (imported)

Novel modular rotating hinge design



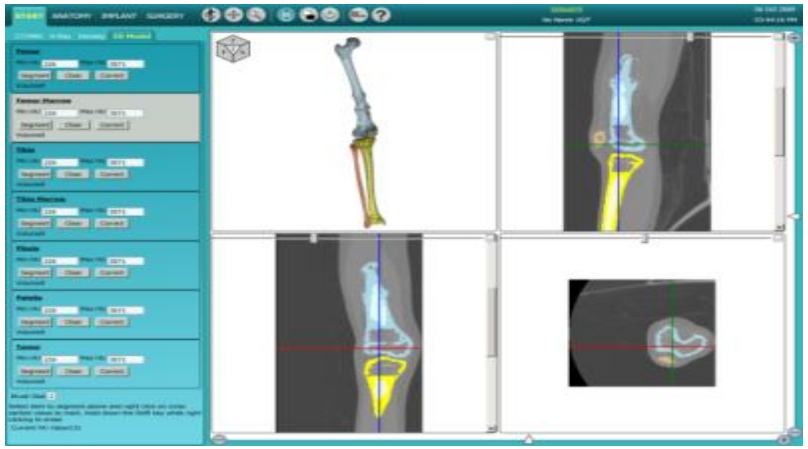
Novel Surgical Instruments

Frugal Manufacture

RP ▸ wax pattern ▸ investment casting ▸ finish machining

Walking Simulator

Implant Safety and Accuracy



OrthoSYS: 3D surgery planning software

Prof. B. Ravi, Mechanical Engineering

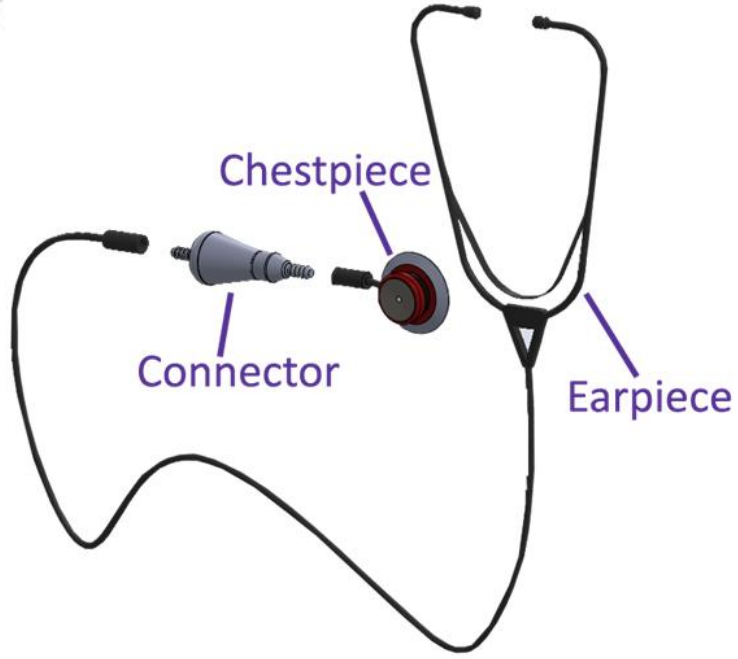
Diabetic Foot Screening Device

- Handy and compact design to measure stiffness of sole
- Sensitive sonsor to measure force accurately
- Reduces cost burden
- 5-wire connection
- 5V DC, 100 Hz
- Operating force: 0-1.5 lb
- Operating tempertaure: 0-70°C

Prof. B. Ravi, Mechanical Engineering

DigiSteth – Digital Stethoscope

Transforming any stethoscope into a digital stethoscope

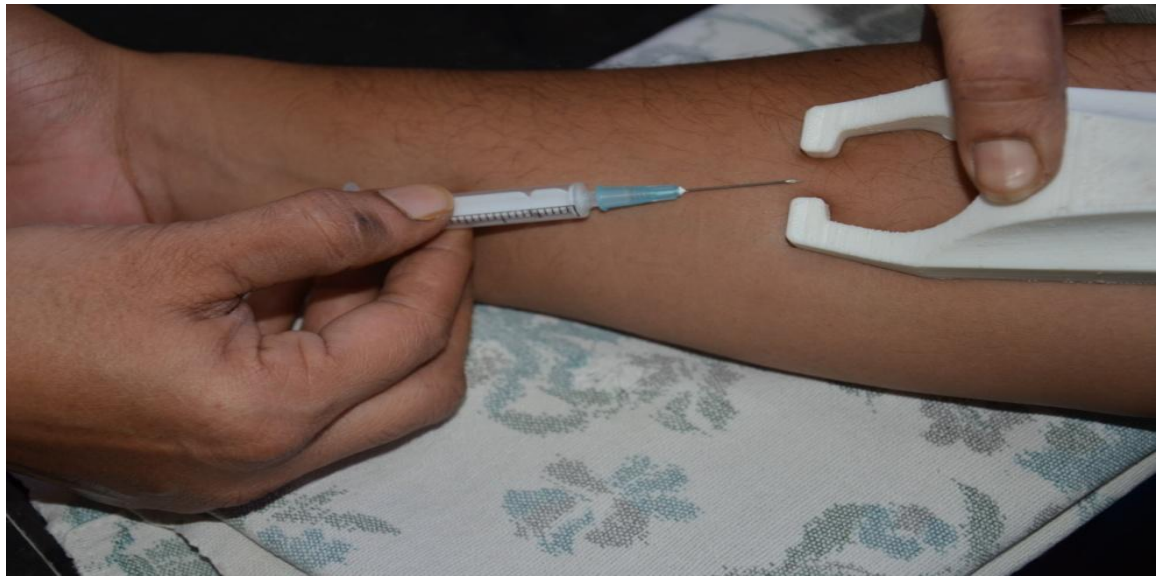


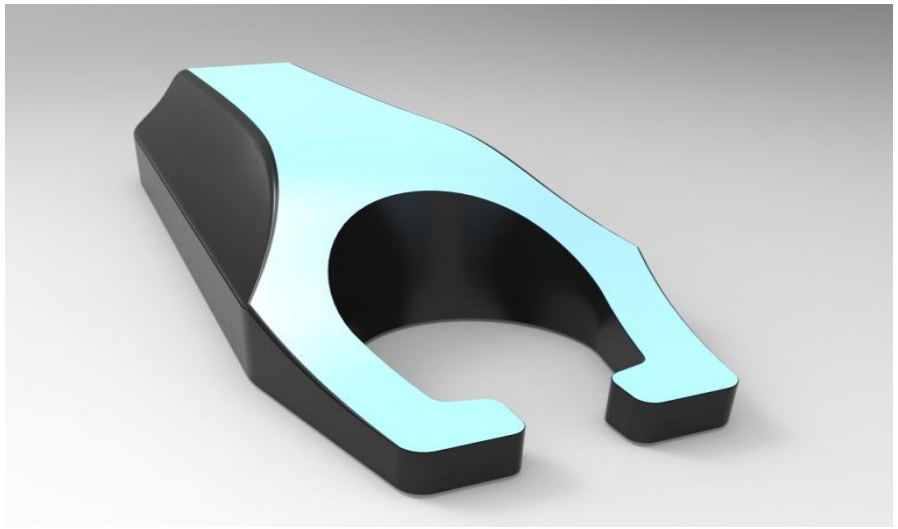
Features of the module

- Volume control
- Recording and playback option
- Bluetooth connectivity
- Traditional look
- Detachable chestpiece
- Provision for simultaneous auscultation

Prof. B. Ravi, Mechanical Engineering

Low Cost Vein Tracer





- Convenient, light weight and affordable
- Ergonomic and user friendly
- LED lights deflected by deoxygenated blood giving a clear silhouette of veins
- Used in busy & frugally run blood camps; blood banks; small and medium sized hospitals

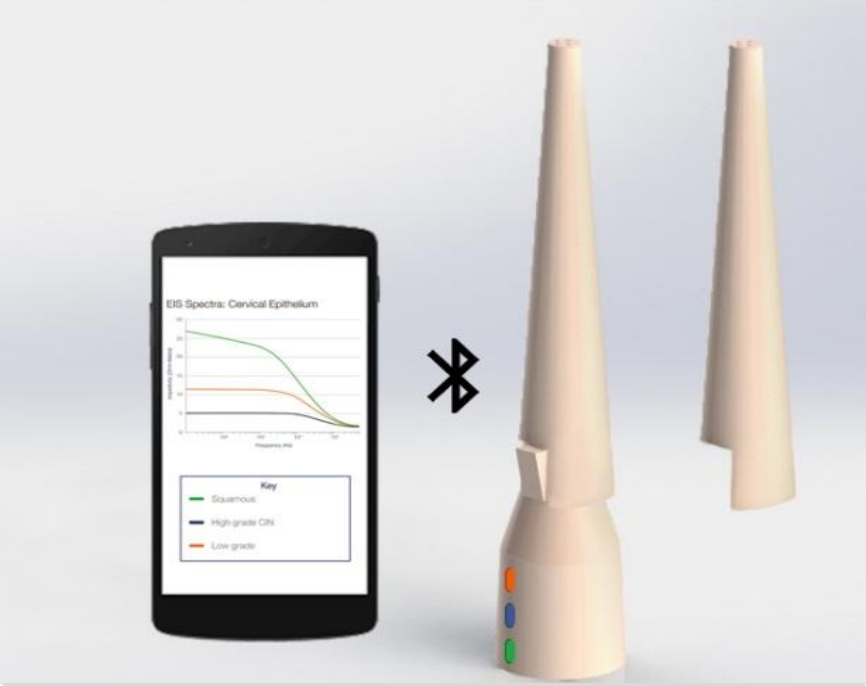
Prof. B. K. Chakravarthy, Industrial Design Centre

Gynae Cam: Preliminary Screening Device For Cervical Cancer

- Affordable with high accuracy/sensitivity
- On-the-spot results
- Minimal training required for device handling
- Reusable, no need of sterilisation
- Rechargeable and portable
- Recordable results - Image captured can be stored on SD Card
- 3x optical zoom and upto 12x digital zoom
- Focal distance of 30 cm, hence need not be too close to body
- Yellow light for better visualization

Prof. Santosh Noronha, Chemical Engineering

SelfCervi: Realtime Self Screening Device for Cervical Cancer



Probe for doctors/health-workers

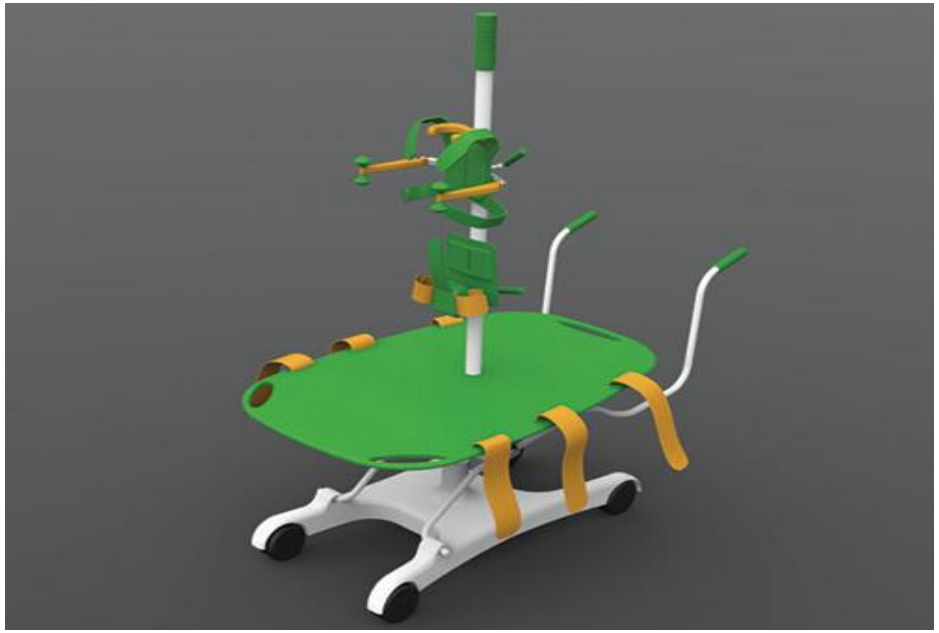
- Clear distinction between normal and cancer cells
- Affordable & simple to use, even self screening
- Real-time, within minutes screening
- Early detection of cancer (CIN)
- Integrated data organizer

One of the University Challenge winners of DST – Lockheed Martin – Tata Trusts India Innovation Growth Programme (IIGP) 2.0 for 2017

Prof. Rohit Srivastava, Biosciences and Bioengineering

Vestibulator

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



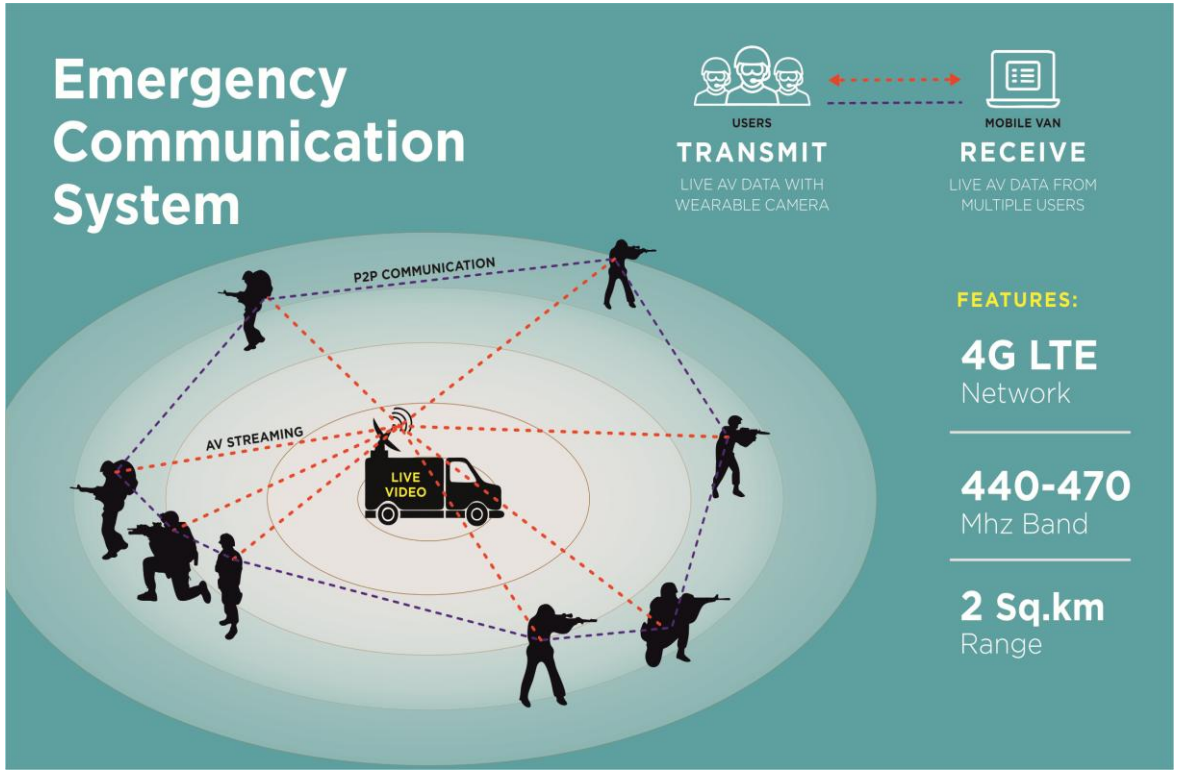
RoVer – remotely operated vehicle

- Wireless control
- Climb steps
- Remote inspection and removal of suspicious objects
- Remote disposal of IEDs

Prof. Anirban Guha, Mechanical Engineering

Broadband Public Protection and Disaster Relief (BPPDR) Communication System

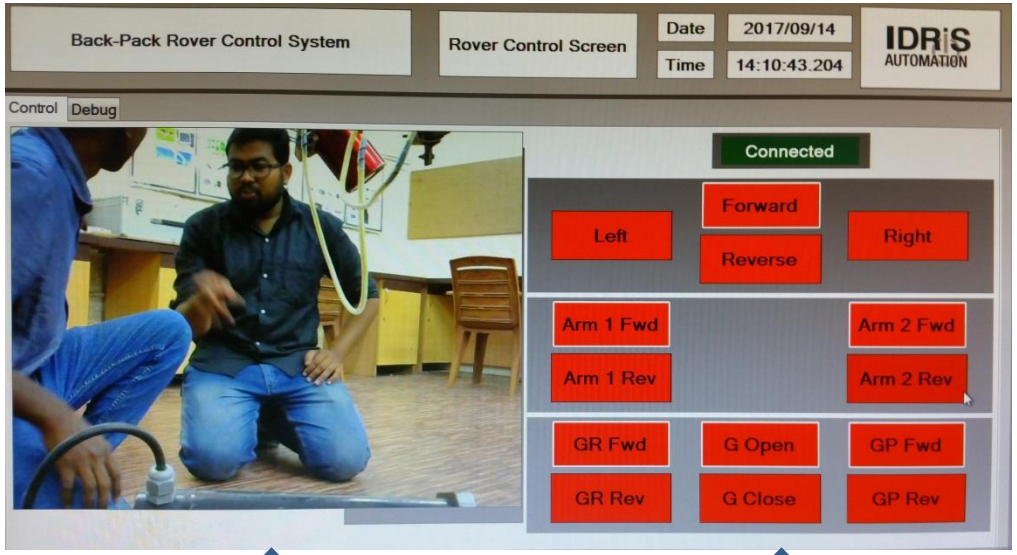
- Designing and development of high speed Broadband Wireless Communication System for Public Safety and Emergency Communication purposes
- Demonstrated one-to-one audio as well as video call using 4G LTE technology on the first prototype
- Design and fabrication of components completed both on the network side as well as the User Equipment side



Prof. Abhay Karandikar, Electrical Engineering

Backpack Rover

- Remotely operated vehicle for handling and disposing Improvised Explosive Devices (IEDs)that can be carried by one man



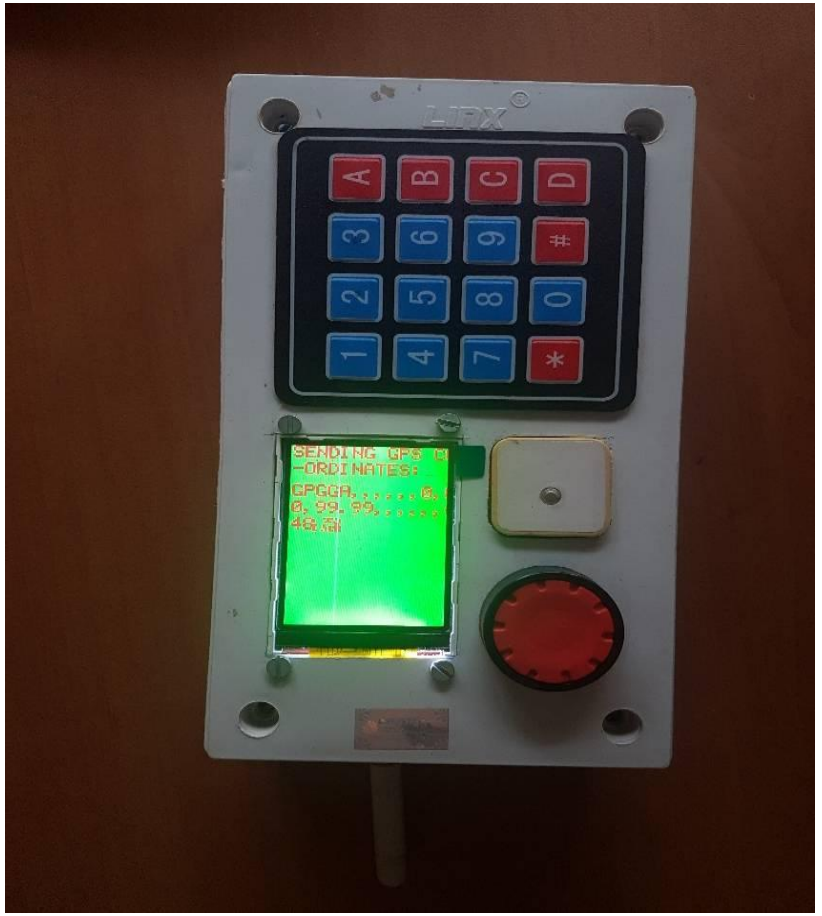
CAMERA FEEDBACK

CONTROLS

Prof. Anirban Guha, Mechanical Engineering

Identification of friend or foe for Coast Guard

- A low cost long range transceiver being developed using off the shelf components
- With encrypted messages, the boat should be able to identify itself using the transceiver and provide its location



Polymer micro cantilever based technology

- Can be functionalised as sensor for various applications like healthcare, defence, etc.
- Framework developed by IITB, manufacturing and testing under progress at SCL, Chandigarh

Prof. Ramgopal Rao, Electrical Engineering

Pulse tube cryocoolers

- Imaging equipment for night vision and heat-seeking missile guidance; cooling electronic devices and sensors
- Ready for commercialization

Prof. Milind Atrey, Mechanical Engineering

Innovation by Design

Design Innovation Center Collaborative Projects

- Prof. B K Chakravarthy & team

Maintenance free post box for India Post by Prof. B K Chakravarthy, India Post Chair Professor

Seat attachment for police lathi (stick) for support during long standing hours

Collapsible helmet for two wheeler ease of use and storage

Solar Rice Cooker with Prof. M V Rane, Mechanical Enginerring

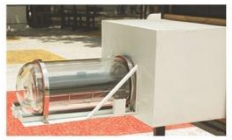
Stainless steel lightweight Palki for Sri Mata Vaishno Devi with Prof. Yogesh Desai Civil Engeering, NITIE, PSA Office

Balloon-Kite hybrid system, a stable aerial platform for applications such as precision agriculture, crowd surveillance, defence surveillance & weather analysis

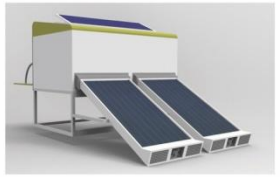
Lightweight Postal Trolley for India Post for bag handling at railway stations with Prof. Ramesh Singh, Mechanical Engineering

Low cost vein tracer for blood extraction

Easy to carry light wight Palki for Ajanta Caves



The Solar Cooker window mounted easy to use



Solar Dryer for preservation of vegetables for farmers in rural areas support from Prof. N G Shah, CTARA

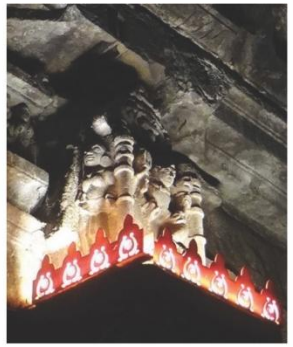
Drumstick Plucker for harvesting matured drumsticks selectively

Easy to carry light wight Bag for Postman

Support of details for Jaipur Foot with Shri D. R Mehta, BMVSS, Jaipur

Domestic water filter for arsenic removal with Prof. Chaudhari, CESE

Smokeless stove which produces coal as by-product support from Prof. Sanjay Mahajani, Chemical Engineering



Heritage Lighting using LEDs to preserve ambience

Societal relevance

Communicator for children with cerebral palsy

Ascender: climbing wheel chair

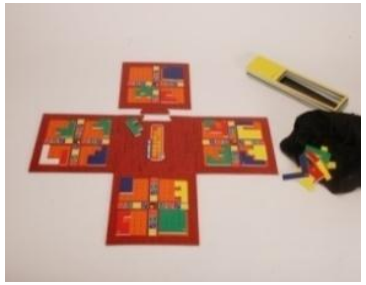
Bed for the Elderly

Online Farmer Knowledge Exchange

Super Critical Fluid extraction

Riding Type Power Tiller

LPG Stove for Visually Impaired



Education & Creativity based Board Games

Technologies and Tools for Cane and Bamboo Craft

Solar Urja Lamp

Indian Rupee symbol

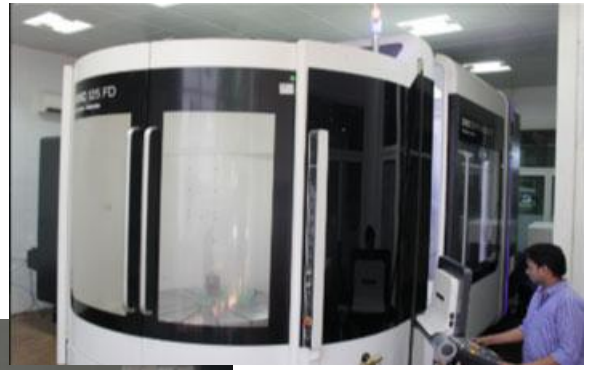
Industry + IITB to pool resources to set up a consortium

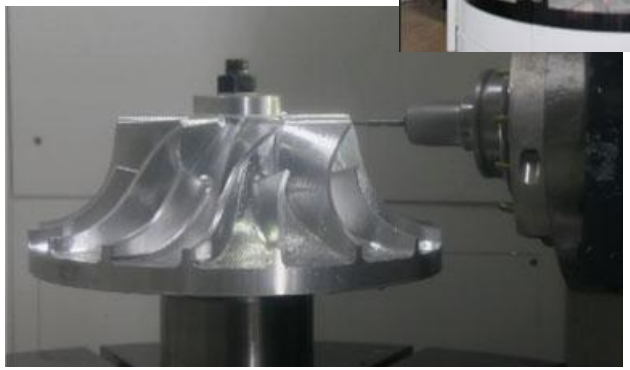
Pilot jaggery plant
1 ton per day

Rajiv Gandhi Sci. Tech. Center, Maharashtra Govt.
Tata Center for Technology and Design

Enable research in emerging areas
IMPRINT, UAY, ...

Advanced Machining
Excellence Cell, NCAIR





National Centre for Aerospace Innovation and Research
IITB, DST, NAL, HAL, Boeing, DMG Mori, Sandvik

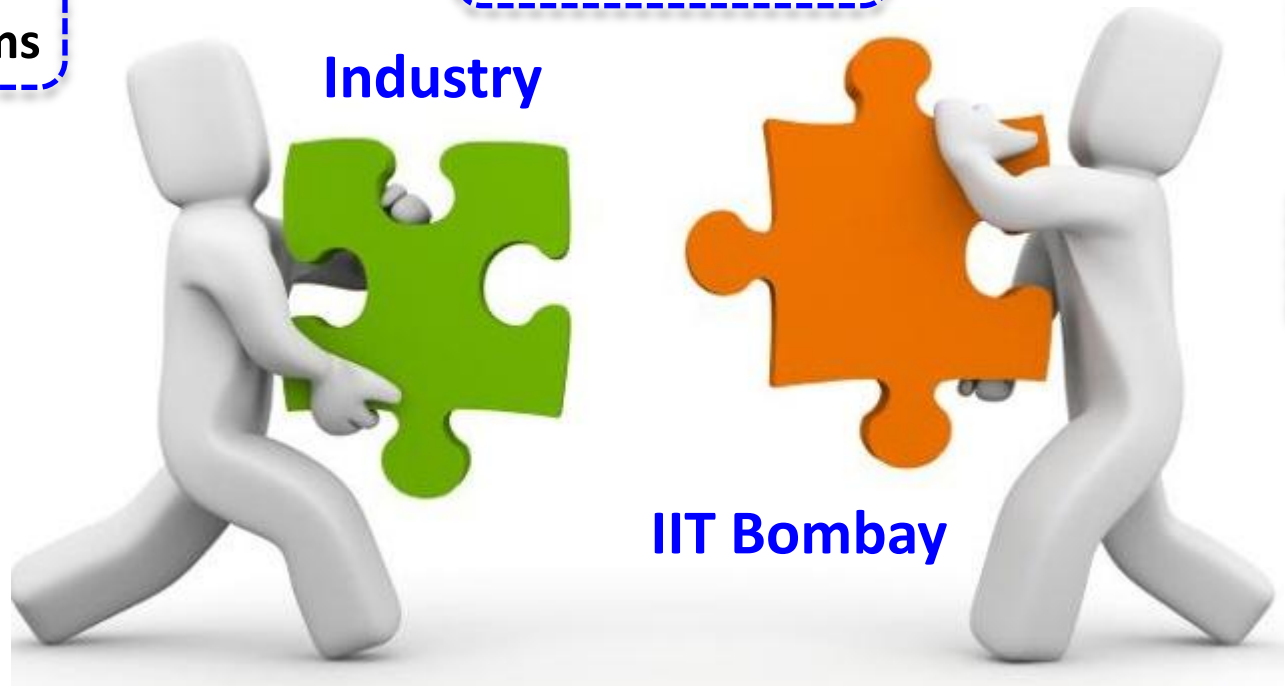
Partnership with Industry

Seek help to solve specific problems

Exploit complementarity

Carry out industry relevant research

Sponsor laboratories, students



Human resource development

Deploy IPs

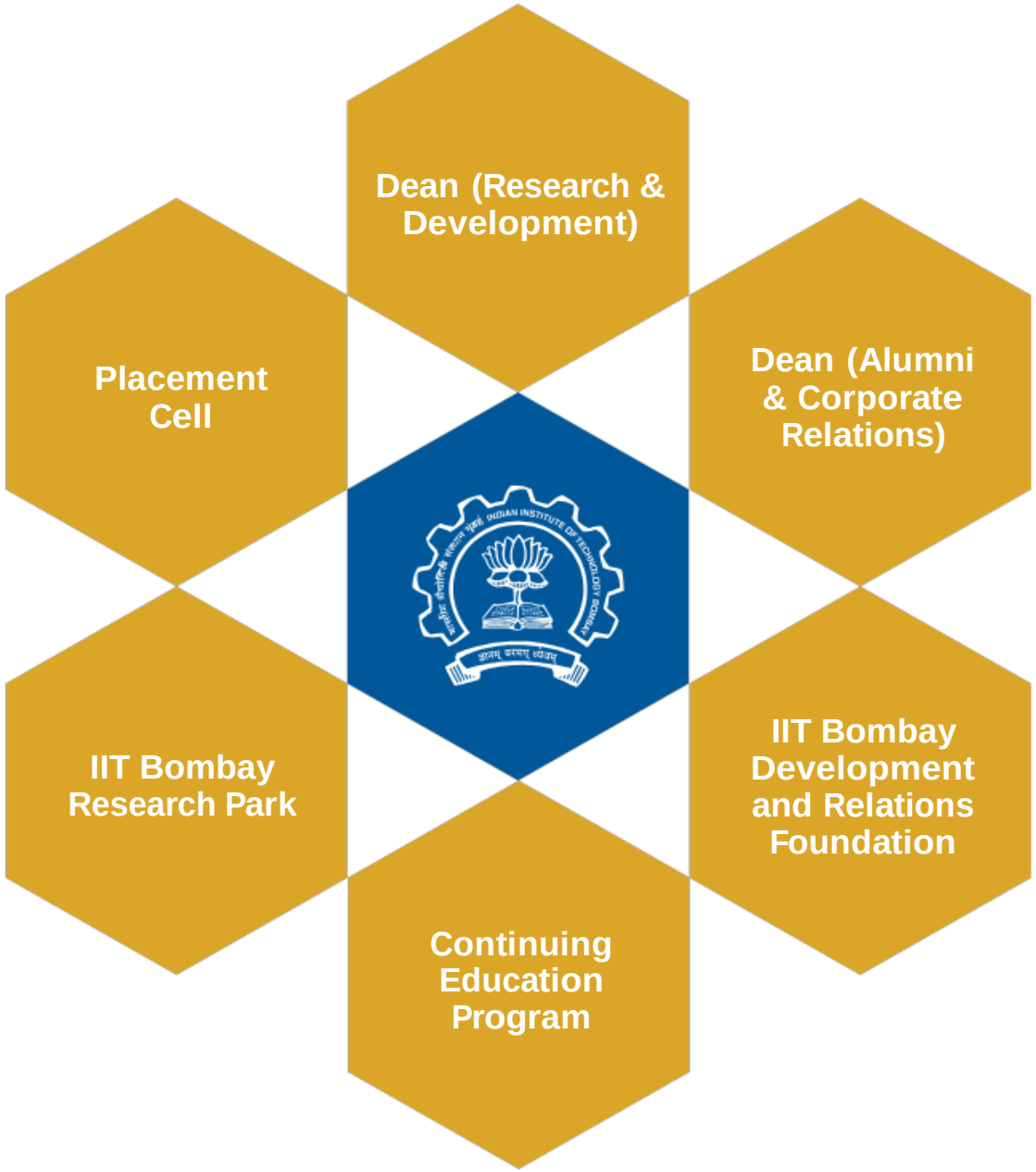
Train industry personnel

Support basic research for knowledge creation

Form Consortia
Visits of Scientists and Engineers

Seed high-tech spin offs

Industry Collaboration



Modes of Industry Interaction

- Consultancy - Short term projects to solve specific problems
- Sponsored Research - Long term research for knowledge generation & manpower development
- Student Sponsorship - Promotion of research & manpower development
- Sponsored Lab/ Facilities - Support for research / lab infrastructure
- Customized Continuing Education Programme for industry personnel
- Endowment Chair Professorship
- Faculty Visit
- Consortia / CoE - to pool resources & enable research in emerging areas

Process

Request for proposal received from Industry

Faculty members identified ; Meeting and initial discussions on expectations

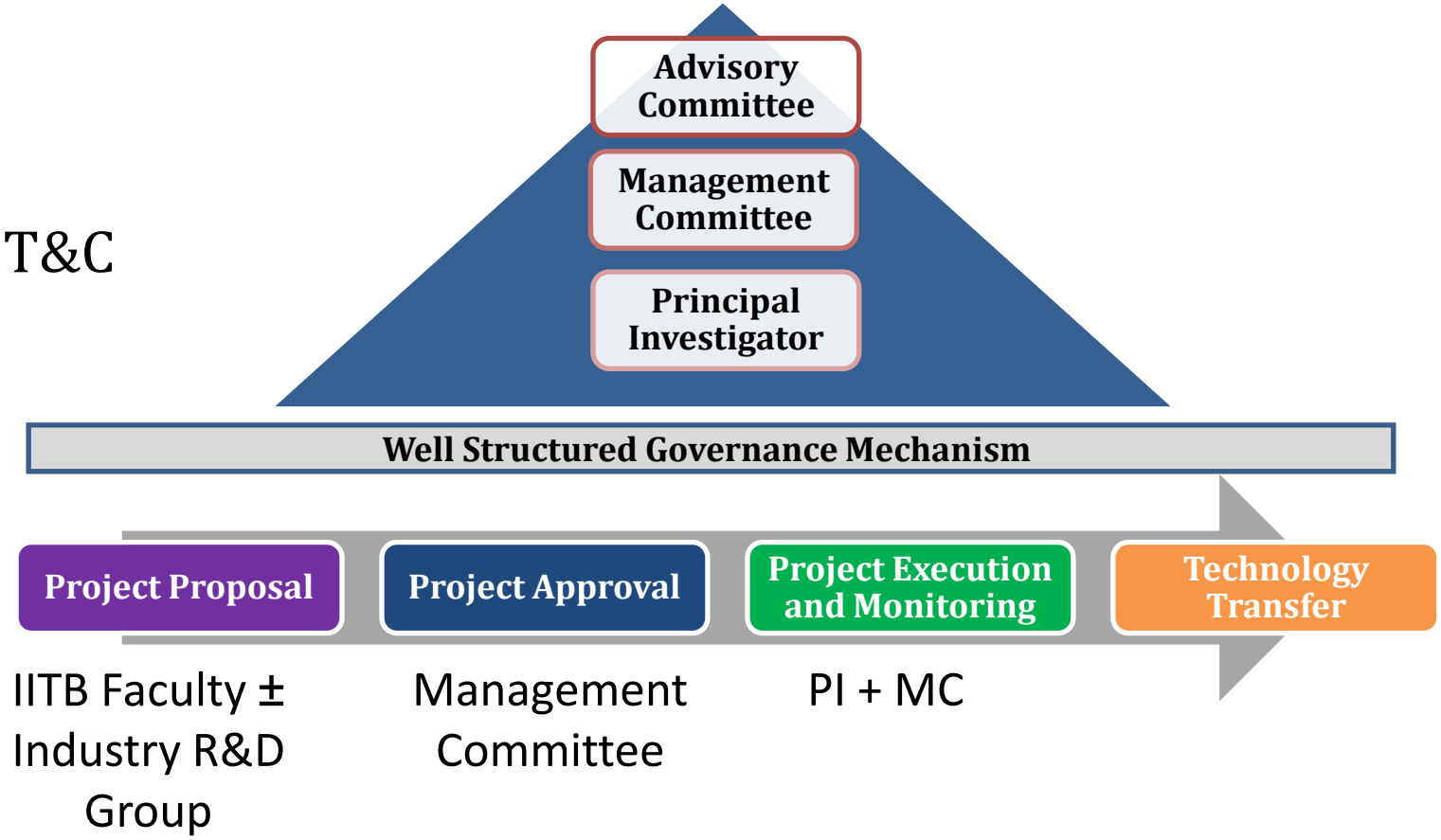
Scoping, budgeting of project between faculty and industry

Agreement finalization

Project initiated

Establish Industry – IIT Bombay Research Cell

- Long term
- Broad areas by Industry
- Fixed funding commitment
- On-the-fly access to data
- Project cycles
- IP: Joint ownership
- Licensing: mutually agreed T&C



Continuing Education Program

Through Professor-in-Charge, CEP

- Widen knowledge base, improve skills of working professionals
- Provide training in critical areas
- Can be short term or long term
- Slow paced to accommodate other commitments
- Can be in-house or @ IITB
- Towards making the Indian industry globally competitive
- Foster learning as a vehicle for innovation and growth
- Open new areas of cooperation & collaborations
- Strengthen industry – IITB interactions

Faculty Visit & Sabbatical

Scientists & Engineers as Visiting Faculty

Visits facilitate formulation of R&D projects

Research Centers @ IIT Bombay

GISE
Advanced Research Lab

Healthcare Research Consortium

Tata Centre
Technology and Design, IIT BOMBAY

National Solar Thermal Research, Testing and Simulation Facility

IIT BOMBAY NCAIR NATIONAL CENTRE FOR AEROSPACE INNOVATION AND RESEARCH

BETiC

FIC-TT

Forbes Marshall Energy Efficiency Laboratory

CA/DE

CEN

National Centre for Mathematics
A joint center of TIFR and IIT Bombay

WADHWANI FOUNDATION

IITB-TTSI Center for Excellence in Telecom

National Mission on Education Through ICT

Shenoy Innovation Studio
Humanizing Technology

CoPT

CCES

SERIUS

CoEST
Centre of Excellence in Steel Technology

Centre for Formal Design and Verification of Software

NCPRE

NCETIS
National Center of Excellence in Technology for Internal Security
Indian Institute of Technology Bombay

Research Centers @ IIT Bombay

- Biomedical Engineering and Technology Incubation Centre [RGSTC, Maharashtra Govt + DST]
- Centre for Aerospace System Design & Engineering [ARDB + MoD]
- Centre for Formal Design and Verification of Software [DAE]
- Centre for Computational Engineering and Science [DAE]
- Centre of Excellence in Nanoelectronics [MCIT]
- Centre of Excellence in Steel Technology [MoSteel]
- Focus Incubation Centre in Technical Textiles
- Forbes Marshall Energy Efficiency Laboratory [Industry]
- Geospatial Information Science and Engineering (@CSE) [DST]
- Healthcare Research Consortium
- National Centre for Aerospace Innovation and Research [DST, NAL, HAL, Boeing, DMG Mori, Sandvik]
- National Centre for Mathematics (with TIFR) [NBHM, DAE]
- National Centre for Photovoltaic Research and Education [MNRE]
- National Centre of Excellence in Technology for Internal Security [MEITy]
- National Mission on Education through ICT [MHRD]
- National Solar Thermal Research, Testing and Simulation Facility [MNRE]
- Power Anser Laboratory [TCS + TCE]
- Shenoy Innovation Studio
- Solar Energy Research Institute for India and the United States
- Tata Center for Technology Development [Tata Trusts]
- Tata Teleservices - IIT Bombay Centre of Excellence in Telecommunication [Tata Teleservices]
- Wadhwani Research Center for Bioengineering [Alumnus]

Sponsored Research Laboratory Facility

- Sponsor a research facility in an area of interest
- Help in building the research infrastructure @IITB
- Shared facility – access control as decided by RPG

By PRAJ industries: Parimal and Pramod Chaudhari Laboratory for Cell Culture

Chair Professorships

- Sponsor “{Industry} Chair Professor”, a distinguished academic position in the Institute
- Selection of IITB faculty as per IITB norms
- Industry representation in the selection committee
- Currently there are around 20 chairs established with donations from alumni and industries

Sponsor student fellowships

- Jointly promote research and manpower development
- Areas of research to be chosen by the Industry
- PhD, MTech, MSc, Dual degree students
- Monthly fellowship + contingency + {travel}
- PM Fellowship: 50% from GoI + 50% from Industry
- IP, acknowledgements, etc. - mutually agreeable T&C

Jointly with the office of the Dean (Academic Programs)

Commercialisation of Intellectual Property

- Collaborative development and licensing
  - Joint ownership of IP
  - First option for exclusive licensing
  - IP ownership to industry on mutually agreed terms

- Licensing of IP generated in the Institute
  - IP generated through academic / unrestricted sponsored research
  - Can be exclusive or non-exclusive license
  - Assign IP on mutually agreeable terms

- Incubation / entrepreneurship
  - Technology business incubator for commercializing IITB IP (SINE)
  - Faculty, students and alumni as incubatees
  - License to use IITB IP

Society for Innovation and Entrepreneurship (SINE)

- Technology Business Incubator of IIT Bombay set up in 2004; a not-for-profit entity
- Facilitates conversion of IIT Bombay R&D into commercial entities
- Helps in building business models / plans, fund raising, approaching clients
- Governing Board members includes IIT Bombay faculty and industry experts
- Incubate companies that have a potential to create economic growth and/or have a strategic or social value
- Intellectual property created by IIT Bombay faculty, students, staff, alumnus

Through Professor-in-Charge, SINE

Impact

112 Cos. Incubated and accelerated	Current: 47
	Graduated/ exited/ acquired: 44
	Folded: 21
3,000+ jobs created during incubation	

36 Cos. Funded by Angels/ VCs.	18 Cos. Funded by Bank/ Govt.
Total funding raised by SINE companies: 500 crore+	SINE investment **vs** externally raised: 1:150+

IITB IP commercialized	28
Faculty involved startups	23
Companies with social innovation	26
Equity liquidation (partial exits in 18 companies)	3 crores+

Policies and procedures emulated in many other colleges

Data as on October 2017

IIT Bombay Research Park

IIT BOMBAY RESEARCH PARK
aspire
APPLIED SCIENCE PARK FOR INNOVATION RESEARCH & ENTREPRENEURSHIP

Vision

Achieve recognition for innovation, entrepreneurship and research excellence through industry-academia collaboration

Mission

- Establish an innovation hub via industry-academia collaboration
- Enable two-way flow of knowledge and resources
- Create joint IITB-industry R&D groups for stronger impact
- Provide a platform for fostering entrepreneurship

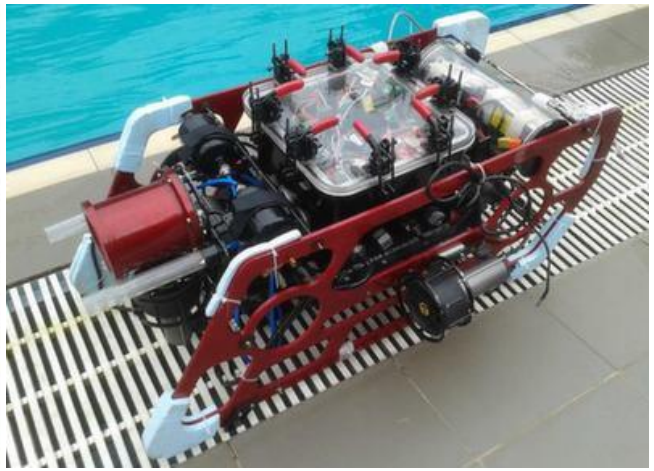
Members

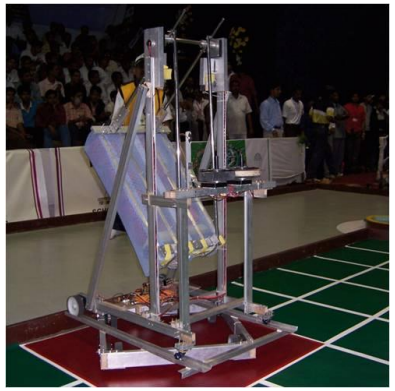
Applied Materials, Bharat Forge, Suzlon, NanoSniff Technologies, TATA Power SED, Cummins

Through the office of the Professor-in-Charge, IIT Bombay Research Park

Student initiatives

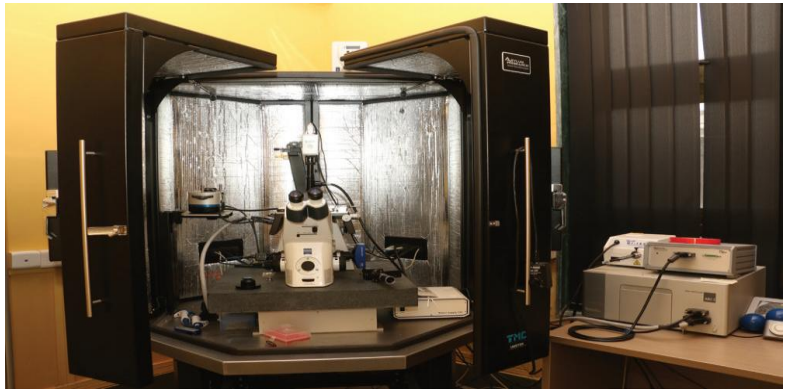
- IITB Racing
- Pratham satellite
- Mars Rover, Land Robot
- Intelligent ground vehicle
- Shunya at Solar Decathlon
- Rakshak: Unmanned Aerial Vehicle
- Matsya: Autonomous Underwater Vehicle
- ASME : Fast, strong & agile multi-functional robot
- Drishti: Auto-tunable lens for universal eye glasses





Thank You

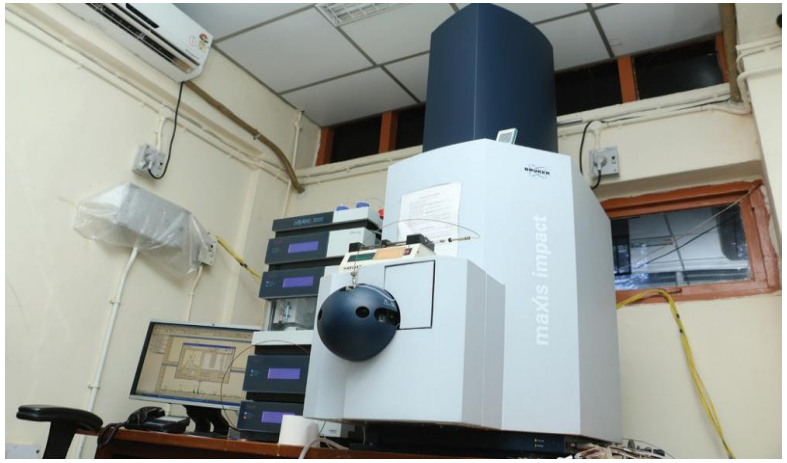
High-End Research Facilities at IITB



Bio-Atomic Force Microscope

Central Surface
Analytical Facility

Fluorescence Activated
Cell Sorting



High Resolution
Mass Spectrometer

High Resolution
XRD System

Environmental Scanning Electron
Microscope