Tata Centre
Technology and Design, IIT BOMBAY

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TURNING POINT

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Inside

MIT & IITB Tata Fellows meet up

The joint orientation of Tata Fellows from MIT and IIT Bombay was a busy day with a mixed bag of activities

The Fellows from MIT-Tata Center and Tata Centre, IIT Bombay, had a line-up of activities in the joint orientation that was planned on campus, in early August. The day had talks, presentations, lab visits, a simulation game and a happy game of cricket packed in good measure.

After the initial round of introductions, the story of Khethworks – a social enterprise formed by Tata Fellows from MIT-Tata Center - was presented to the audience. Prof Chetan Solanki from IITB then spoke about his project on reaching 1 million Solar Urja Lamps (SoUL).

In the lab visits planned after that, the IITB Tata Fellows took their counterparts around campus. Both institutes' Tata Fellows were brought up to speed with their project work and each other, through an interactive speed-dating game. Indoor cricket followed and the four teams ensured that it was a win-win game.

The MIT-Tata Center team, some fellows and two project managers from TCTD, IITB, followed this initiation with a week-long trip to Karnataka, to learn more about social innovation.

- Gayathri Thakoor, Project Manager

A novel solution to treat grey water

The project team hopes to make the IITB residents aware of the quality of recycled grey-water

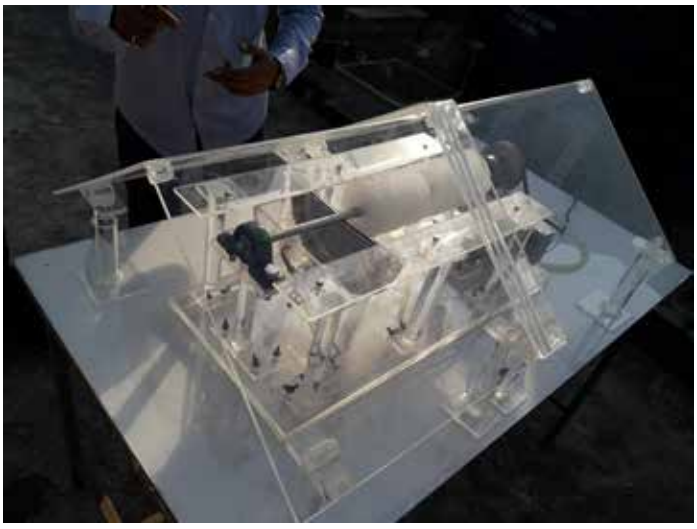
WATER

The increasing awareness of water scarcity in India has led to the idea of grey water recycling. Through the project - Characterization of Grey Water and Development of a Cost Effective System for Grey Water Recycling - Prof Suparna Mukherji, Centre for Environmental Science & Engineering, and her project team have been working on a novel low cost solution to treat grey water which comes from kitchens, bathrooms and not from toilets. This recycled water can be then used for toilet flushing and gardening purposes.

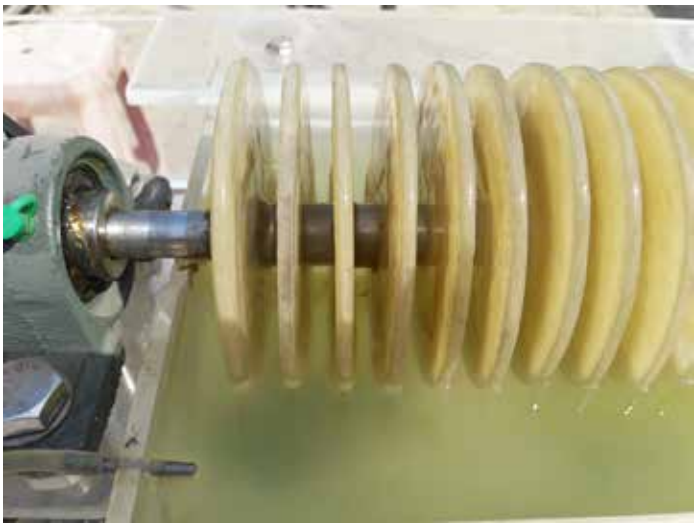
The team is involved in the development of the novel 'Rotating biological contactors' (RBC) – a technology-based reactor with a non-woven fabric, with a volumetric capacity of 2.5 litres. The project team is developing an RBC system which rotates at high speed, aerates the system & has a non-woven fabric filter. Biological treatment happens in the first two stages and collection in the third stage, and between these two stages there is non-woven fabric. The biofilm developing on this fabric improves the quality of grey-water. Since it does not have a disinfectant unit, the removal efficiency of solids, turbidity & organic matter are the parameters that are being worked upon.

The solution is being compared with the already existing `Sequencing batch reactor' (SBR) plant installed (110 kilo-litre/-day) at Hostel 10 in IIT Bombay. Prof Mukherji elaborates, "The grey water is first sent to an equalization tank, after which it goes to a SBR where the biological treatment of grey-water is done by the use of micro-organisms. Then it is followed by filtration in the activated carbon unit where most of the organic salts are removed. Disinfection follows using UV or chlorination part. This water is to be used for toilet flushing & gardening."

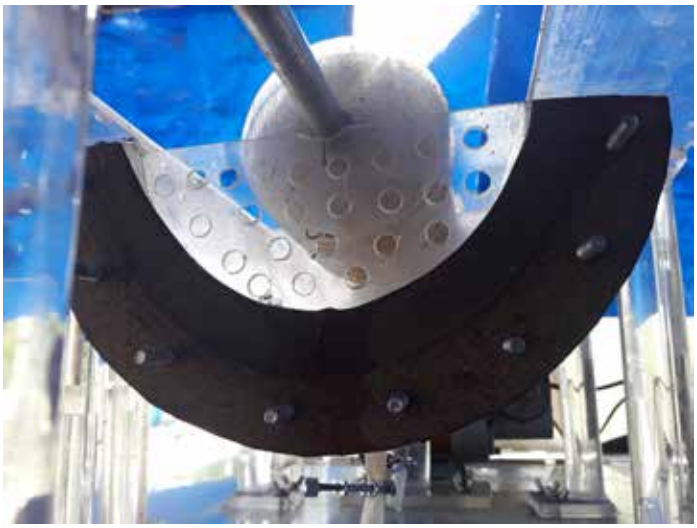
Among the various solutions available, this project prototype has the novel non-woven fabric which is key.



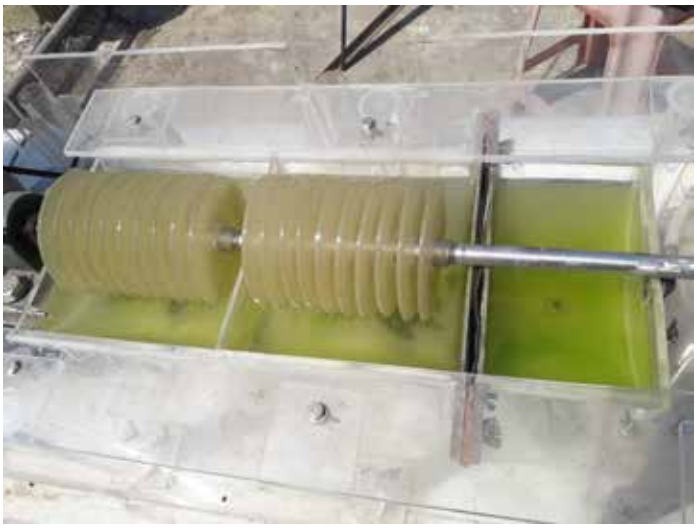
Fabricated prototype of the novel RBC



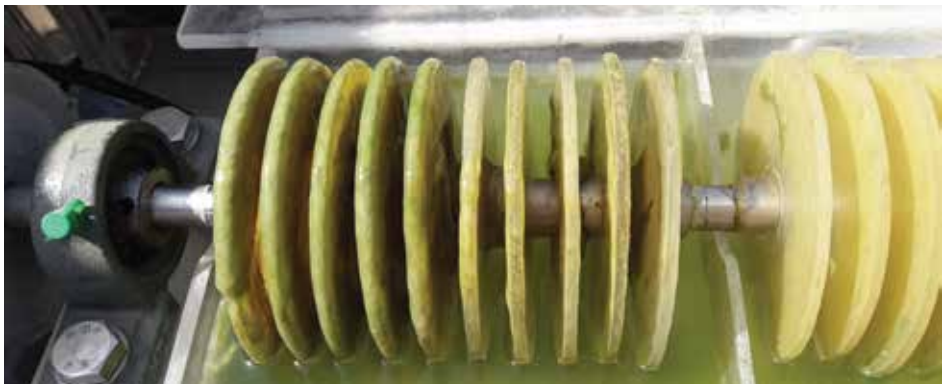
First signs of biofilm development on the rotating media



Sectional view of non - woven fabric



Algal growth observed in reactor during early stages



Thick algal bacterial biofilm formed

Algae nuisance reduced after covering the reactor

The plant in Hostel 10 is being studied for various parameters of performance and these results can be shown to IIT B administration to take a note on the functioning of the plant. Apart from that, the building residents are key stakeholders. Making them aware of the quality of grey-water is one big challenge.

The team has faced various operational challenges in monitoring the components of the SBR plant as well as in the characterization of grey-water inlet & recycled water outlet in the SBR plant due to huge variations in inlet water. There are other issues to tackle concerning input water variability, development of serum due to excessive biofilm etc. throughout the development of this project. However, the project team is looking forward to scaling up the RBC prototype to cater to the residential needs of grey-water recycling with its current volumetric capacity of 2.5 litres & then aiming for technology transfer opportunities in the future.

- Vipul Ahuja, Tata Fellow 2016

New water bacteria sensing system

The sensing system can quickly indicate the presence or absence of bacteria in water

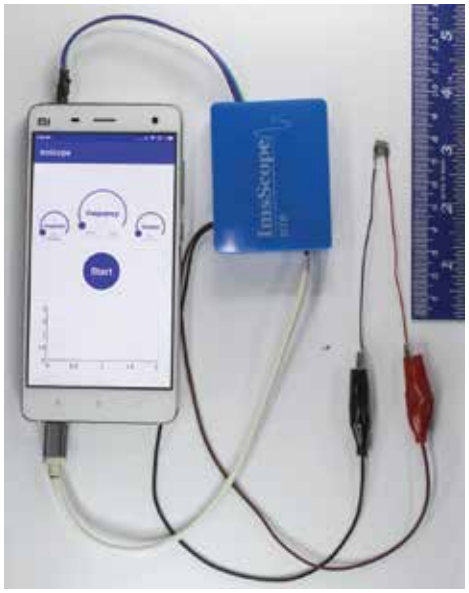
WATER

With a vision of creating the water quality map for India, Prof. Soumyo Mukherji, Department of Biosciences and Bioengineering, and his team have developed a very inexpensive, paper-based water bacteria sensing system that can be deployed on a wide scale. Through the Centre's project - EIS platform for bacteriological monitoring of water – the team has developed a highly portable sensing system that can quickly indicate the presence or absence of bacteria in water.

The PI and his team have utilized a technique known as Electrical Impedance Spectroscopy. The system employs a paper-based sensor and a mobile phone to generate and analyze the various frequencies used to estimate the water quality. Such a setup ensures high portability and huge reduction in costs. Currently, it is planned that the sensor will be employed for recycled and treated grey water monitoring in municipal plants and private housing societies.

One such grey water plant is already setup in Hostel 10 at IIT Bombay and this sensor system is being considered for deployment there, so that it will enable quick monitoring and certification of the quality of treated water. Another possibility is the use of this sensor system by water treatment companies to determine the amount of chlorine dosing needed, based on the quantity of bacteria in water. Once the sensitivity of the sensor is improved, it can be used for a wide variety of purposes that can have a big impact in looking at the water quality scenario of the country.

Different configurations of gold electrodes sputtered on filter paper



Handheld impedance spectroscopy device for bacteria detection in water

- Jasleen Chhabra, Tata Fellow 2016

Individualizing the Metabolic Model

The model is specific to everyone's needs and requires variability in population and building layers of genetics, diseased states and its effects on metabolism

HEALTHCARE

Q & A with Prof. Kareenhalli Venkatesh, Department of Chemical Engineering, on the Tata Centre project - Digital Automated Wellness Management Platform for Indian Infants and Children

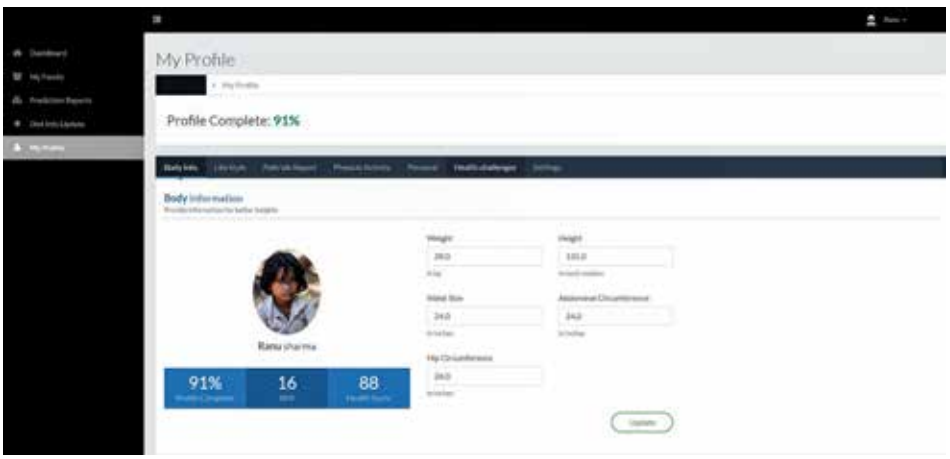
Q1. What is the project about?

A1. Our project started out with trying to develop a whole body metabolic model in adults where we would model the metabolism in liver, muscle, adipose tissue and through blood, connect all these organs. The key idea was to capture the individual's lifestyle and see how the diet, physical activity, stress levels, etc. acted as inputs to predict the metabolic state. Later on, it helped to predict how the body weight, fat percentage and the muscle mass changes occur as a function of the lifestyle choices. With this as the basis, we developed a model for children wherein the variation of body weight and height was incorporated.

For children, the model takes in inputs such as physical activity and diet to predict the muscle mass, BMI, height, etc. An App and a web-based portal have been developed where NGOs dealing with malnutrition can put individuals' data and then try to optimize the diet so that the success rate improves. The model is designed to meet UNESCO standards for the acceptable percentiles of children in the healthy range.

Q2. What motivated you to work for such a socially-oriented project?

A2. There has suddenly been an increased risk in lifestyle-related problems like heart attacks and diabetes in India. It is predicted that by 2025, India will be leading the numbers in terms of patients with such diseases.



However, it is possible to prevent these by just making lifestyle changes. Our aim was to use the model to capture the data well in advance and identify which people were most prone to developing such diseases, and if possible, advise them to make healthy adjustments to their lifestyles.

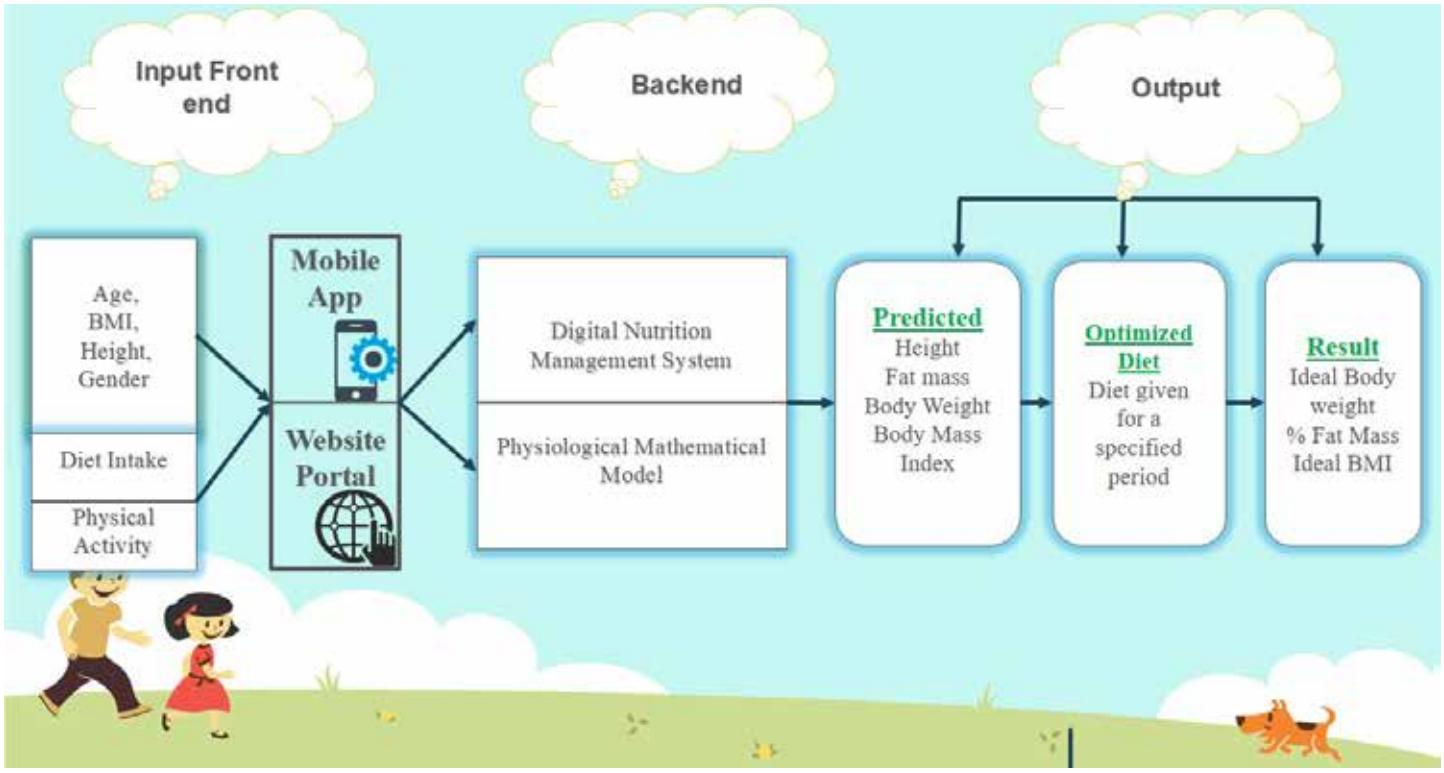
For children, there's a double-faceted problem of malnutrition that needs to be tackled. While those in cities suffer from obesity due to improper diet, the relatively obscure regions have undernourished and underweight children, thereby making them susceptible to illness. We were motivated to develop a model for children along similar lines such that a scientific, physiologically based model could be developed – one that could be used by parents, schools, doctors and NGOs and could be used to improve children's health.

Q3. Can you elaborate on the tools or technologies used in your project?

A3. The model for children is adapted from the one we developed for adults. It is unique in the sense that no such model currently exists anywhere in the world. The portal can be accessed by hospitals, schools or parents, and the data is uploaded to the cloud for further processing. As data pours in, the model will keep refining itself using techniques such as machine learning, artificial learning, data reconciliation, regression analysis etc. Moreover, since the data is stored in the cloud, it can be used by the child throughout life. The digital nature of the project also offers the advantage of being successfully demonstrated in a small region and rapidly scaling-up after that. Once we gather sufficient data, the model can be used to individualize so that the variability between children can be captured. Further, layers can be built on the model to capture genetics, diseased states and its effects on metabolism in a population.

Q4. Who is the target audience for your project?

A4. Since obesity and undernourishment affect children in both urban and rural areas, we have to adopt a multipronged approach. Initially, we are targeting hospitals; to engage with them and ask them to start using our portal.



We also plan to target the health units of schools to constantly monitor the children's health, and be in touch with NGOs and government agencies that deal with malnourished children. Once we have sufficient data and the model is improved further, we can process the data and draft a policy document for the government that can be used for different strata of society- tribal, rural or urban. That would be useful for the government to look at specific areas that need improvement and also monitor whether their actions are yielding the desired results. Since the model is generic for children, the platform can be used to address obesity among children, which is also becoming an issue in our country. The model can also be used by the food industry to develop healthier food formulations and to predict its effect on a population.

Q5. Have you carried out any field-testing until now?

A5. While we have analyzed the data with some children from Dharavi, a definitive success case has been the study of children of daily workers in IITB. Their data was taken and following it up, we were able to achieve errors of less than 10%. That has been a great confidence booster.

Q6. Are there any collaborations with other organizations in the project?

A6. While we have obtained a lot of data from research studies being undertaken on malnourishment especially by Prof. Narendra Shah, CTARA, IITB, we have tried to see how the macro and micro nutrients are balanced to improve their health. We are also collaborating with a local hospital for pilot testing of our platform for both obese and undernourished children. At this point, the focus is on collection of data to validate our model. Once we achieve that robustness, we will release it to organizations for specific projects.

Q7. Can you give an idea regarding the timeline of the project?

A7. The work on the adult model is being carried out for the past 7-8 years and for about two years for the children's model. The model will be fine-tuned in the coming months. With feedback from various organizations, the plan is to generate a white paper which will form our basis of approaching different government agencies.

Q8. What challenges did you face while executing the project? Do you expect more in the near future?

A8. The lack of data was a huge challenge. Most of the data that was available was for Caucasians, Europeans and Americans. We wanted to develop a model that was specific to Indians. When we shifted to the children's model, there was no reference available anywhere in the world. So,the lack of data was, and is, a major challenge. In order for our model to be useful, it had to have a good predictive capability. That could come only through parameters, which needed lots of data to be analyzed. We are still on the lower end of data collection but six months down the line, we expect better data inflow from various agencies. It is necessary to ensure that a robust platform is made specifically for Indians. Another challenge we face is sourcing the food and nutritional database for indigenous food items. We are working towards developing such a database which will help in suggesting local diet preferences to mitigate obesity and mal-nourishment.

- Jasleen Chhabra, Tata Fellow 2016

The young guns in the fold

The Centre has awarded its Fellowships to the choicest of students, amidst tough competition

After a comprehensive selection process, 22 new aspirants were awarded the prestigious Tata Fellowship this academic year, by the Centre. There are 20 M Tech students and 2 PhD scholars from across various departments who have made it to this list.

The process of selection involved about 100 M Tech students from across IIT Bombay taking a written test to participate in the End to End Innovation course – Pro Seminar - and to apply for Tata Fellowship. This year, the participants for the test included research staff from IIT Bombay.

These Tata Fellows are expected to work with the Centre on projects of social innovation to develop technologies for the needs of communities in India and other developing nations. While the fellows get their basic degree in the respective Departments, they work on the ongoing projects at the Centre as part of their academic requirement.

The Shailesh J. Mehta School of Management (SJMSOM) will train the Tata Fellows in the Pro Seminar course.

While the team at the Centre has oriented the new Fellows to its activities, an outline of the involvement that is expected of them in the next two years has been clearly defined.

- Gayathri Thakoor, Project Manager

Welcoming new projects and PIs

The Centre oriented the new PIs and their projects to its activities and working process

The Centre welcomed nine new projects and the respective supervisors to its activities in July. This was part of the Centre's initiative to work closely with the various faculties.

An introductory meeting was first organised to welcome the faculty supervisors (PIs) and Co PIs of the new projects recently granted by the Centre. The faculty members gave short presentations of their projects and described the envisaged solution outcomes they were working on or were about to start soon.

Prof. Sanjay Mahajani, the Professor-in-charge, detailed the group about the Centre's ability to assist in every possible function to get successful deliverables. He also elaborated on the Solution Readiness Level process which is to plan project milestones, to help move from seed to translation stage, for the TCTD-funded research projects.

In another session, the significance of the Stakeholders' Analysis was emphasised upon to the new PIs and their project teams. Prof Arti Kalro from SJMSOM, explained the relevance of involving the stakeholders, right from the initial stage in every project. The theory was then effectively applied in Centre-specific case studies presented by postdoctoral fellow, Dr Sonal Thengane and project manager, Chandrakala Sharma.

- Gayathri Thakoor, Project Manager

Sensing heavy metals in water

The sensor µ-sense can be used to detect the presence of heavy metals in water

WATER

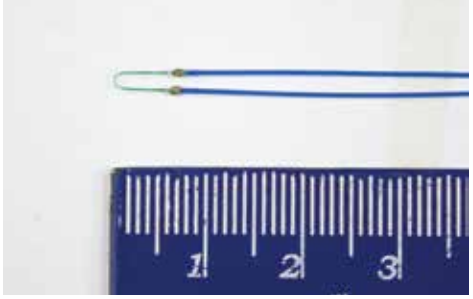
India faces a widespread problem of water contamination by heavy metals. In order to ensure that water quality is good enough for drinking and agricultural purposes, the heavy metal levels in water must be below a certain threshold, or should ideally be zero. Testing the presence of such metals is a time-consuming and costly process currently, and thus cannot be carried out at frequent intervals, and at all locations.

With this in mind, Prof. Soumyo Mukherji and his team have worked on the project, "Heavy metal sensing in water using optical fiber sensors" to develop a water quality sensor system. It leverages on the previously developed optical fiber sensor platform called µ-sense, and can be used for detecting the presence of mercury, lead and arsenic in water. The system utilizes an optical fiber coated with receptors sensitive to these metals. The sensor is highly sensitive and can detect heavy metal levels as low as ppm and ppb.

The standout features of the sensor system are fast response time, its portable nature and low cost which is less than one-tenth of the instruments currently available in the market. This implies that it can be used by local bodies such as the Gram Panchayats & Municipal Corporations at frequent intervals for water quality monitoring. The work is also being funded by agencies other than Tata Centre.

- Jasleen Chhabra, Tata Fellow 2016

Portable device for heavy metal sensing using optical fibre



TCTD funded projects for 2017-2018

Project Name	PIs	Domain
"Development of Multisensory technique for intervention of developmental dyslexia: An electro-physiological and behavioural approach"	**Prof. Azizuddin Khan**	Healthcare
VMOCSH: Voice based Mobile Crowd Sourced Helpline	**Prof. Kameshwari Chebrolu**	Education
Financial analysis of agrarian families to identify the crisis in agrarian society	**Prof. Bakul Rao**	Agriculture & Food
Rural and Urban employment generation to cater to potential e-cycle market opportunity in India	**Prof. Arindrajit Chowdhary**	Energy
Assessment of acceptance levels of potential solutions disseminated through participatory and non-participatory approaches for rural development	**Prof. Anish Modi**	Agriculture & Food
Triboelectric generators (TEG) for wind energy harvesting	**Prof. Dipti Gupta**	Energy
Experimental Study to Evaluate Emissions from Cookstoves using Solid Fuels with a Focus on Reduction of Exposure (White paper)	**Prof. Virendra Sethi**	Energy
Phone Based Remotely Excited Flexible Microwave Resonator Patch Array (FMRPA) prototype development for High Resolution Dielectric Contrast Mapping of Skin Tissue	**Prof. Siddharth Duttagupta**	Healthcare
Improved kitchen air quality in Mumbai's Dharavi slum	**Prof. Ronita Bardhan**	Housing

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