Tata Centre
Technology and Design, IIT BOMBAY

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TURNING POINT

AUGUST 2016

Inside

Orientation for new IITB & MIT Tata Fellows

August had a special orientation planned for the newly joined Fellows from MIT & IITB at IIT Bombay. Scheduled for over five days, the meet-up had an eclectic combination of the Tata Fellows interacting with each other. The agenda included an introduction to the activities here at Tata Centre, interventional success case studies, lectures, the Narangpur Express simulation game, meeting entrepreneurs in the energy, irrigation, housing and waste management sectors, presentations from the Tata Trusts and a field visit to Igatpuri Livestock Centre in Nasik.

Dream to Innovate

Kalpana 2016 - a resounding success

Tata Centre's much-celebrated event to encourage innovation and fabrication across India - Kalpana 2016, rang through right from March to June. With about 3,000 applicants registered from every corner of the country, the best solutions for TCTD's domains – Food & Agriculture, Waste Management, Water, Healthcare, Energy, Education and Housing, dared to flash in the Final 10 of both the competitions: Nirmiti – prototype-making and Drishtikon – poster-making.

The final round started on June 22nd and the teams worked in full gusto. After a buzzing week of activity and adrenaline rush, on June 29th, the teams with their prototypes and futuristic poster solutions, were ready to present to an experienced panel of experts.

Entering its climax, the winners were declared. Aakash Bhardwaj and Bhawna Soni from YMCA University of Science and Technology won for their prototype, and Anil Nandal and Navneet Navi from Chandigarh University for the best poster. As they ran up to be awarded by Prof Sanjay Mahajani, Prof Alka Hingorani and Prof Santosh Noronha, they were pictures of joy and relief. TCTD's aim of guiding students from all over India and mentoring them to reach higher through such a hands-on fabrication initiative called Kalpana was achieved successfully.

- Gayathri Thakoor
Project Manager,
Education

Waste plastic into fuel oil

"The project has dual benefits – taking care of waste and providing an energy source."

Q&A with Prof. Srinivas Seethamraju, Dept. of Energy Science & Engineering

Q.1. What was the motivation behind this project?

SS: The use of plastic in various forms has become inevitable in today's life, for a variety of reasons. It has substituted many traditionally used materials like wood, ceramics and metals due to various advantages such as convenience, being lighter in weight, resistance to corrosion by most chemicals and lower cost. The rapid urbanization and population growth with improved quality of human beings' lives have increased the demand for plastics by 10% every year since 1950. About 60% of the plastics used end up as waste after a single use with the major contributors being polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET) and polystyrene (PS). Waste plastics have created a huge load on the municipal solid waste (MSW) management accounting for about 25-35% by volume of the total MSW. While PET has a good recycle market, some of the products made from PE, PP and PS are difficult to recycle. So, an alternative is to convert them into fuel oil or other value-added products like diesel using pyrolysis.

Q.2. What is the novelty of this approach towards waste management?

SS: Though people have tried gasification and incineration of waste plastic, we have chosen pyrolysis since it is a milder thermal process. In this project, we are trying to develop an indigenous process to convert the mixed plastic (predominantly PE, PP and PS) waste into valuable fuel oil through pyrolysis using suitable catalysts. The novelty is the use of spent-FCC or red mud as catalysts – wastes from other industrial processes. Appropriate reactor modifications also will be tried out.

Q.3. What is the current status of your project?

SS: We performed some preliminary experiments in a simple test set-up with reactor capacity of 500 mL, using virgin PP with and without a catalyst. The catalyst chosen was spent FCC catalyst. At 440°C and a catalytic loading of 5 to 7.5%, no solid residue was observed. The liquid product from these experiments had good physical properties for being considered as a fuel oil – density of 0.780 g/mL and calorific value of ~45 MJ/kg.

Since the target is to deal with waste plastic, we performed some experiments using each of the following individually – used bucket and an empty Bournvita plastic jar made of PP, used plastic bags from D-Mart, used milk pouches, and LDPE bubble wrap waste. While the PP waste behaved in a similar manner as the virgin PP, the PE waste didn't. Pyrolysis of the PE waste resulted in wax formation and suffered from low conversions despite the use of

catalyst – we are further investigating this presently.

Q.4. What challenges are you facing and how would you deal with that in future?

SS: With our current reactor configuration, it is difficult to separate the catalyst from the residue left. Also, the catalysts need to be tested for their long-time activity. We have been focusing on use of a single plastic like PE or PP in our experiments. It is difficult to predict the effect of mixing PE and PP together on the performance parameters like conversion or oil yield. We are also facing issues with component characterization of the pyrolysis oil obtained.

To overcome the catalyst separation issue, we plan to modify the reactor configuration – this is also envisaged to increase the catalyst lifetime. To take care of a mixed plastic feed, we plan to perform experiments based on experience from the individual plastics with changes in the reactor temperature, catalyst weight used, etc. We hope to resolve the component characterization problem using GC-MS or other available analytical techniques.

Q.5. How would your project benefit the society?

SS: Foremost, it would help in lowering the burden on landfills and save valuable land. It is also expected to keep the water bodies clean which otherwise are polluted by the waste plastic. Besides these benefits, the liquid produced from this technology can be used as a fuel in portable power generators, as a fuel in boilers and burners of other small-scale industries. The char or solid residue left behind also has various applications – it can be used to make activated carbon which has further use as a catalyst or adsorbent, or can be used as carbon black. Thus, this project has dual benefits – taking care of waste on one hand and providing an energy source on the other hand.

- Sanjay Kumar Singh,
Tata Fellow 2015

Dressing the trauma

The control of hemorrhage is crucial in first aid and field trauma care, especially at the golden hour.

Many a time, with hospitals being a distant reality, casualties are difficult to treat when the victim reaches the hospital. The control of massive bleeding is the critical step in first aid and field trauma care. Among the various techniques and dressings to control bleeding, the hemostatic wound dressing has the most effective application as it can be applied to all types of injuries. But, the currently available products for hemostatic wound dressing in the Indian market are either very costly or the material used come with their own set of problems like rising temperature at wound site, special storage requirements and allergic responses.

The need has been to develop a cost-effective, durable, easy to use dressing, according to the situation. Concentrating on the coagulation process while clotting, increasing the rate of reaction and the correct composition of materials for this dressing, this project amalgamated all these factors into a low cost and stable biomaterial for hemostatic wound dressing.

The six months of making the correct composite powder of the two polymers - a biopolymer and a superabsorbent polymer - and optimizing the solution, have been challenging. The mechanism arrived at works like this: the powder absorbs the blood leading to the swelling and forms a gel which exerts pressure at the wound site, resulting in the formation of a large layer of gel mesh covering the wound area within minutes.

The raw material used is cheap, an aid to the healing process and completely biodegradable, hence it does not need to be removed from the body after use. It thus reduces the wound cleaning cost and the medical staff's time spent in the procedure. It is planned that the design of the applicator will have an airlock mechanism to avoid contamination with the blood and be user-friendly for professionals and non-professionals.

So far, the project has established the method to prepare the material and its characterization. This composition has been submitted for patenting and the team comprising Prof Rohit Srivastava, Shruti Mankar and Yasodha Kannan (BSBE), is now working on another composite of similar materials and optimizing it. The biocompatibility and in vitro cell toxicity studies have been completed. With the preclinical phase studies (animal studies) going on currently, the aim is to make this the immediately available and sustainable healthcare solution.

Details	Numbers
Motor Vechicle Crashes	1.25 million
Fatalities in low-income & middle-income-countries	90%
India among worldwide fatalities	10%

- Yasodha Kannan, Tata Fellow 2015
and Shruti Mankar, Project Staff

Collaborative Learning

Context and Students as Co-Creators

Two summers and a change in project title later, we are beginning to understand the meaning of collaboration and the significance of complicity and collusion in learning. This journey has helped us better understand both the process of design and the essence of solution seeking (and making) in a specific context.

We set out to design an assistive apparatus for English Language Learning in a context far removed from any access to the language, using various kinds of tools—including technology (tablets with specific software), a natural approach to language learning, and feedback oriented self-learning modes and mechanisms. Acknowledging the limitations of teachers, students, researchers and resources has been critical to the process.

Though the site we serve is but two and a half hours from our campus in Powai, Mumbai, we have traveled a world away, in fact, on paths that are often unmarked and laden with surprises, both pleasant and otherwise. Understanding the context and the difficulties of learners—often first-generation school-goers with no support system within their immediate or extended families, unused even to the sounds of the language, which they encounter only in structured classroom lessons that are often taught in the native language rather than in English—was a challenge that humbled us as much as it made our approach more nuanced, subtle shades of difference reflecting in each iteration of interaction and design.

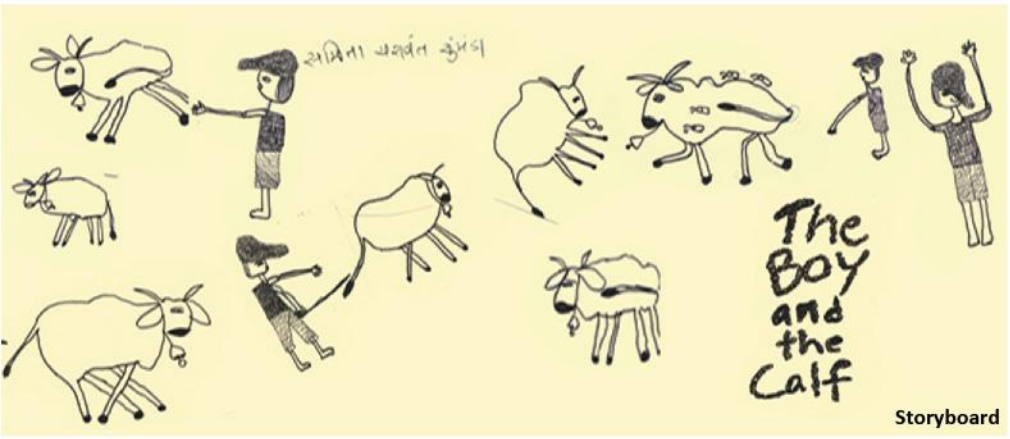
We had some technology to test, and a few enthusiastic and willing teachers by our side when we started. But the students, themselves, have been our most ardent co-designers. When we are lucky, it is through active participation in ideas; at other times, it happens through a deep and genuine disregard of concepts and hypotheses that do not suit their need.

Any conversation about what holds learners' interest, what motivates them, or what their ideal learning environments could or should be, frequently morphs into a discussion of issues that seem peripheral, yet are both acute and central to learning: how tired are these students, who help their parents in the fields in the mornings or work in brick kilns through the night, and/or perform copious and necessary chores to run the home and feed the family? Girls of only 7 years of age sometimes cook entire meals at home! How tired are they? How attentive can they be in class after walking to school from far distances, often without the fortification of any—leave alone a good—breakfast? Is there electricity at school that day to support any technology, not just the kind that we bring with us? Understanding the context continues to inform our choices and shape the solutions we seek and select.

Storybook

And yet we have found that some of our systems and approaches to language learning through stories, such as student participation and collaboration in content generation—including the writing of stories in native language that we then translate, the creation of artwork and illustration for such stories as are selected, an increasingly profound design involvement in storyboarding and book layout—have exceeded even our fantastic aspirations. To watch this emerge from a bunch of young people who have otherwise only learnt to receive and remember is to be both stunned and delighted.

There is definite, though patchy, progress in proficiency levels. It is not easy to use the Common European Framework of Reference for



Storyboard

Languages or the Cambridge English Scale here to speak of learners' progress. But our experience is teaching us also to question and tweak external standards that cannot account for the remoteness of our context: the complete absence of the language in the air, for instance, or the enormous distance from the concerns of such a language as it travels from urban areas to a rural setting. We are therefore also interested in exploring and understanding the appropriateness of such markers of progress as are provided by the many modes of foreign- or second-language pedagogy when deployed in our contexts.

It has been a little over a year, yet there is much to brag about. Not for what we have wrought ourselves, but for what these children have created alongside us. We have also witnessed other kinds of journeys in this language-learning odyssey: painfully shy students, often girls, afraid to touch a tablet when we first met them, now question and confront us with bugs in the feedback feature of the application; teachers, who initially waited for specific, repeated, incessant instruction to set up tablet reading schedules or even take on tablet charging responsibilities, now participate more fully, often providing vital input for further research in processes that might be more suitable and sustainable. These have been eventful months, indeed!

Four sets of stories (each set comprising three versions of the same story, graded on an increasing level of difficulty), written and illustrated by students with help from artists and design associates, will shortly be ready.

The feedback feature on the tablet application is progressing steadily. We are working with Sensibol Audio Technologies and with students of Prof. Preeti Rao (Department of Electrical Engineering) on this axis, to find ways of providing meaningful feedback to ease self-learning. This feedback formula accepts Indian English accents in their rich variety.

Is LETS still about language learning? It is, indeed, though it is now also about other things. These are—or should be—obligatory in all pedagogies, though they are particularly relevant in remote contexts in a society that is still searching for a self-definition that is both economically and culturally inclusive. Stoking the innate curiosity of young people needs no defense, but this exercise is also—and especialy—about creating opportunities for learners to become teachers, and for consumers to become creators of content.

For more about the project, please visit
http://www.tatacentre.iitb.ac.in/15mobitech.php
For comments and suggestions, write to us at **edutctd.iitb@gmail.com**

- LETS Team

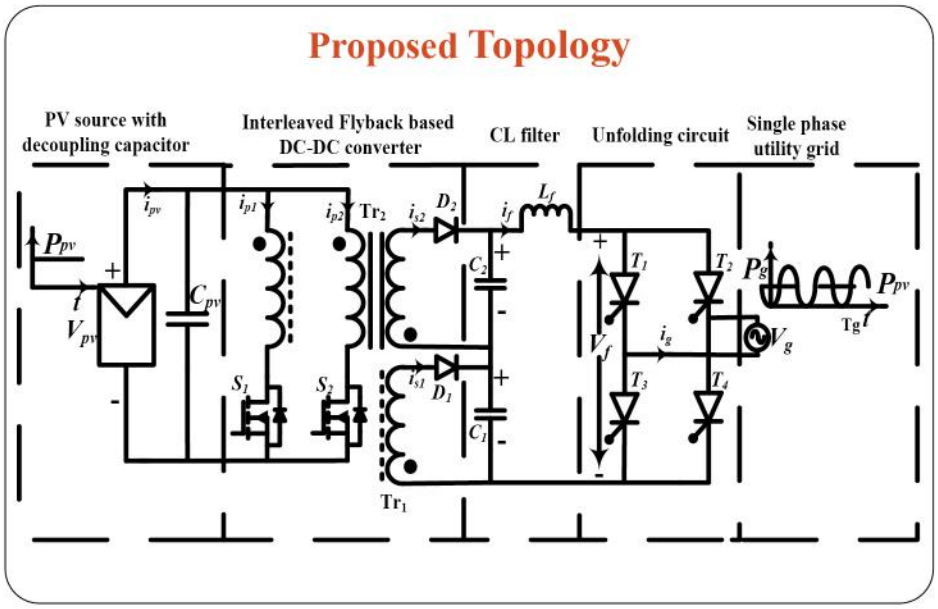

Students at Grammangal, Aina, creating illustrations for stories

Fine-tuning the Solar PV micro-inverters

Some rural areas in India don't have a grid or standalone application with adequate energy storage...and a high per Watt cost of the existing systems.

The benefits of the ongoing "solar energy revolution" are not reaching the masses due to high costs, poor compatibility of India's grid conditions to work with imported systems and lack of awareness about standards and regulations. Grid-connected module integrated inverters or micro-inverters are quite popular because of their high efficiency, modularity, scalability and other attractive features. Currently, the solar PV micro-inverters are available only with European or American compatibility standards and do not conform to the Indian grid conditions.

A team comprising Prof Vivek Agarwal and Tata Fellow Tirtha Lodh, have tried to build a reliable, compact, low cost grid connected/standalone solar PV micro-inverter in the power range of 200W to 300W with a remote monitoring feature. Here, a parallel input, series output interleaved fly-back principle-based highly efficient micro-inverter for the solar PV module-integrated converter application has been proposed, with the features of achieving high AC output voltage from low voltage PV module, transformers with lower turn's ratio leading to reduced leakage inductance, reduced current stress on primary side switches and low peak inverse voltage across secondary side diodes. Among the suggestive methods to improve efficiency has been the use of hybrid control based on DCM, BCM, 1-phase and 2-phase operating modes of the interleaved fly-back converter depending upon the instantaneous power level. Another has the use of an auxiliary circuit to recover the leakage energy and to achieve ZVS soft switching for the two main switches of these micro-inverters. An APDC (Active Power Decoupling Circuit) scheme for improving the reliability of the proposed micro-inverter structure has also been proposed which results in very low voltage ripple across PV, high MPPT efficiency and low grid current THD. Moreover, the leakage energy of the fly-back transformer can be handled more efficiently with the same APDC. An efficient single stage multi-port converter and its control based on flyback principle for solar PV module integrated micro-inverter application have also been proposed. This configuration can be used for grid connected as well as standalone applications with battery backup. The salient features of the proposed topology are that it provides galvanic isolation between solar PV, battery and the load and achieves high voltage gain. Moreover, the battery does not have to handle the 100 Hz ripple power required by the AC load, neither during the day mode nor during the night mode. Attempts have been made to gather system information (like PV voltage, current, temperature and grid current THD) in a nearby PC through wireless communication, using Bluetooth protocol to display the data in a web server through Ethernet. This is expected to be helpful for monitoring the installations in remote locations.



Some challenges faced have been sub optimum tuning of the MPPT as well as output current control controllers, design of the magnetics of the high frequency transformer and the layout of the printed circuit board. The problems in the way of testing the system up to rated power levels and obtaining high enough output voltage to be compatible with the power grid, are being sorted. The plan is to complete the remaining design and simulations, and set up the hardware experiments of the proposed control and the topology, and to build a single compact printed circuit board for incorporating the driver circuit, power circuit and the sensing circuit together. The system will then be put to extensive testing under practical conditions.

- Tirthasarathi Lodh
Tata Fellow 2014

TCTD funded projects for 2016-2017

Seed grant projects

Project Name	PIs	Domain
Study of Pre-treatment (Bio-Chemical and Steam) of Cotton-stalks for Beneficiation as animal-feed	**Prof. Madhu Vinjamur**, Department of Chemical Engineering **Prof. Narendra Shah** (CTARA) **Dr. Suhas Zambre** (TCTD)	Agriculture
Value Addition of Cashew Apple through Processing and Preservation	**Dr. Amit Arora**, Centre for Technology Alternatives for Rural Areas (CTARA)	Agriculture
Evaluation of the performance of traditional seed storages and design and development of seed storage system for community level seed banks and marginal farmers	**Prof. Upendra Bhandarkar**, Department of Mechanical Engineering **Prof. N G Shah**, Centre for Technology Alternatives for Rural Areas (CTARA)	Agriculture
Does inefficient agriculture supply chain cause 'distress sale'? Learnings from the experience of Maharashtra	**Prof. Vinish Kathuria**, SJMSOM **Dr. Disha Bhanot**, Post-Doctoral Candidate, TCTD	Agriculture
A digital aid for language (Hindi) teaching and learning	**Prof. Pushpak Bhattacharyya**, Computer Science & Engineering Department	Education
Compact efficient modular water based biogas scrubber	**Dr Milind V Rane**, Institute Chair Professor, Department of Mechanical Engineering	Energy
Energy-effecient freeze pre-concentration of sugarcane juice for Kakvi / Jaggery making	**Dr Milind V Rane**, Institute Chair Professor, Department of Mechanical Engineering	Energy
Development of Indigenous Screen-printable Silver Paste for Solar PV	**Prof. Parag Bhargava**, Department of Metallurgical Engineering and Materials Science (MEMS)	Energy
Flutter based wind energy harvesting	**Prof V. Kartik**, Department of Mechanical Engineering	Energy
Developing CAR-T cell technology platform for cancer immunotherapy	**Prof. Rahul Purwar**, Department of Biosciences & Bioengineering	Healthcare
EIS platform for bacteriological monitoring of water	**Prof. Soumyo Mukherji**, Department of Biosciences and Bioengineering	Water
Heavy metal sensing in water using optical fiber sensors	**Prof. Soumyo Mukherji**, Department of Biosciences and Bioengineering	Water

Characterization of Grey Water and Development of a Cost Effective System for Grey Water Recycling	**Prof. Suparna Mukherji**, **Prof. Sanjeev Chaudhari** and **Prof. Anurag Garg**, Centre for Environmental Science and Engineering	Water
Detection and sensing of arsenic in drinking water	**Prof. Rajdip Bandyopadhyaya**, Department of Chemical Engineering	Water
Comparison of various available domestic water purifiers and building the basic understanding and knowledge data base	**Prof. Upendra Bhandarkar**, Department of Mechanical Engineering **Dr. Murali Sastry**, CEO, IITB - Monash Reasearch Academy	Water
Humidification-Dehumidification Desalination System	**Prof. Shankar Krishnan**, Department of Mechanical Engineering	Water
Utilization of Waste Tire Rubber and Waste Plastic for Construction of Roads	**Prof. Dharamveer Singh**, Department of Civil Engineering	Waste Management

Translation grant projects

Feasibility study of Jaggery making and related products	**Prof. Sanjay Mahajani**, Department of Chemical Engineering **Prof. Narendra Shah**, CTARA **Prof. Vinish Kathuria**, SJMSOM	Agriculture
Design and Fabrication of Power Electronic Controllers for Certain Home Appliance Motors	**Dr. Vivek Agarwal**, Department of Electrical Engineering	Energy
Translation to pre-clinical and clinical trials of low cost bone and near net shape graft for Dental and orthopedic bone reconstruction	**Prof. Jayesh Bellare**, Department of Chemical Engineering	Healthcare
A mobile phone microscope with applications in point-of-care diagnostics and health education	**Prof. Debjani Paul**, Department of Biosciences and Bioengineering	Healthcare
Development of a Telepathology framework	**Prof. Santosh Noronha**, Department of Chemical Engineering	Healthcare
Microcrystalline Silicon Piezo-resistive sensor for wide ranging pressure applications-PHASE II	**Prof. Rajiv Dusane**, Depatment of Metallurgical Engineering and Materials Science (MEMS)	Healthcare
Billiscope: Jaundice detection in Neonates	**Prof. Soumyo Mukherji**, Department of Biosciences and Bioengineering	Healthcare

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