TURNING POINT

Tata Centre
Technology and Design, IIT Bombay

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The silver lining

Three graduating Tata Fellows and one former Tata Fellow were awarded silver medals by Prime Minister Narendra Modi at this year's convocation ceremony in IIT Bombay

To commemorate the Diamond Jubilee year at IIT Bombay, a grand convocation ceremony for the graduating students was held on 11th August '18, graced by the presence of Honourable Prime Minister of India, Mr. Narendra Modi. The event was also attended by the Minister of Human Resource Development, Mr. Prakash Javadekar; Governor of Maharashtra, Mr. C.H. Vidyasagar Rao; and the Chief Minister of Maharashtra, Mr. Devendra Fadnavis.

In a proud moment for Tata Centre, three graduating Tata Fellows - Jasleen Chhabra, Sujit Modi, and Yash Lalai – and one former Tata Fellow, Parth Joshi, were awarded with the Institute Silver Medal for being the 'most outstanding student of all students who completed the requirements for the degree of Master of Technology' in their respective branches. There were the other Tata Fellows who also graduated that day from the Institute.

Inspiring the students to be bold and resilient in the pursuit of excellence, the Prime Minister stressed on the importance of developing knowledge and skills for the upliftment of the society and nation. Terming the Institute as a part of a larger umbrella of 'India's Instrument of Transformation', he emphasized on the need of nurturing scientific temper and creating a hub of innovation to make India a developed economy. Evoking a sense of pride and attachment to the motherland, the Prime Minister urged the graduating batch to utilize their technological skills in innovative manners to bring about social impact.

Tata Centre wishes the graduating Tata Fellows and the award winners the very best for their future endeavors and hopes that they continue devoting their efforts for the betterment of society.

Tata Fellows - Jasleen Chhabra, Sujit Modi, Yash Lalai, Parth Joshi, receiving their awards

Adding value to cashew-apple juice

The challenge was to develop a simple technology solution easy for the farmer in the rural setting to understand and replicate.

This is an interview with ***Prof. Amit Arora,*** Centre for Technology Alternatives for Rural Areas, and the PI of the Tata Centre project - Value Addition of Cashew Apple through Processing and Preservation

Testing the technology solution

Q: What has been the motivation behind the project and how did you go about defining the problem?

A: The cashew-apple is rich in sugars, antioxidants and ascorbic acid. The ascorbic acid content is six times more than that of orange juice. The biggest hurdle to utilizing the fruit is its perishable nature and high tannin content which imparts astringent taste to the fruit. We were informed about the large losses in cashew-apples by a PhD student who hailed from one of the cashew-growing areas. Further groundwork revealed these losses to be as high as 90%. Our initial work focussed on the physicochemical characterization of the fruit, followed by the evaluation of feasibility of different techniques to reduce astringency of the fruit. Shelf-life extension and value addition were the other aspects covered in the study.

Q: Could you exemplify some of the challenges that were faced in this project?

A: The first challenge was procuring the cashew-apple fruit. It is a seasonal fruit that is available only 2-3 months a year and deteriorates within 10-12 hours of harvesting. It was a difficult task to procure good quality cashew apples that could be transported over 400 km.

This challenge-turned-opportunity helped us break geographical barriers and make connections in different regions of the state

The process of obtaining the fruit acquainted us with a variety of stakeholders, deepening our understanding.

The other challenge was to develop a simple technology solution that is easy for the farmer in the rural setting to understand and replicate. So even though we tried sophisticated techniques such as ultrasound and microwave to reduce the fruit astringency which were clearly promising, we eventually standardized a process using natural agents as treatment for tannin removal without compromising the nutritive value of the fruit.

Q: Could you please share some of the learnings of the project?

A: The most important learning was that success is dependent on proximity. With nearer the user, there is better clarity about expectations, and the easier it is to deploy the solution.

The real challenge is to make the technology convenient for stakeholders.

In this case, cashew apple producers and processers need to be convinced that the technology is cost-effective, consumes less water and energy footprint, and is user-friendly. Next is tying up with the industry, and if this collaboration works right from the beginning, the realization of 'lab to land' is taken care of.

Q: Please elaborate on the novelty proposed in your solution.

A: Reduction of astringency of cashew apple juice has been tried before. But not many have paid attention to the other constituents of the juice. The novelty of this project lies in the fact that it caters to a multi-objective outcome; it minimizes the undesired attributes while maintaining the desirable ones. We have a technology solution ready which reduces astringency of cashew-apple juice using simple green processes while preserving the ascorbic acid and sugar content, thereby significantly improving the acceptability of the juice. Shelf-life extension by freezing and value addition by blending cashew-apple juice with orange, pomegranate and pineapple juices have been evaluated and well accepted by a sensory panel with more than 25 participants included in the study.

Q: What have been the outcomes of the project?

A: The academic outcome includes filing of a patent and manuscripts communication. There have been no field trials yet, but a potential technology transfer is being looked at with an interested cashew-farm owner. This collaborator owns around 1,000 acres of cashew plantation and is interested in our developed solution, right from astringency removal to value addition. After elaborate discussions, he has shown interest in a long-term association with us. If everything works as planned, we look forward to erecting a pilot plant processing facility and having field trials to establish techno-economic feasibility, by the next season.

- Sayali Savant, Project Manager

A super-cool translation

The idea is to reach the cool roof coatings technology across the country

A project in the Centre's Energy domain is now a successful translation out in the industry. More, the faculty member, Prof. Anand Khanna, Dept. of Metallurgical Engineering & Materials Science, who led the project - Development of coloured cool coatings – has now taken lead in forming Thermogreen, a private limited company, to disseminate the technology solution. Joining him in this venture as a co-inventor is Dr. Narayanan Rajagopalan, the PhD graduate who has assisted him on this project right from inception.

The team of 7 includes the inventors, COO, who takes care of the outreach, and three established investors from the industry. The investors who hold 50 per cent share in the company have had an initial investment of Rs. 2 crore. A technology transfer of this solution was effected to Thermogreen, in July this year. A local manufacturer has been outsourced the task of making the solutions for the market, as per Thermogreen's specifications. This arrangement is set to achieve a capacity of 50,000 litres a month. Another outsourcing facility is being looked at, and the company is in the process of acquiring land in either Hyderabad or near Mumbai. The company is also venturing into the setting up of two labs for the manufacturing of paint coating and griffin coating.

The product - Thermocool 0.3m – is a 100 micron single layer with an easy coating system and it claims to reduce the heat build-up within the buildings, thus resulting in lower dependence on air conditioning, cutting down of energy costs and reducing global warming. Thermogreen has two products to offer: one for concrete and the other for metal substances. The strategy is simple: Offer the proof of concept to interested parties free of cost, facilitate application of the coating on site, get the impact studied and reported, and then target dissemination through paid-for orders.

Rather than target the solution to homes, reaching out to the governmental departments involved in the heaviest of infrastructural expenditure is key. Proposals have been sent to defence agencies for use of the intervention across their facilities. The Indian Railways have taken to the product by applying the cool roof coatings on 37 railway coaches. The Tamil Nadu Police Housing premises, Tata Motor Plant in Pune, and a housing complex in Powai, Mumbai, have tried the proof of concept, and are now ready for more. In the pipeline are projects with CPWD, Apollo Hospitals, TVS, Century Enka and Unilever group of companies.

"To take the research to the industry, the solution also has to be price-conscious. So it is important to identify suitable partners who believe in how good your product is," feels Prof. Khanna. With two patents in the fold, the company's cool roof and fire-retardant coatings are about to be patented internationally so that interest from the Gulf region, South Africa, Thailand and Cambodia can also be met with.

- Gayathri Thakoor,
General Manager - Programs

Waste into Fuel Oil

The types of waste plastics used for the experiments in this project were HDPE, LDPE, PS and PP, collected from the IIT Bombay community

Experimenting with polypropyline and HDPE mixture

Plastic pyrolysis has been recognised as one of the most promising technologies to convert waste plastics to value-added products with comparatively low energy requirement and better social acceptance. This project team headed by Prof S Srinivas, Dept. of Energy Science & Engineering, performed preliminary experiments on plastic pyrolysis with both virgin and waste plastics in thermal and catalytic modes. Since the experiments with spent FCC catalyst, which is a waste from the oil refineries, showed good yields and conversion, further experiments were performed with varying percentage of catalyst loading to find the optimum catalyst loading.

The effect of temperature and catalyst loading on product yields and quality were studied in the range of 400-560°C and 0-7.5% (w/w), respectively. The effect of heating rate was also evaluated – from these studies, the optimum heating rate was found to be 10°C/min and the optimum temperature was found out to be 510 °C. Nitrogen was used to maintain an inert atmosphere in all the experiments.

Following an extensive literature search in scientific papers and patents on the reactors used (for both batch and continuous mode of operation), the operational, technical and economic feasibility challenges in this plastic to fuel conversion process has been understood. A major hurdle in commercialization of plastic pyrolysis is the heterogeneity of the feed – it is necessary to understand and quantify the interaction effects between different compositions of waste plastics. Currently, the project team is working on the scale up from lab scale to a process that can handle 10-15 kg/h of feed. The plan is to work with a screw-reactor or a modified fixed-bed reactor for the prototype

The team has also been working on the downstream process part for recovery of the catalyst used in the catalytic pyrolysis process so that it can be used multiple times after ensuring sufficient activity in the process. This will help in overcoming the challenge in the cost of catalyst and its regeneration.

Looking at various approaches, the team has developed a lump-based kinetic model to predict the yields of a mixture of plastic waste, with the help of the parameters obtained from pyrolysis of individual plastics. The kinetic data generated using a designed meso-scale TGA set-up will estimate the parameters of the model and thus, help in improving the predictions. The derived kinetic model is then envisaged to be used in a process simulation tool for doing the process design and performing a techno-economic assessment of this process. Based on the experimental data and process simulation results, the feasibility of a plant that can process 100 kg/h or more of plastic waste will be evaluated.

- Satyam Sahu, Tata Fellow
& Dr. Sachin Jadhao, Research Staff

Welcoming the Fellows

Orientation of the new Tata Fellows at IIT Bombay

The new batch of 21 Tata Fellows for 2018 - 2020, were welcomed in an orientation session. After a quick round of introduction, their journey over the next two years was sketched out and expectations from them were discussed. Prof Sanjay Mahajani, the Professor-in-charge, and visiting faculty, Prof. R Anantheswaran, wished the students much success in their endeavours. The project managers then led them through their roles as representatives of the Centre's activities. A visit to the Centre's administrative setup and the Product Realisation Lab completed the first such interaction with the Tata Fellows.

- Rohan Ohri, Tata Fellow

Storing seeds all the way

The seed storage unit maintains an inner temperature around 10-15°C lower than the ambient temperature

The seed storage unit (SSU) has been specifically designed by a project team headed by Prof. Narendra Shah, CTARA, for the project - Evaluation of the performance of traditional seed storages and design and development of seed storage system for community level seed banks and marginal farmers. This is meant for marginal farmers to store their seeds for one or two seasons while maintaining their viability. The seeds to be stored are packed in polyethylene bags, which helps maintain their relative humidity throughout the storage period. Low power requirement is the USP of the SSU.

In a workshop recently held at BAIF Central Research Station, Urlikanchan, Pune, the stakeholders were updated about the performance of the SSU.

Thornless cactus experiments at Urli farms, BAIF

The experimental outcomes and the way forward were also discussed by agricultural scientists from Maharashtra, who had also attended the workshop. Some of the problems discussed included the voltage fluctuations damaging the PCBs of the unit and the loss in viability of groundnut seeds. During discussions it was revealed that oilseeds have storage problems and the maximum keeping period of groundnuts is three months without the pod, and six months for seeds within the pod. There were suggestions for a display panel, voltage stabilizer and a see-through glass or acrylic panel.

In another exhibition to display innovations in a zero budget natural farming training camp organized in Shirdi, the Centre's SSU intervention was appreciated with much interest by representatives of Niti Aayog and certain farmer producer companies (FPCs).

Experimental data for a 9-month period demonstrated that the SSU units, under observation at 14 different agro-climatic locations, were functioning well and maintained the seed viability to a desired level

The team is now awaiting data for the next six months from the 14 different locations. Following this, the scale-up and dissemination action steps can be zeroed down upon. Potential routes of dissemination include targeting seed traders, seed conservationists, seed companies, FPCs, women run self-help groups at village levels, and government agencies such as NABARD.

- Sayali Savant, Project Manager

Meeting the Fellows

Get-together of Tata Fellows from IIT Bombay and MIT, USA

The joint interaction of Tata Fellows from MIT and IIT Bombay started with an information-packed day of talks, presentations and lab visits. Prof. Sanjay Mahajani, Professor-in-charge, spoke about the Centre's activities, followed by everyone's introduction. A few of the Centre's projects were presented, after which the MIT Tata Fellows were taken around for lab visits across the campus. Later, Prof. Virendra Sethi, Centre for Environmental Science and Engineering, presented his research on environmental pollution and JVR Murty, a development professional, enlightened the audience on water governance. Day 1 of the orientation then ended with a game where everyone loosened up for some fun times. Some IIT Bombay Fellows and staff joined the MIT visitors' trip to Ahmedabad, Dahod and Bengaluru, over a week-long immersion trip.

- Rohan Ohri, Tata Fellow

Learning to teach and learning to learn

The LETS team with AIF instructors

In which teachers learn book making with original art and original content as a tool for instruction

Each person with a book for their personal library

At the heart of the LETS experiment is the understanding that changing the way learners think about learning and knowledge—specifically through increased autonomy and self-direction—changes not only motivation and attitude, but also engenders a transformational shift in the relationship between learner and what is to be learned. Our particular switch-and-bait for the situation in remote, rural India, with its paucity of teachers and (often a) poverty of pedagogical tools has been to enable learners to generate their own content for learning. We speak here of autonomy at a quite different level of operation from the reasonably well-understood model of collaborative, peer-to-peer, discussion-inducing, knowledge sharing that many progressive institutions of learning now choose to practice.

One fortuitous fall out of such a process is that as learners gather the means to generate their own content, and especially as they put it together, their own worlds and realities become part of the learning material; *they write themselves in.* Cultural representation needs neither separate mention nor *particular* attention.

Artful mess

Since March 2018, we have been working with the Agastya International Foundation (AIF) as our partners in order to translate and communicate the process of content generation to art and language teachers through storytelling and book making. A series of workshops have been planned and conducted to train the trainers to articulate, then disseminate, both purpose and process, to facilitate reflection and collaboration in content collection, collation, translation and creation of product, viz., books with text and illustration for language learning. (The process is subject agnostic and may be used to generate content across the spectrum of disciplines and topics.)

Four workshops for instructors have been conducted so far—three at the AIF campus in Kuppam, Andhra Pradesh, and one at IIT Bombay, in the months of March, April, June and August, 2018. Four more remain, and will be completed by December 2018. The participants in the workshop include ten instructors from the MediaArts Lab at AIF who teach and interact with students from 700 schools in the tri-state region of Tamil Nadu, Andhra Pradesh and Karnataka, either through their visits to various school campuses or on-site at AIF, where each group of students visits several times a year.

Each of our workshops runs four to five days, and is separated operationally into components of the process of story telling and illustrated bookmaking, but insists—and is, in fact, contingent—upon the collaborative creation of pedagogy rather than just product. A brief preview of the four completed workshops follows:

Learning paper folding and cutting techniques

Story-'building'

Various exercises that play with words and images initially help in building bits of stories, drawing characters, and nudging imagination to newness. Two of the five days of this workshop were spent on seeking stories, the third in unlearning old forms and the last two in storyboarding, visualizing, creating illustrations for their group-discussed and critiqued, individually chosen tales.

Understanding perspective

The second workshop built on the first, focusing on observation, perspective, choice of viewing angles and quality of illustration. Most instructors had visualized their representations as pan shots, which is what most had commonly seen in available illustrated books. This second workshop allowed discourse and debate on formulaic representation formats and the ways of freeing oneself to seek new forms, and then play with various visual frames and perspectival provocations. Again, the first two of five days were technique-heavy, with particular exercises in sketching and perspective study, and the next three in creating illustrated stories in paired groups, where one of the pair of participants had a strong narrative sense while the other was more visually inclined. They were free to choose medium keeping story in mind.

The LETS design team brought the work of the participants back with them to polish and print prototypes.

A lesson in story telling and narrative structure

Illustrated texts to print-ready books

The third workshop was hosted at IDC, IIT Bombay. This four-day workshop involved hands-on activities for two days, including visits to a printer's shop floor, paper folding and cutting techniques, a screen-printing demonstration, bookbinding and allied activities. Two days were spent reconfiguring the books, book covers and book designs begun in previous workshops in the light of new inputs. There was serious discussion on and practice of what it takes to transform illustrated pages from early works to polished, print-ready quality.

Introducing students in the mix

Even as the instructors continued working on their own books, this was the first workshop in the current series to include students from a local school. The instructors were to run the workshop, with oversight by the LETS team. This was the transfer of process. With 30 students working under six instructors—two per group of 10 students—the process, it was hoped, would be smooth and streamlined. Chaos ensued: so many exercises, so many minds! Timelines were stretched. But shining through this medley of activity and anxiety was a sustained sense of excitement and discovery, inspiration and openness that both students and instructors confessed to time and again.

Students making their first illustrated story books

Through three workshops and their many days together, all participants had been encouraged to break boundaries, question status quo, build using new tools and old alike but with awareness of possibilities and freedom of choice. Now we were asking them to lead students into the same vibrant terrain. From all evidence to hand—feedback from instructors and also from students—this fourth workshop appears to have been successful on that count.

Which is what counts most. There are four more workshops to come in this year, which will involve both students and instructors and will see the role of the LETS team abate until it fades. Once there is relative autonomy of content creation and book making, the design team will become responsible for the second half of the program, which is to convert select books to print readiness and publish them. We are also looking at putting together a business plan with the help of Tata Centre and its partners to see how to make such books available to urban markets and rural libraries around the country.

Teaching is hard work

LETS team:

Prof. Alka Hingorani (PI), Aarti Latkar (Research Associate), Sanket Pethkar and Umesh Wagh (Design Associates), Pratik Kulkarni (Design Intern), Safiya Shaikh (Project Staff)

Bags full of learning

This is a reflection shared by one of our graduating Tata Fellows about the experiences of working on her project

With a big jute bag filled with rice straw and a handful of mushroom seeds, I embarked on this adventurous journey of trials, experiments and failures. Having chosen the project myself, I was clueless about where to start and how to do something technologically fancy with my project: Mushroom cultivation.

As Tata Fellows we were expected to work on solutions to eventually benefit the resource-constrained communities

Mushroom cultivation could definitely help rural communities who grew paddy, by bringing in incomes during the non-paddy season. Here was an area that required less labour and investment. More, agricultural institutes and NGOs were ready to come forward and train the willing farmers. So, if it meant working around the technical objectives, I decided to get my hands dirty. I picked up the raw material and seeds from the lab, followed each theoretical step of the production cycle and finally left them to grow in a lab incubator for around 40-45 days. What mushroomed after that was a realization that I wasn't really getting my hands dirty, but worse…I had my hair and face filled with flying particles of straw. One cycle of mushroom production done, I understood the basic factors involved. I ran back and forth between the literature quest and experiments to identify the missing element in mine. Thus, there were more trials – many failed to give clear answers, while some lead to conclusions.

I also decided to test my experiments with a group of paddy farmers who grew mushrooms on field. Tata Centre connected me to many such groups, and I fixed a session with their local leader. The idea was to add a chemical solution to their paddy straw and analyse the mushrooms yield from the modified raw material. Everything happened according to plan; they were given the necessary stuff, and explained about the steps to follow. My excitement or concern was barely reflected as they didn't really know the implications of my research. This was partly because I hadn't bothered to explain to them about my research…. maybe because I assumed that they wouldn't understand my work!

Meanwhile back in the lab, I waited for a month for the mushrooms to grow. I was in touch with the local leader who answered my questions about the progress on field. Finally, I went back only to find that they had sold a part of the produce two days before because there were too many locals asking for mushrooms there. The news saddened me because I couldn't get any idea of the whole yield. But I realized something very important then – I could not simply go and ask them to do certain things, and then sit back and wait for the results. Continuous engagement with them would have helped them to see value in the project, the way I did. I could have walked that extra mile to convince them about the importance of the work we were doing. They would have understood if only I had tried!

With a packet of errors, learnings, experiments and field trips for over one and a half years of work in my hand and a tag of being a mushroom farmer on my sleeve, I completed my project with a learned smile and bags full of wisdom.

- Priya Kedia, Tata Fellow

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