Connect

WITH THE INDIAN INSTITUTE OF SCIENCE

Volume 6 | Issue 2 | June 2019

IISc's Milestone
Celebrating the anniversary with photos of IISc's early days

The Plant Database
A growing digital repository of knowledge about India's flora

On Teaching
Two faculty members reflect on teaching and learning

ISSN 2454-6232

IN THIS ISSUE

EDITORIAL

This issue of *Connect* commemorates a special occasion: 110 years of IISc's existence! Although the groundwork for setting up the Institute had begun several years before, the British-run Government of India published the vesting order for IISc on 27 May 1909 – which is considered the Institute's anniversary. In celebration, we bring you a series of old photographs from the earliest years of the Institute – the laying of roads and foundations, construction of laboratories and residential quarters, the people who were involved in this work, and the earliest students, faculty members, and buildings at the Institute. And don't miss our selection of signatures by visitors to the Institute, from royals and heads of state to a particularly famous mountaineer.

In other stories, Jahnavi Phalkey, science historian and Founding Director of Science Gallery Bengaluru, writes about Re:Collect, a new initiative that seeks to document and preserve the memories of the generation of scientists, engineers and laboratory technicians who built the infrastructure to transform science and engineering in India. IISc and IIT Madras have agreed to serve as host institutions for the initiative.

We also tell you about an ambitious project to digitally document India's flora at IISc, a growing effort to include more women in academic events like workshops and panel discussions, and an ecologist's project to revisit classic scientific papers in an attempt to unearth the stories behind them.

In the March issue of the magazine we dove into the field of cryptography to understand what it was and how it was used; in this issue we explore the limits of cryptography and why it can't be treated as a magic bullet.

Maria Thaker and Siddharth Jhunjhunwala, both recipients of the Dr Priti Shankar Teaching Award for 2018, reflect on learning and teaching in this issue, while G Ambiga, former nurse at the Health Centre for nearly three decades, recalls her time at the Institute and the moment she met Indira Gandhi.

TEAM CONNECT

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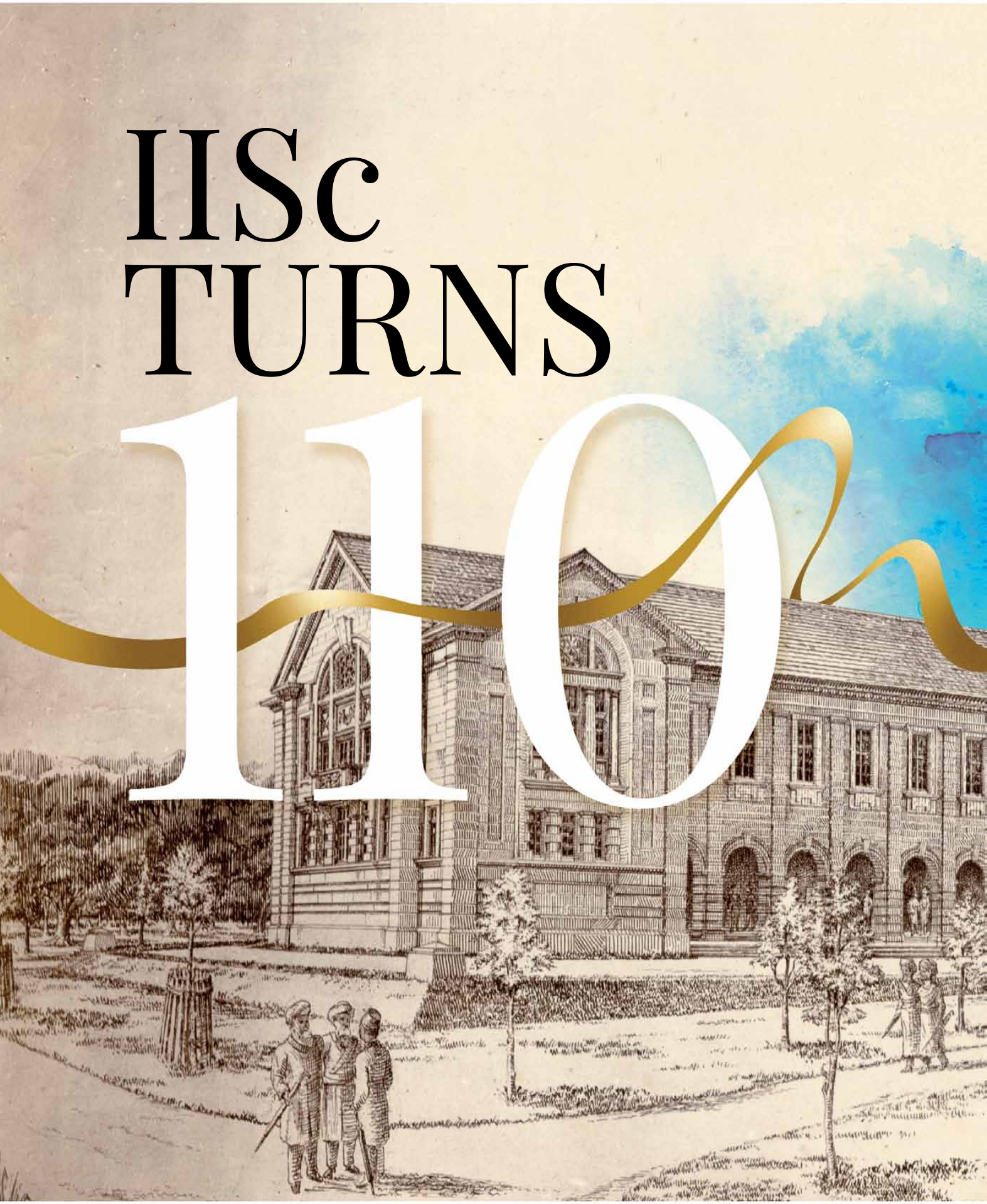
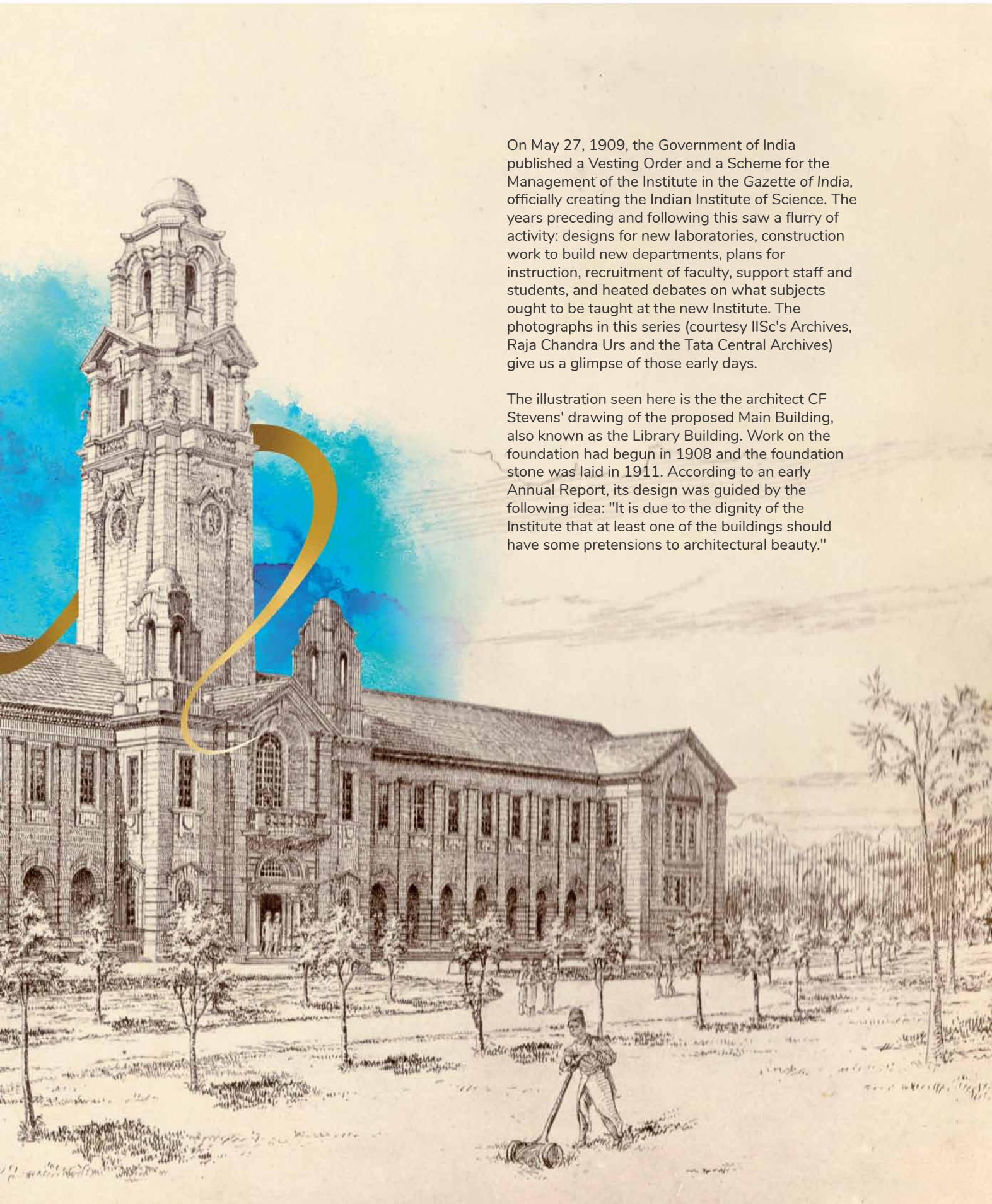
Design: Magnetyz | **Printer:** Sri Sudhindra Offset Process

IISc TURNS 110



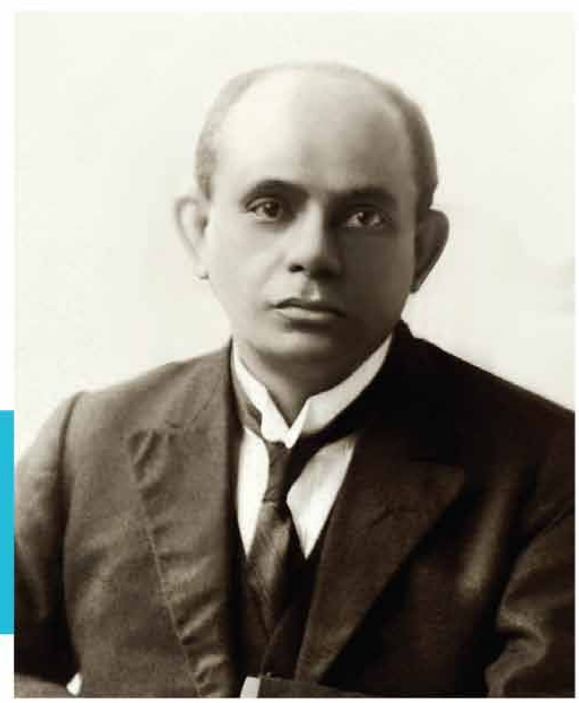


On May 27, 1909, the Government of India published a Vesting Order and a Scheme for the Management of the Institute in the *Gazette of India*, officially creating the Indian Institute of Science. The years preceding and following this saw a flurry of activity: designs for new laboratories, construction work to build new departments, plans for instruction, recruitment of faculty, support staff and students, and heated debates on what subjects ought to be taught at the new Institute. The photographs in this series (courtesy IISc's Archives, Raja Chandra Urs and the Tata Central Archives) give us a glimpse of those early days.

The illustration seen here is the the architect CF Stevens' drawing of the proposed Main Building, also known as the Library Building. Work on the foundation had begun in 1908 and the foundation stone was laid in 1911. According to an early Annual Report, its design was guided by the following idea: "It is due to the dignity of the Institute that at least one of the buildings should have some pretensions to architectural beauty."

IISc's First Promo

JN Tata (left), his sons, Dorabji (centre, seated) and Ratanji (right, standing), and RD Tata – JRD Tata's father. JN Tata was an industrialist who wanted to create an institute of higher learning in India, and began working towards this in 1889. He passed away in 1904, five years before the signing of the Vesting Order for IISc.



To implement his vision of creating an institute of higher learning in India, JN Tata appointed his protégé, Burjorji Padshah, a scholar and educationist. Padshah was responsible for laying the groundwork for the institute that Tata had in mind.

ters

The Mysore Royals were instrumental in bringing the Institute to Bangalore: the Regent Maharani, Kempananjammani Vani Vilasa Sannidhana, promised over 370 acres of land, Rs 5 lakh towards capital expenditure, and a recurring annual contribution to run the Institute. At the time, she ruled on behalf of her teenage son. In this photograph, the Maharani is seated in the centre, flanked by her sons – Maharaja Krishnaraja Wadiyar (left) and Yuvaraja Narasimharaja Wadiyar. At her feet is Narasimharaja's son, Jayachamaraja Wadiyar, who succeeded to the throne after Krishnaraja, and who visited IISc on several occasions.

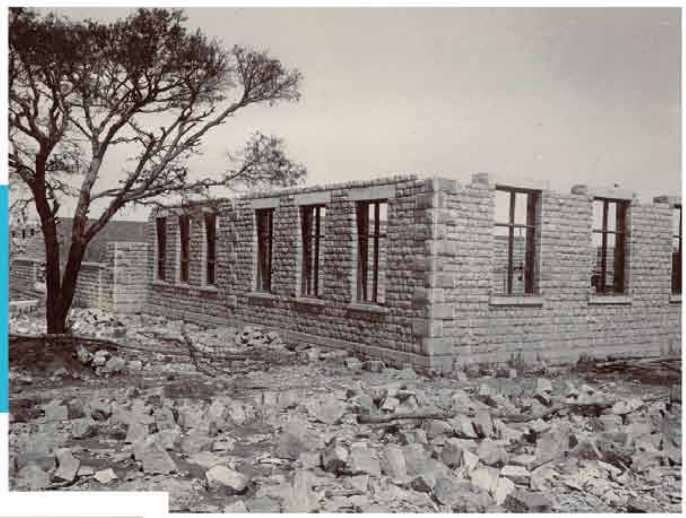
Morris Travers, a British chemist, worked with Nobel Laureate William Ramsey, and assisted him in the discovery of inert gases such as xenon, neon and argon. He was appointed the first Director of IISc in 1906 and oversaw the construction of the Main Building and the setting up of the early departments and library. In 1910 Travers married Dorothy Gray, who helped him make social contacts in Bangalore by organising dinners and gatherings at IISc.

Buildin the Institute

Early construction at IISc was done by TCW Skipp, with whom the institute signed a contract in 1908. Before the end of that year, most of the drainage and sewer system had been laid by Pallonji Edulji & Sons. This photo shows the Institute's main road (known today as Gulmohar Marg) being laid. By June 1910, all key roads were nearly complete.

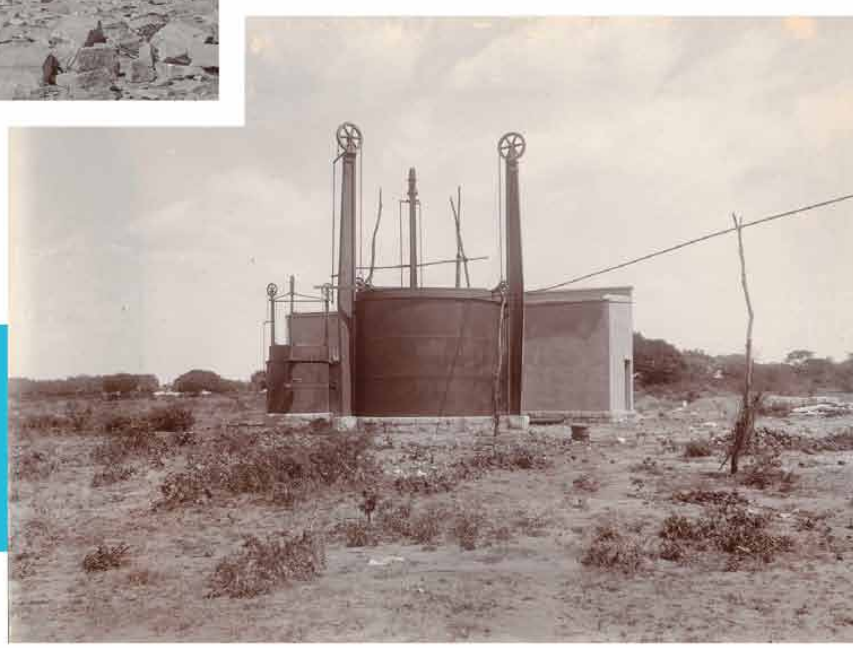
The hostel was meant to house 72 male students, each with their own room, in two blocks with four messes and kitchens. No tuition fees were charged to students, but a small fee was charged for accommodation. A portion of the hostel was ready for occupation by 1911.

g

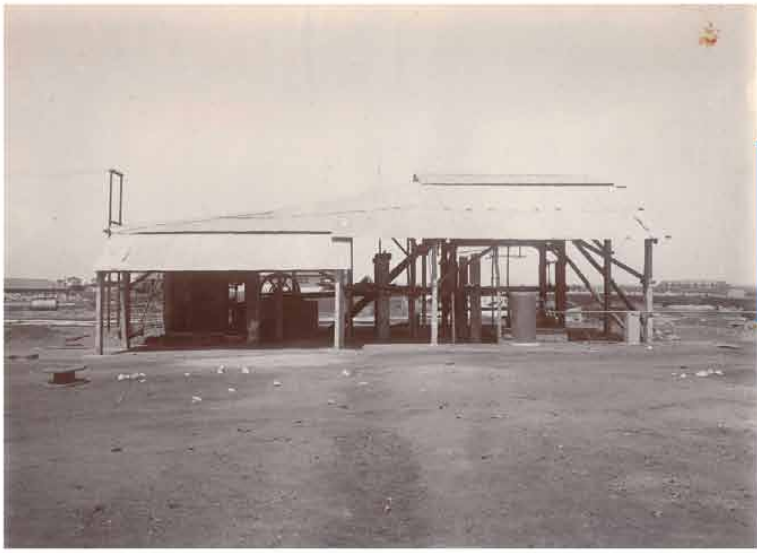


The laboratory for Applied Chemistry being built.

Construction of the Electrical laboratory. Both the Chemistry and Electrical laboratories were opened on 24 July 1911.



Purchased and set up in 1908, this was a Mansfield oil-gas plant, with two generators and a storage gasometer holding 2,000 cubic feet. The plant was arranged to supply gas but was not connected to the laboratories on campus until a few years later.



The stone plant on campus at which blocks of stone used to construct the Main Building were shaped.

A September 1909 photo of the workers involved in construction at IISc. A report from June 1910 says: “The contractor has certainly done his best to collect men from the neighbourhood, and has even imported carpenters from the Punjab.”

A view of the European “subordinate” quarters under construction. Only a select few Europeans were meant to be allotted bungalows on campus at first: the Director, five professors, four assistant professors, the librarian, and two “subordinates” (the term that appears to have been used at the time for administrative staff). The others to get accommodation on campus were “servants”, “sweepers”, and “maistries”.

The “Maistries’ quarters” being built. Funnily enough, the lists of construction expenditures in the early years mention “hire of bulls”, but makes no mention of donkeys.

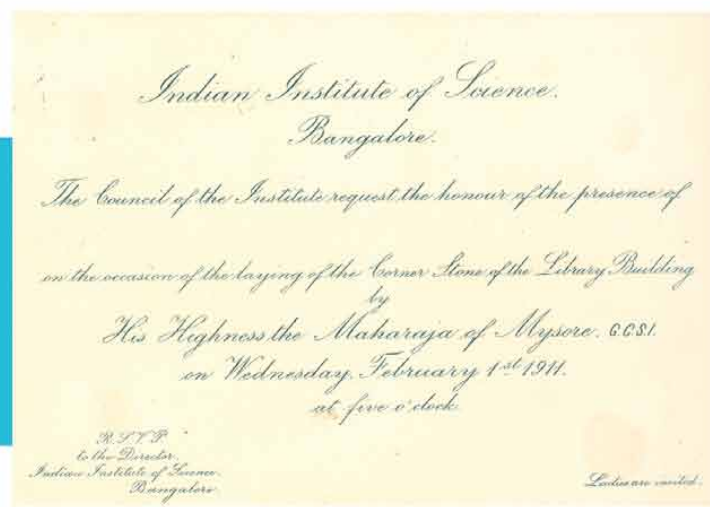
The “Servants’ quarters” under construction.

The making of the Director’s Bungalow, also known as Bungalow No. 5. Nineteen out of IISc’s 20 Directors so far have lived here during their tenure.

Important events marking IISc's initial

The Viceroy of India, Lord Hardinge, visited the Institute around 1913. IISc decorated its campus to welcome him.

On 1 February 1911, the Maharaja of Mysore, Krishnaraja Wadiyar, laid the Foundation Stone of the Main Building. The occasion saw speeches made by Morris Travers, Dorabji Tata and CF Stevens (the architect). Speaking after the ceremony, the Maharaja recalled how the Institute was set up, and paid tribute to the the founder, JN Tata. Towards the end of the ceremony, the Institute organised a musical performance by the Band of the 2nd Battalion Queen's Own Cameron Highlanders.



Indian Institute of Science
Bangalore

The Council of the Institute request the honour of the presence of

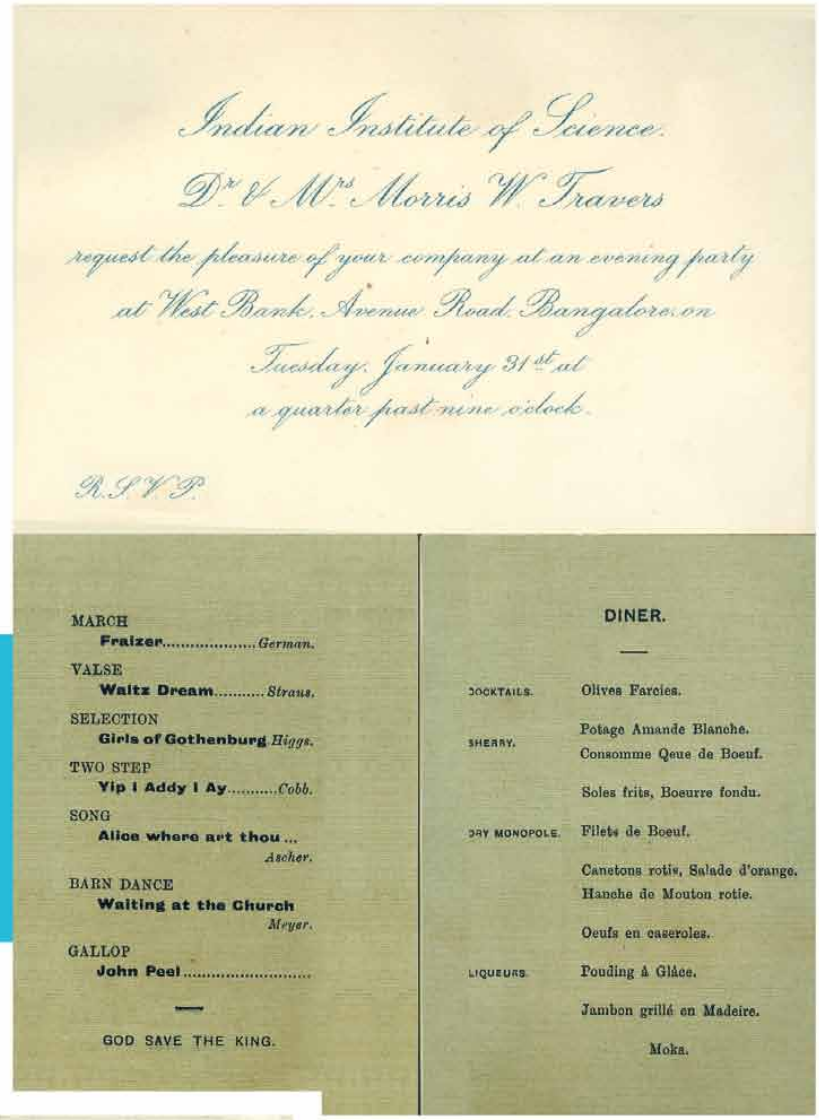
on the occasion of the laying of the Corner Stone of the Library Building
by
His Highness the Maharaja of Mysore, G.C.S.I.
on Wednesday February 1st 1911
at five o'clock

R.S.V.P.
to the Director
Indian Institute of Science
Bangalore

Lectures omitted.

days

On the eve of the ceremony, Alfred Hay and Norman Rudolf, both professors at the Institute, hosted social gatherings to celebrate the unveiling of the Foundation Stone. Later that night, Morris and Dorothy Travers hosted a post-dinner party.



Indian Institute of Science.

Dr & Mrs Morris W. Travers

request the pleasure of your company at an evening party at West Bank, Avenue Road, Bangalore, on Tuesday, January 31st at a quarter past nine o'clock.

R.S.V.P.

MARCH
Fraizer.....*German.*

VALSE
Waltz Dream.....*Straus.*

SELECTION
Girls of Gothenburg *Higgs.*

TWO STEP
Yip i Addy i Ay.....*Cobb.*

SONG
Alice where art thou ...
Ascher.

BARN DANCE
Waiting at the Church
Meyer.

GALLOP
John Peel.....

—

GOD SAVE THE KING.

DINER.

—

COCKTAILS. Olives Farcies.

SHERRY. Potage Amande Blanche.
Consomme Queue de Boeuf.

Soles frits, Boeurre fondu.

DRY MONOPOLE. Filets de Boeuf.

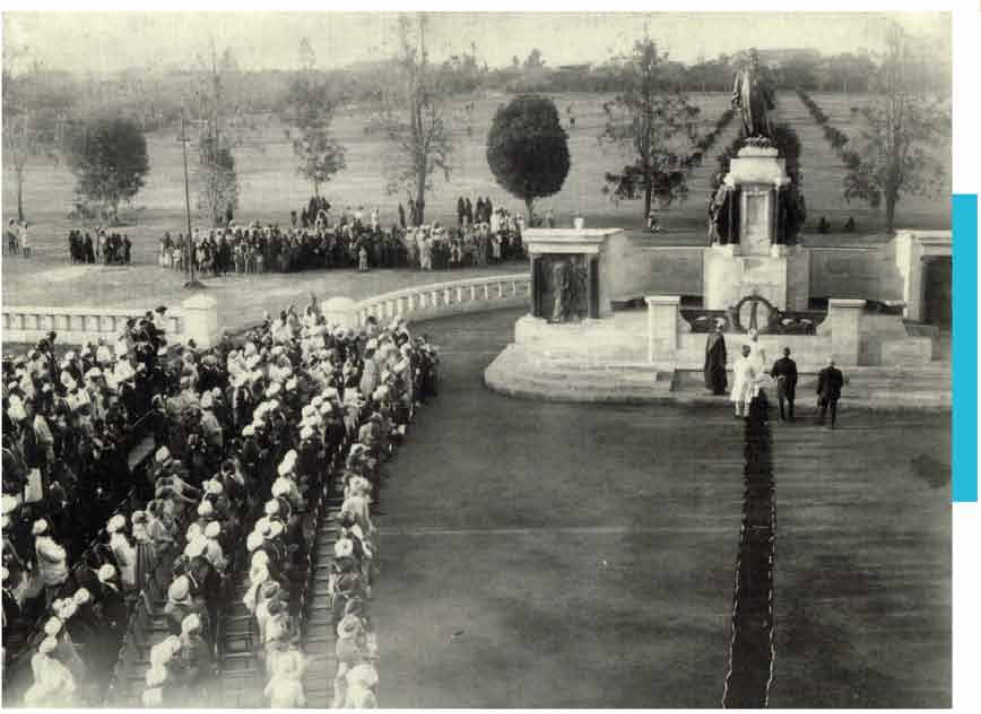
Canetons rotis, Salade d'orange.
Hanche de Mouton rotie.

Oeufs en caseroles.

LIQUEURS. Pouding à Glâce.

Jambon grillé en Madeire.

Moka.

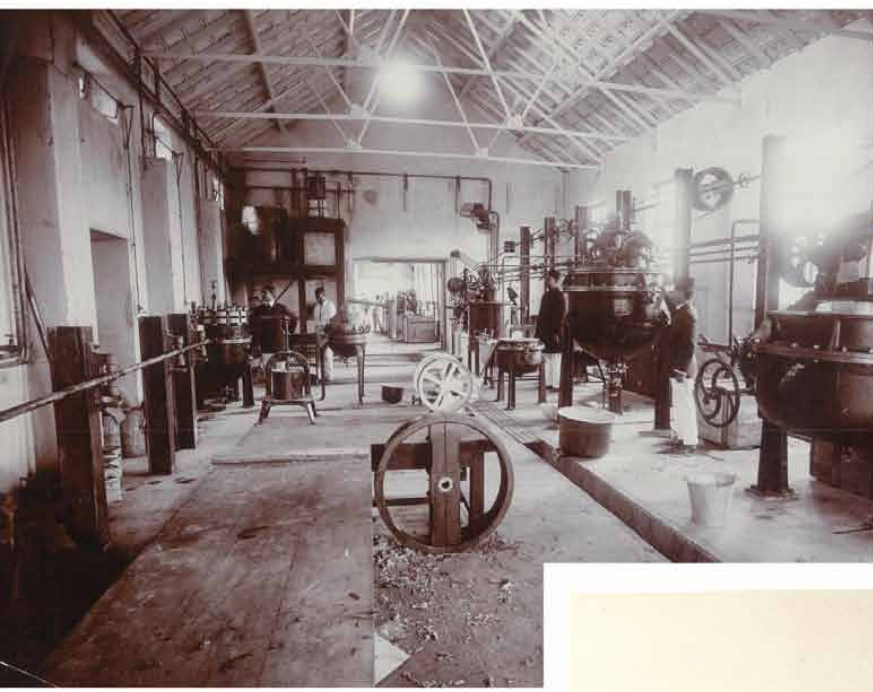


On 10 March 1922, Krishnaraja Wadiyar, the Maharaja of Mysore unveiled the memorial to IISc's founder JN Tata. Alfred Hay (IISc's Acting Director at the time), Narasimharaja Wadiyar, WP Barton (the British Resident in Mysore) and Dorabji Tata attended the event. The monument was created in England by a British sculptor named Gilbert William Bayes. The cost of the monument, including shipping, was Rs 75,000.

Academics

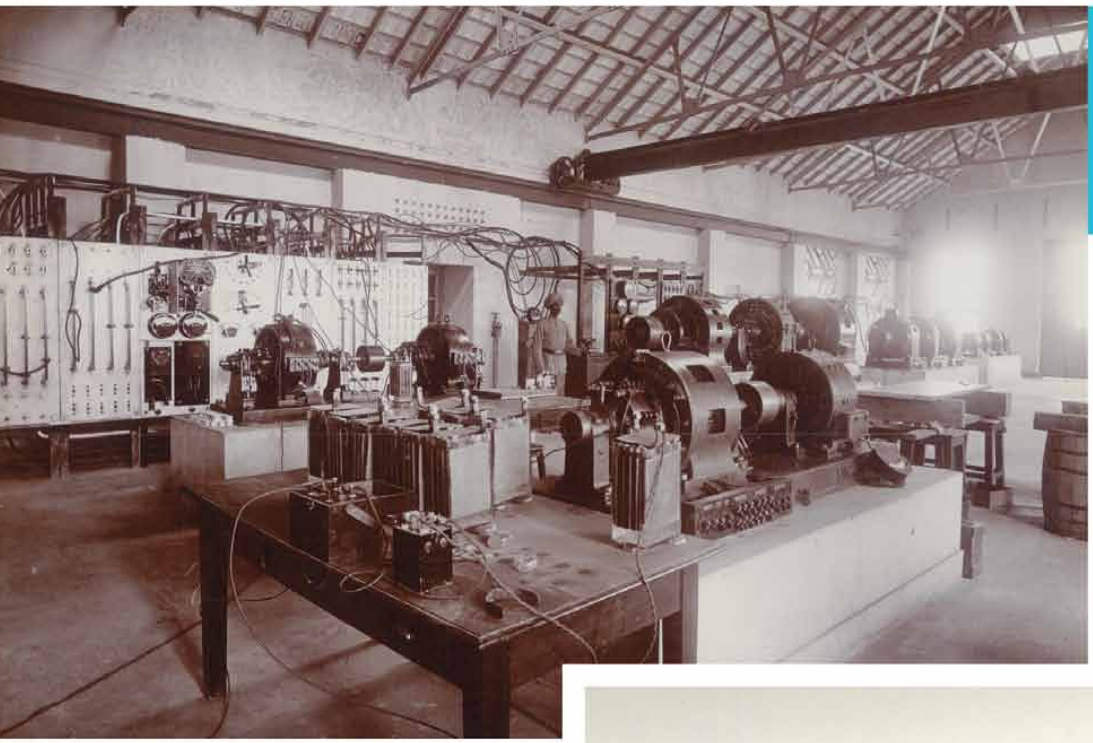
When IISc opened its doors to students in 1911, over 500 applications were received. Of these, only 34 students were selected to join the departments that existed then – General & Applied Chemistry, Organic Chemistry, and Electrical Technology – though not all of them ended up joining. The students can be seen in the photograph taken in 1912. It also has Morris Travers (seated, centre) and other faculty members.

The Departments of General and Applied Chemistry were the first to be set up in IISc along with Electrical Technology (Organic Chemistry started a few months later). General Chemistry was headed by Travers, who oversaw the setting up of the lab seen here (c. 1913). While it initially functioned from the Main Building, General Chemistry later got a separate building to its east.



The machine room of the Department of Applied Chemistry (c. 1913). Norman S Rudolf was appointed as Professor in the department. Rudolf is credited with designing the labs of Applied Chemistry, which got its own building south-east of the Main Building.

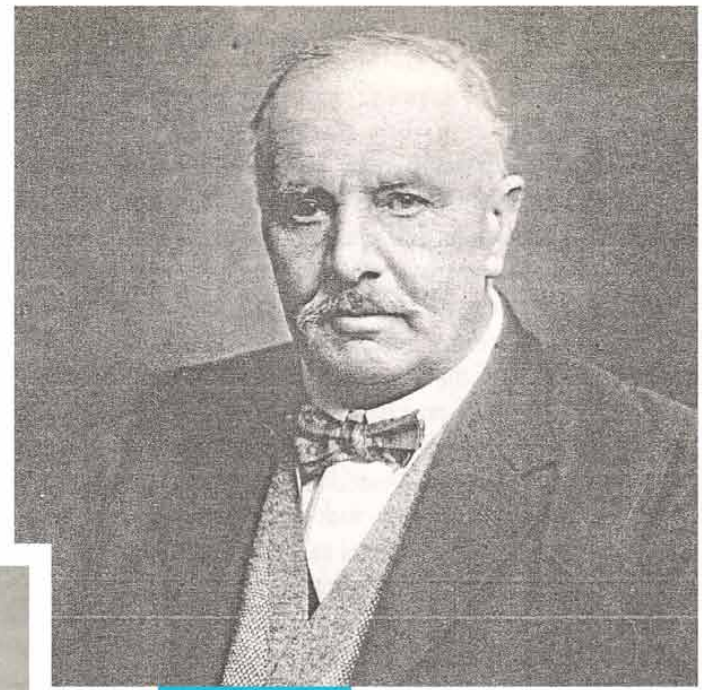
The lab of HE Watson, who was hired as Assistant Professor in the Department of General Chemistry.



The machine room of the Department of Electrical Technology headed by Alfred Hay from around 1913. Hay also designed the machine room which measured 70 ft by 30 ft. This department was built west of the Main Building. It later became the Department of Physics and now houses the undergraduate labs.

The Department of Biochemistry, which was established under Gilbert J Fowler in 1921.

The library took up most of the first floor of the Main Building. It was built to hold more than 60,000 books and journals. The first librarian was CFH Tacchella from Trinity College, Dublin, who also taught students French and German. This part of the library is now the Reception Hall.



Sir Martin O Forster, a chemist like his predecessor Morris Travers, became Director in 1922. During his directorship that spanned over a decade, several new courses and research programmes were initiated. He also ensured adequate funds for campus amenities for sports and physical fitness.

Sir Alfred G Bourne, a zoologist, succeeded Travers as Director in 1914. This was a challenging period for the fledgling Institute, compounded by the outbreak of World War I. Even when there was enormous pressure on IISc to focus on applied research, Bourne emphasised the value of research in basic sciences.

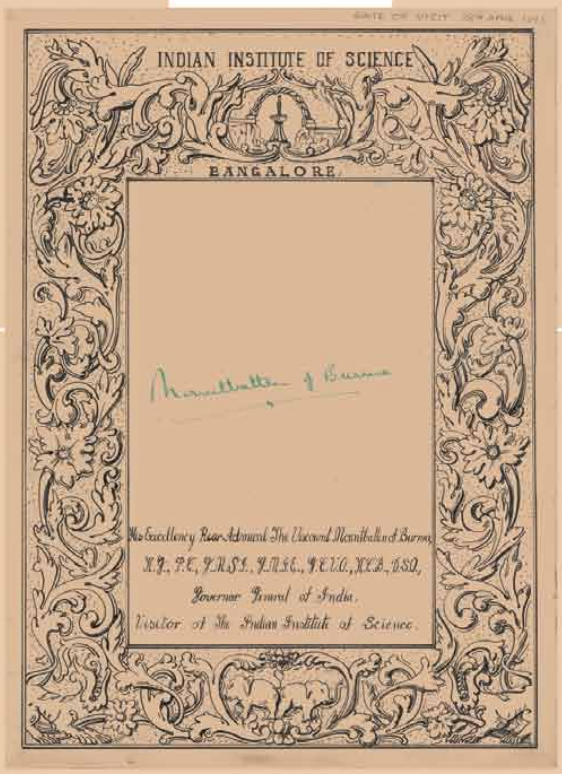
Gilbert J Fowler, known for his work on the activated sludge process of sewage treatment, was appointed as Chair of Applied Chemistry in March 1916. In 1921, he became the Chair of the newly created Department of Biochemistry. Besides sewage treatment, he studied fermentation of mahua flowers for alcohol production and manufacture of acetone from jawari for use in ammunition.

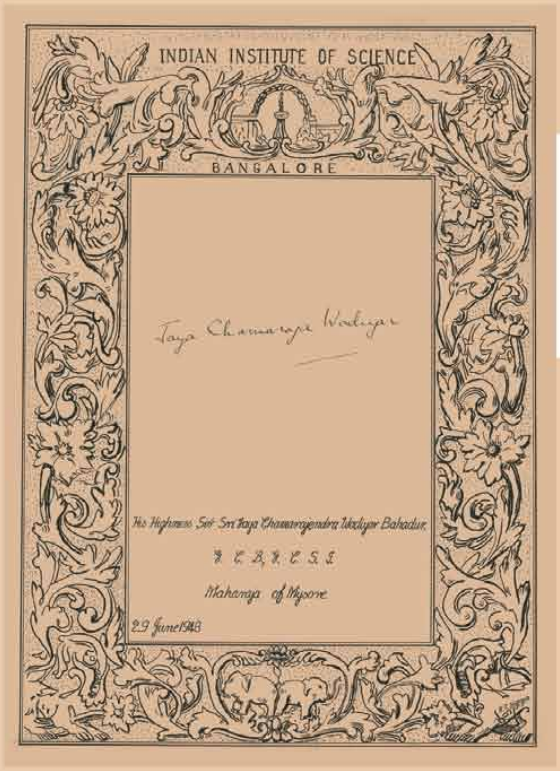
Famous Visitors

Since its inception, IISc has hosted several distinguished scientists as well as politicians, diplomats and celebrities from around the world. For most of the Institute's existence, it has maintained a 'Visitor's Book', in which signatures and words of encouragement are collected. To mark IISc's 110th anniversary, here is a small selection of signatures from IISc's Archives marking a few interesting visits.

1

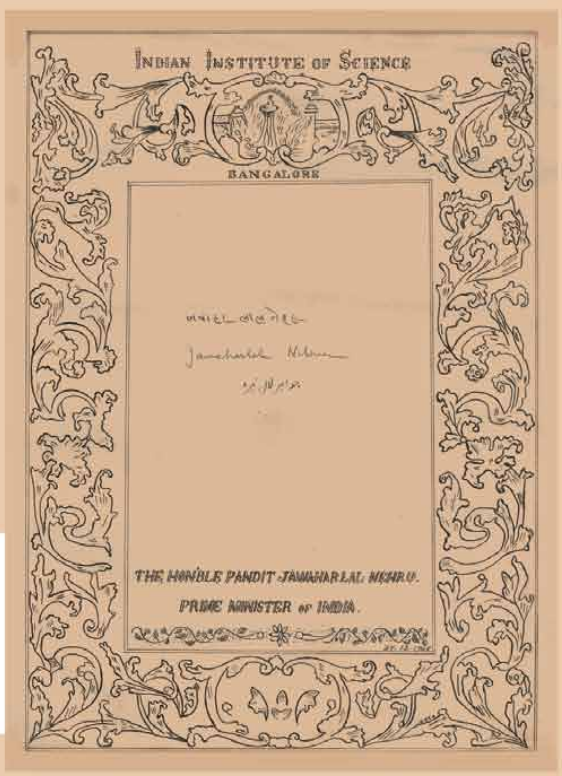
Louis Francis Albert Victor Nicholas Mountbatten, better known as Lord Mountbatten, was the last Viceroy of India. He visited IISc on 28 April 1948, while holding the post of the first Governor-General of India.





2

Jayachamaraja Wadiyar, the Maharaja of Mysore, carried on his family's tradition of providing IISc with funds and scholarships for running the Institute and occasionally for its expansion, when needed. The Maharaja visited the Institute on several important occasions, including during its Jubilee celebrations in 1958.

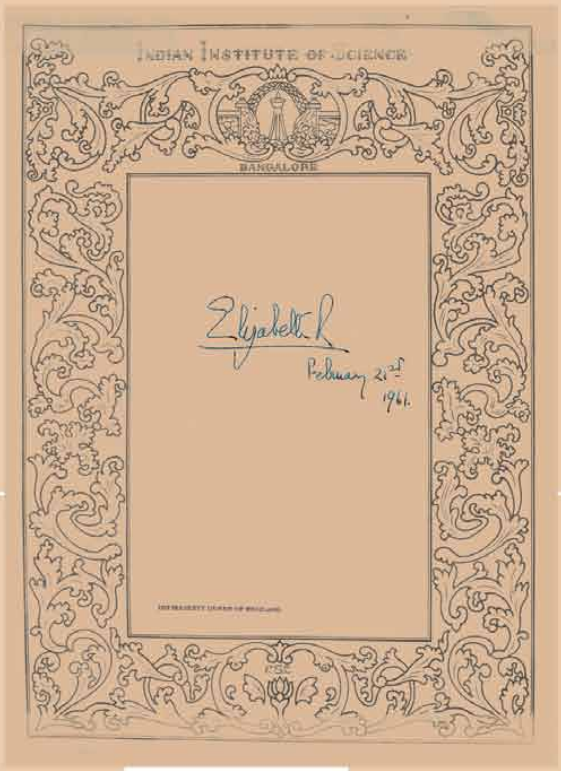


3

Jawaharlal Nehru, India's first Prime Minister, visited IISc on 27 December 1948. He returned in 1951 when the Indian Science Congress was held in Bangalore.

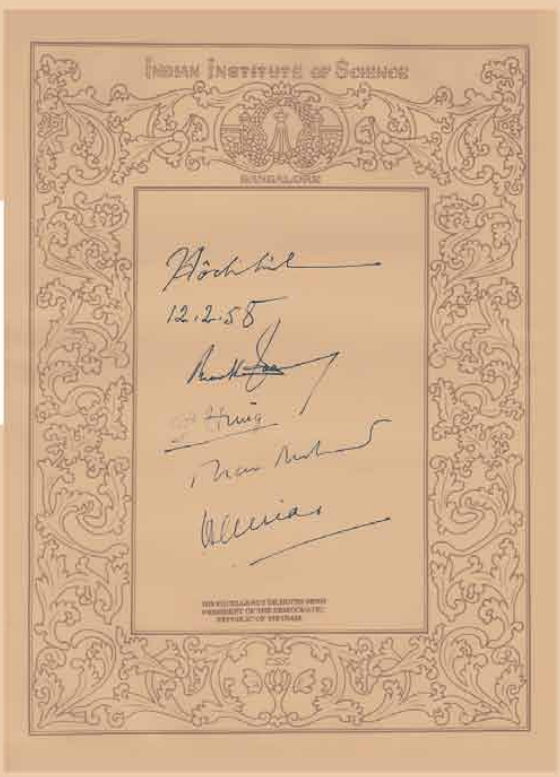
4

Nikita Khrushchev, Premier of the erstwhile USSR, visited the Institute in 1955 on his first ever trip to India. After independence, India had close ties with the USSR and communist countries, several of whose leaders visited the Institute.



5

Ho Chi Minh, the Vietnamese communist revolutionary leader, visited IISc on 12 February 1958 when he was President of the Democratic Republic of Vietnam.

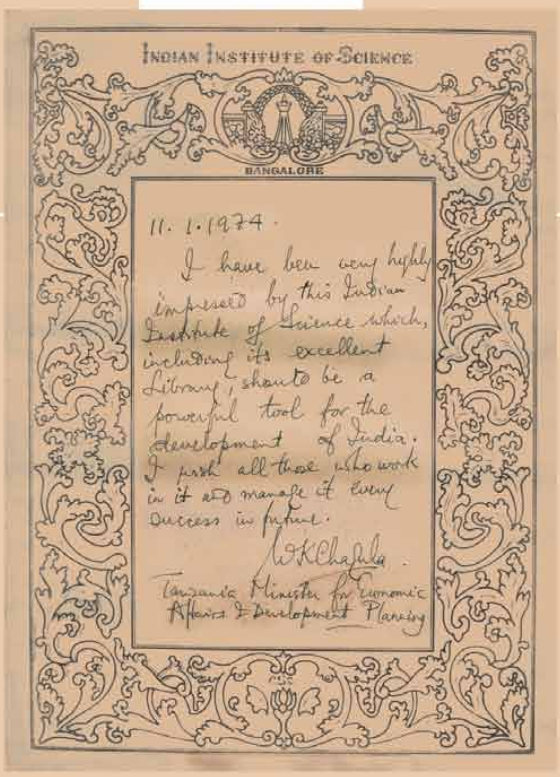


6

Queen Elizabeth visited IISc on 21 February 1961. The initial 'R' in her signature stands for "Regina", which means queen.

7

Dr Wilbert Kumalija Chagula, Tanzania's Minister for Economic Affairs and Development Planning, visited IISc on 11 January 1974. Chagula had trained in medical science before becoming an academician, Member of Parliament, a Minister, and eventually, a diplomat.


INDIAN INSTITUTE OF SCIENCE

BANGALORE

11.1.1974.

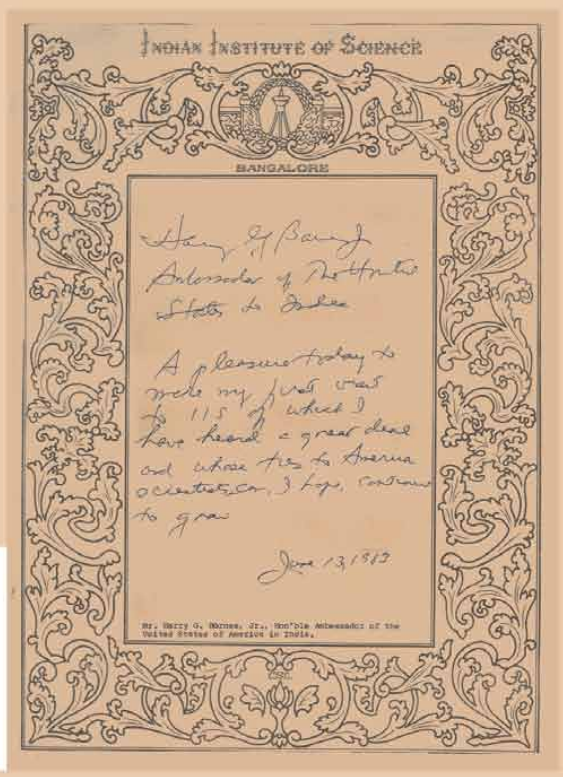
I have been very highly impressed by this Indian Institute of Science which, including its excellent Library, shall to be a powerful tool for the development of India. I pray all those who work in it and manage it every success in future.

W K Chagula.

Tanzania Minister for Economic Affairs & Development Planning

8

Harry G Barnes Jr was the US Ambassador to India when he visited IISc on 13 June 1983. He is said to have helped end military dictatorship in Chile.


INDIAN INSTITUTE OF SCIENCE

BANGALORE

Harry G Barnes Jr
Ambassador of the United States to India

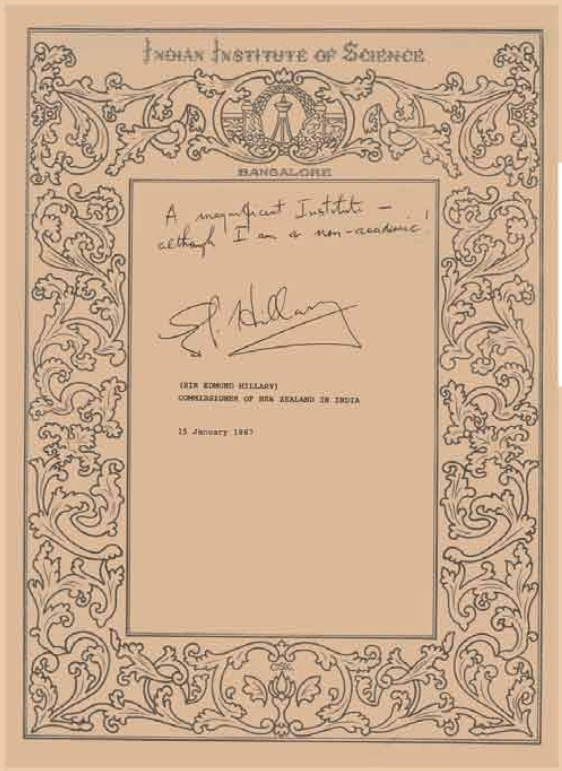
A pleasure today to make my first visit to IISc of which I have heard a great deal and whose ties to American scientists, I hope, continue to grow

June 13/1983

Mr. Harry G. Barnes, Jr., Hon'ble Ambassador of the United States of America to India.

9

Mountaineer Sir Edmund Hillary, who climbed Everest in 1953 with Tenzing Norgay, served as New Zealand's High Commissioner to India and Bangladesh, as well as Ambassador to Nepal, between 1985 and 1988. He visited IISc on 15 January 1987.


INDIAN INSTITUTE OF SCIENCE

BANGALORE

A magnificent Institute – although I am a non-academic

(SIR EDMUND HILLARY)
COMMISSIONER OF NEW ZEALAND IN INDIA

15 January 1987

The Story Behind IISc's Online Plant Database

Rohini Krishnamurthy

A scientist and his small team of volunteers have steered the cause of plants by creating a unique database, an important first step in the battle for species conservation and habitat restoration

On the third floor of IISc's Biological Sciences building is a room which, at first glance, may seem like a computer science lab. But only one half of the room has computers, while the other half has old newspapers, roughly A3-sized thin cardboard sheets called herbarium sheets, blotting sheets and stationery strewn around. And in the corner of that portion is a press, a piece of equipment used for pressing plant specimens brought from the field.

Noel Sebastian, a project assistant, who is just back from a field trip, stacks plant specimens between newspapers and places them on the press. On a table beside the press is a bunch of herbarium sheets that have dried plant specimens pasted on them. These sheets are also labelled: the date of collection, the family, genus, and species to which it belongs, and habitat where it was found, along with the names of the collectors. The herbarium sheets are stored for posterity in the specimen repository, Herbarium JCB (Joseph's College Bangalore) in the Centre for Ecological Sciences (CES). Sebastian and his colleagues now have the mammoth task of digitising these collections. Once digitised, the information becomes part of a massive database which is at the heart of three websites that have so far been launched by CES that are accessible for free: Digital Flora of Karnataka in 2014, Digital Flora of Peninsular India and Digital Flora of Eastern Ghats in 2019.

Herbarium JCB has collections from all over Karnataka and is a new avatar of what was first set up by the late Cecil J Saldanha, a botanist who taught at St Joseph's College, Bangalore. After retiring, he moved to the CES, and with him, his herbarium. The eminent botanist died in 2002, leaving behind a rich collection of plant specimens. Eventually, in 2007, the mantle of taking the herbarium forward rested on Sankara Rao, who had retired from IISc's Department of Biochemistry.

The database is expanding not just because of Rao's team but also other botanists excited about the project. “I thought there was a lot of information in the herbarium in the form of collection of plant specimens with data on each of [the] 20,000 specimens. I thought I can compile it into a database, instead of bringing this out in a printed form,” he says.

Eventually the mantle of taking the herbarium forward rested on Sankara Rao, who had retired from IISc's Department of Biochemistry

So among the first things that Rao did was to present his vision for the herbarium to CES in 2008. “I talked about it in the wake of India losing its diversity, habitats and how this information could be used in creating awareness,” he says. “With some help, I created a database of 100 species and showed how with the click of a button, people can access information on plants.” Most people in the audience were impressed and CES gave him the go-ahead to digitise the herbarium. They also provided him with the necessary infrastructure: storage facilities, an anteroom, a few computers and a project assistant. Thus began the laborious process of expanding and digitising the herbarium.

Field trips

In this process of creating the digital herbarium, the team added another crucial feature, through which they could update changes in plant diversity. Rao says, “Some plants collected for the herbarium are 30 years old. In that span of time, we can expect a considerable change in the habitat or the vegetation.” One way of going about it is to revist areas that were surveyed earlier to document changes in plant distribution.

A visit to Ottinene in Udupi district about six years ago by the team, illustrates the importance of field trips. Arun Singh, who was then a part of the team, found that certain flowering plants belonging to the genera *Ceropegia* and *Eriocaulon* had disappeared from the region, even though herbarium records mention its presence in Ottinene. His trip to Jenkal Betta and Bisle in the Western Ghats also proved futile, as he couldn't spot the indigenous trees *Isonandra stocksii* and species of *Cynometra* and *Hopea*, indicating that these plants may have been wiped out in that region.

In addition to its use in monitoring changes in species distribution, field expeditions have also opened doors for discovery: A member of Rao's team, Raja Swamy, has identified three new species and rediscovered six species that were once thought extinct. Singh also recalls finding plants that were stated as endemic to Kerala such as *Paracroton integrifolius* and *Atuna indica* in Karnataka.

Photo credits: Raja Swamy

Swamy discovered Ceropegia pullaiahii in one of his many field trips

But field explorations are not as glamorous as they sound. Swamy recalls being chased by two elephants during his recent trip to Thithimathi in Kodagu. The forest guards managed to scare the elephants in time. Encounters with wildlife or poisonous insects aren't the only challenge; they often work under the scorching sun or in heavy rains – they have even found themselves in the midst of flash floods.

Making of herbarium sheets

Once plants are collected from the field, they go through a few stages of processing. Rao explains, “This is important to preserve the collected plant specimens, especially woody ones as they lose their leaves, flowers and fruits, soon after they are separated from the plant. We also do this to avoid fungal contamination.” This step happens in the field, where they kill all of the collected specimens by dipping them in either alcohol or formalin.

Photo: Raja Swamy

Photo: Sankara Rao

Plant specimens from the field are placed in the Press

The collected samples – carefully placed between blotting sheets or newspapers – make their way into the anteroom of the herbarium. It is here that the next stage of processing begins.

Photo: Raja Swamy

A completed herbarium sheet

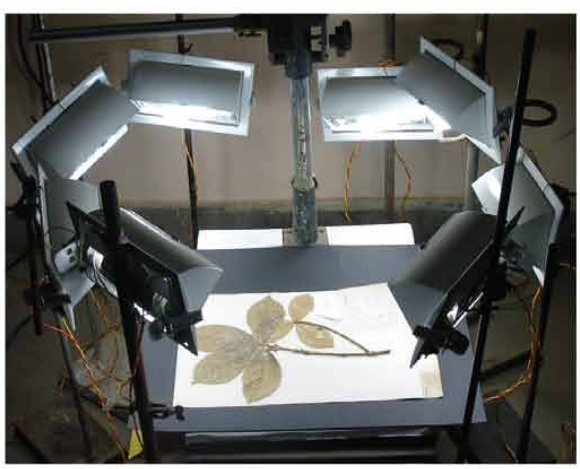


Photo: Raja Swamy

Rao built this equipment to scan completed herbarium sheets. The scanned images are then fed into the database

Rao's team then stacks a bunch of specimens on the Press to flatten and dry them. "We paste or stitch the dried specimens on the herbarium sheet, along with the numbers assigned to them on the field. My team enters collection details on the herbarium sheets and in the database," he explains. "We then store these specimens [sheets] in our herbarium, where they are placed alphabetically in their designated cupboards."

Going digital

Not long after Rao began his initiative, he realised that although he and his team had expertise in the areas of botany and ecology, computer programming – essential to creating a digital database – wasn't their forte. Fortunately for him, he found much-needed support from Deepak Kumar, a former PhD student from the Electrical Engineering Department.

> *"We have profiled about 10,000 species in Peninsular India and about 4,500 species in the Eastern Ghats"*

It took the team seven years to share their first database with the outside world. When they launched the website on flora of Karnataka in 2014, they made sure that information about every plant in the online database had been peer-reviewed by experts in the field.

Rao, however, wasn't ready to rest on his laurels. The team then set their eyes on surveying species that inhabit the rest of South India, setting the stage for more collaborations and field trips, not to mention the laborious process of preparing and digitising new herbarium sheets. In 2019, Rao's team launched their second and third websites. Elaborating on the projects, Rao says, "We have profiled about 10,000 species in Peninsular India and about 4,500 species in the Eastern Ghats, all of which can be accessed by clicking on the alphabetically sorted list in the database." By clicking on a species, you will find details such as its technical name, vernacular name and common name.

Those visiting the website can also view scanned herbarium sheets and photos from field trips. Calling this the first version, Rao says that his team will continue updating it. The website also allows people to reach out to the team by sending in their comments, queries or suggestions. He encourages people to write to them if they spot changes in plant diversity, which he says will be verified by the team.

The database is expanding, thanks to a few botanists. Recently, Rao forged ties with SP Khullar from Panjab University, who has authored a book on Western Himalayan ferns. “He has agreed to share information about ferns particularly from the Western Himalayas, helping us broaden our database,” he says. Swamy adds that the herbarium of the Regional Plant Resource Centre, Odisha, has also contributed to this effort by sharing their entire collection of plants from Odisha. “I went to Bhubaneswar, scanned all of them, and brought them to IISc. This has now become a part of the Herbarium JCB.”

Plant conservation

Rao also claims that his websites can play an important role in species conservation and habitat restoration. “The website provides information on species and their spaces: district- and state-wise locations, types of habitats and species that grow in these habitats, their conservation status, and whether a species (endemic) is restricted to a particular location. Additionally, information on indigenous plants present in the website can strengthen afforestation efforts.” Because habitat destruction causes wildlife to stray into human habitation, he believes that habitat restoration can also reduce human-wildlife conflicts.

Rao is concerned that certain species will be exploited for commercial interests, which is keeping him from releasing the GPS data of each of the documented species

Data from the websites can also serve as the baseline in studies which track changes in plant diversity over time. For instance, Rao’s team recorded dwindling numbers of India’s own living fossils: plants belonging to the genus *Cycas*. Considered one of the oldest living plants, they date back to 200 million years, some of which are present in small pockets in Karnataka. “While their contemporaries, the dinosaurs, are not alive, these plants are alive. Peninsular India has its own indigenous species: *Cycas indica*, *C. beddomei*, *C. swamyi*, *C. sphaerica*. *C. indica* remained undiscovered until 2007 and C. beddomei is seen only in Tirumala hills. These plants are now being misused: the locals cut their leaves and sell them to florists, who use them to make bouquets,” he says.

Rao also has concerns that certain species will be exploited for commercial interests, which is keeping him from releasing the GPS data of each of the documented species online. But he is open to sharing this information if he is convinced that it will not be misused.

As for the plans he has envisioned for the herbarium, Rao continues to be ambitious – his team will soon be gathering data from parts of central India. To do this, he is joining forces with botanists from other parts of India, including Pradip Krishen, who works on habitat restoration. He is keen on including species from north India as well, all of which requires abundant funding – the biggest deterrent to this project.

The herbarium needs more funds for field trips as well as to attract experts to work there

“Each field trip costs Rs 40,000 to 60,000,” says Swamy, about field visits they do in the South. But Rao adds that they’d need to shell out more to fund trips they make to the north.

Rohini Balakrishnan, Chair of CES says, “He [Rao] developed this digital database, essentially single-handedly, with the help of a small team of volunteers, without any kind of monetary remuneration. He did this on an absolute shoestring budget that we could provide him and with fairly primitive equipment, much of which he rigged up himself and paid for himself.” The herbarium needs more support not just for field trips but also to attract eminent experts to work at the herbarium. It has, however, made a good start. Recently, the herbarium received a generous grant from Lakshmi Narayanan, former CEO and vice chair of Cognizant Technologies.

Besides funding, the group has had some hitches in getting permissions from government agencies and forest officials. They have even been sent back several times from field sites. Rao, however, is optimistic that things will change. “We’ll show the world what we have done. And on that basis, we can hope for more help and funding.”

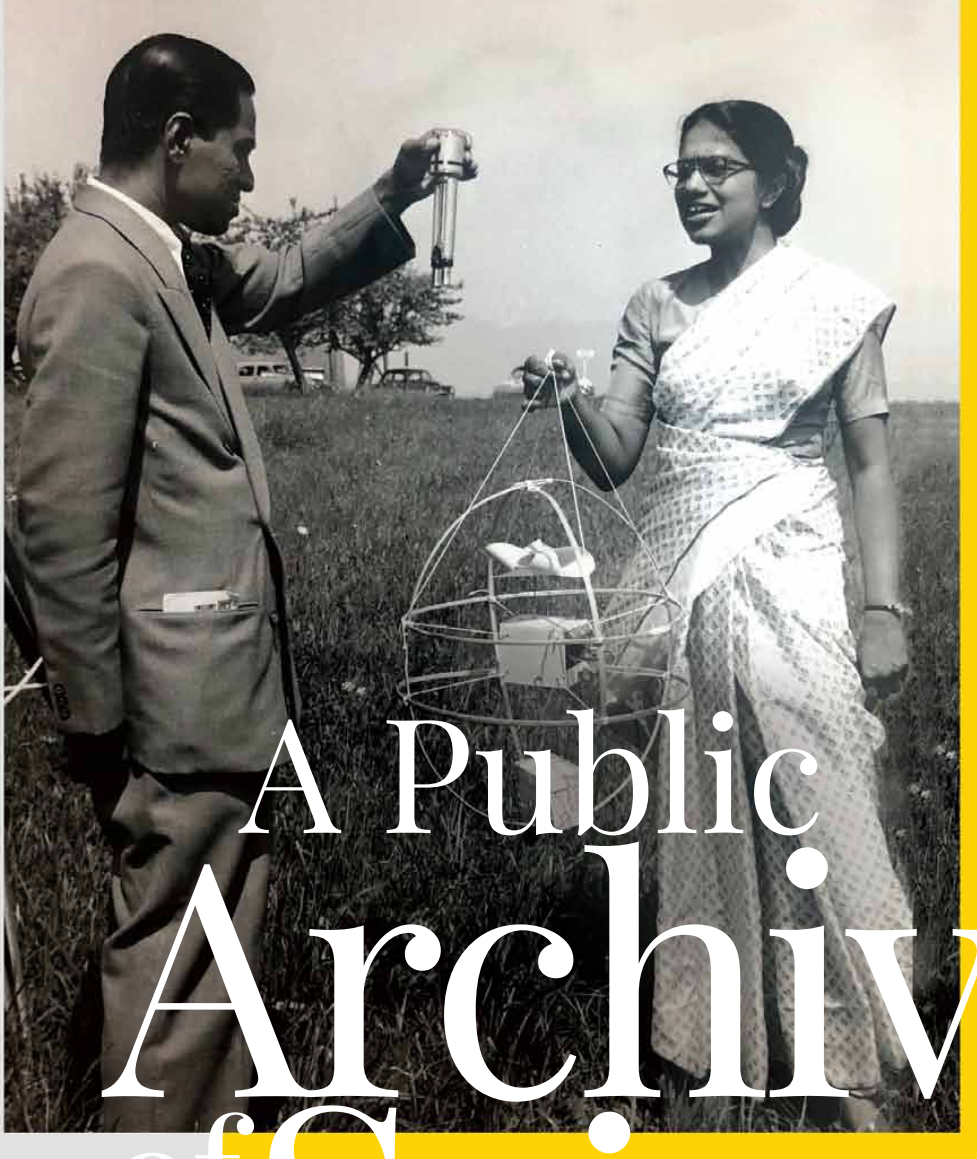


Photo courtesy: World Meteorological Organization

Meteorologist Anna Mani and a colleague work on a radiosonde, a balloon-borne weather-measuring equipment. Field experiments are tricky and often throw up hilarious moments. Re:Collect wants to capture the joy and frustration of doing different kinds of research, including field work

A Public Archive of Science in India

Jahnavi Phalkey

IISc and IIT Madras have agreed to host the institutional chapters of Re:Collect, a first-of-its-kind public digital repository to document memories of Indian science

We are fast losing the memories of a generation that built the infrastructure to transform Indian science and engineering in the 20th century. To capture and preserve these experiences, my team and I have initiated a public archive of science in India called Re:Collect. This crowd-sourced online repository will collect and house recordings of conversations with free India's first generation of scientists, engineers, and laboratory technicians about their work and their lives in a time and a world to which we have lost connection – in short, it will document memories of science in action. The project is urgent and the task enormous.

Re:Collect is the first attempt in India to draw on the inquisitiveness of the public, especially the young, to unearth, document, and to begin to appreciate India's interesting history of science and technology. Towards this, we draw inspiration and learning especially from P Sainath's People's Archive of Rural India (PARI) and Guneeta Singh Bhalla's 1947 Partition Archive – both highly successful volunteer driven public digital archives.

What Sainath says about the need for a people's archive is true also for the rich history of science in India, "Without any systematic record, visual or oral, to educate us – let alone motivate us – to save this incredible diversity, we are losing worlds and voices ... of which future generations will know little or nothing. Even as the present one steadily sheds its own links with those worlds." Re:Collect India takes on the challenge to promote an *intergenerational conversation, to build a public digital archive and to plug into a network of institutional archives* willing to accept documents and objects discovered. The Archives and Publications Cell (APC) at IISc and the Indian Institute of Technology Madras have agreed to host our first institutional chapters and also consider receiving such materials.

Why Re:Collect?

The story of science is mostly told as a story of Europe and North America. Stories and contributions from India and other parts of the world are lost in this narrative: Re:Collect seeks to change this skew. However, we simply do not know enough about the experience of science and engineering on the Indian sub-continent to do that convincingly. While it is heartening to see new institutional archives opening up, we have few oral histories and do not yet have substantial collections of personal papers of scientists and engineers. These are essential to write the history of scientific practice, and without them we cannot ever write credible biographies and thought-provoking prosopographies like Gary Wersky's *The Visible College: The Collective Biography of British Scientific Socialists of the 1930's* (1978), Marwa *Elshakry's Reading Darwin in Arabic, 1850-1930* (2013) and Michael Boulter's more recent *Bloomsbury Scientists: Science and Art in the Wake of Darwin* (2017).

Re:Collect was shaped by an awareness of the above followed by my own experience of working on what was imagined as a blockbuster exhibition on India at the Science Museum London. I was looking for interesting objects and their stories for an exhibition to follow the stupendous success of "Cosmonauts: The Birth of a Space Age" about 20th century history of Soviet science and technology. Given my research in history of science, I knew it would be difficult: I did not then appreciate just how much! King's College London, where I was employed at the time, came to the rescue with seed funding for research on the exhibition and this is how Re:Collect was born. (A smaller exhibition was eventually staged at the same venue, showcasing a longue-durée history of knowledge making and science in India – not that different from the Science in India exhibition of 1982.)

The Re:Collect process

Photo courtesy: IISc Archives

Students of the Department of Electrical Technology, IISc, in front of a 300 Watt transmitter they designed and fabricated for the Royal Air Force, for communication with London during World War II. Science and engineering are rarely the work of a lone genius. Re:Collect seeks to document and tell stories about the collective energy and camaraderie that built and pushed such projects like this ahead

Through the initial seed fund from King's, I created a list of over 1,000 senior scientists and engineers (all born before 1947), organised by their current city of domicile. Based on our learning from comparable projects, Shaun O'Boyle – science communicator, Madhushree Kamak – designer, and I have developed *handbooks* to help generate commensurate material. We have an established protocol for audio and audio-visual recording of interviews in laboratories, for creating audio-summaries and transcriptions of these, and finally, for documenting objects and instruments of historical interest.

Re:Collect India is to be driven by young and not-so-young Fellows. The Fellows are essentially

volunteers to interview the first generation of free India's scientists, engineers, and technicians preferably in their laboratories or field sites, as may be relevant. They may even video record the interview as long as it adheres to the standards specified by the protocol. We want to encourage the need to listen to and capture the stories that the pioneers of modern Indian science want to tell. The conversations are meant to capture the enthusiasm, challenges, setbacks, struggles of teaching, of conducting research, establishing disciplines, institutions, and building equipment in India after independence. Within this process as well as separately, we encourage the documentation of objects in teaching and research. The resulting conversations about scientific practice will become an oral history archive, and also generate an object inventory.

A digital archive of people in science

Re:Collect will produce three major outcomes: a digital public archive of people in science, an inventory of historical objects in teaching and research, and finally, an open access exhibition website with stories of science in action. In due course, we would like to add in full text official and credible reports related to science and engineering in India. As a bonus, we hope that the Re:collect process will help generate donations of personal papers and objects to institutional archives.

At the same time, the Re:Collect experience and our online orientation workshops will help volunteers develop useful new skills. Our volunteers are called citizen archivists; they may want to become storytellers or storytellers may consider becoming archivists. Re:Collect India will always respect the scientist's, engineer's and laboratory technician's intellectual ownership of their story, and we will always acknowledge the volunteer's contribution alongside their submissions to and transcription work on the archive.

Institutions of science and their archives, especially in India, are seldom accessible to the interested lay person. Moreover, written documents fail to capture the excitement, the tragedy and the occasional triumph of everyday science. Video and spoken-word recordings of conversations, accompanying historical and contemporary photographs, and supporting documents made freely accessible digitally is therefore the appropriate form – as a public resource – to share the experience of and reflect on the place and space of science and engineering in India's recent past.

Re:Collect will produce three major outcomes: a digital public archive of people in science, an inventory of historical objects in teaching and research, and finally, an open access exhibition website with stories of science in action

We are exploring collaborations with universities, in India and abroad, to eventually host the website and the repository to ensure continuing growth and long-term sustainability of the project. Further, we actively seek collaboration with people who can use materials from the repository for research, writing, filmmaking, and pedagogy. We are delighted that our first institutional chapter will be hosted at IISc's APC. This is among the country's oldest research institutions with a rich history: I can easily imagine an intergenerational conversation on this campus taking the form of an Assistant Professor talking to an Emeritus Professor who they have always wanted to ask something. Or it might be a team of enthusiastic undergraduates talking to a former director. Just as well, I can imagine the campus community coming up with names of senior scientists but equally lab technicians that we have long since forgotten. A search in the nooks and crannies of the Institute is likely to throw out long lost equipment built with great effort. Who knows – we might even find VM Ghatage's lost painting of Ludwig Prandtl!

As people across generations meet and talk to each other, the young will meet the experienced. The stories shared will shed light on institution building and leadership in science, on the trials and travails of doing experimental research in India – all immensely useful learning for an early career scientist or an engineer. Moreover, the material itself will lay the foundations for future history writing; and more generally, the project will help create a historical sensibility around science in India.

As India comes under the spotlight in what promises to be the Asian century, general recognition of India's struggles and accomplishments in science remains woefully inadequate both at home and abroad. This global lack of awareness is untenable especially when India is being seen as an engineering powerhouse with huge potential in scientific research.

Jahnavi Phalkey is Founding Director, Science Gallery Bengaluru. A historian of science and filmmaker, she is the author of Atomic State: Big Science in Twentieth Century India, *and director-producer of the film Cyclotron*

We learned (the hard way) not to have manels

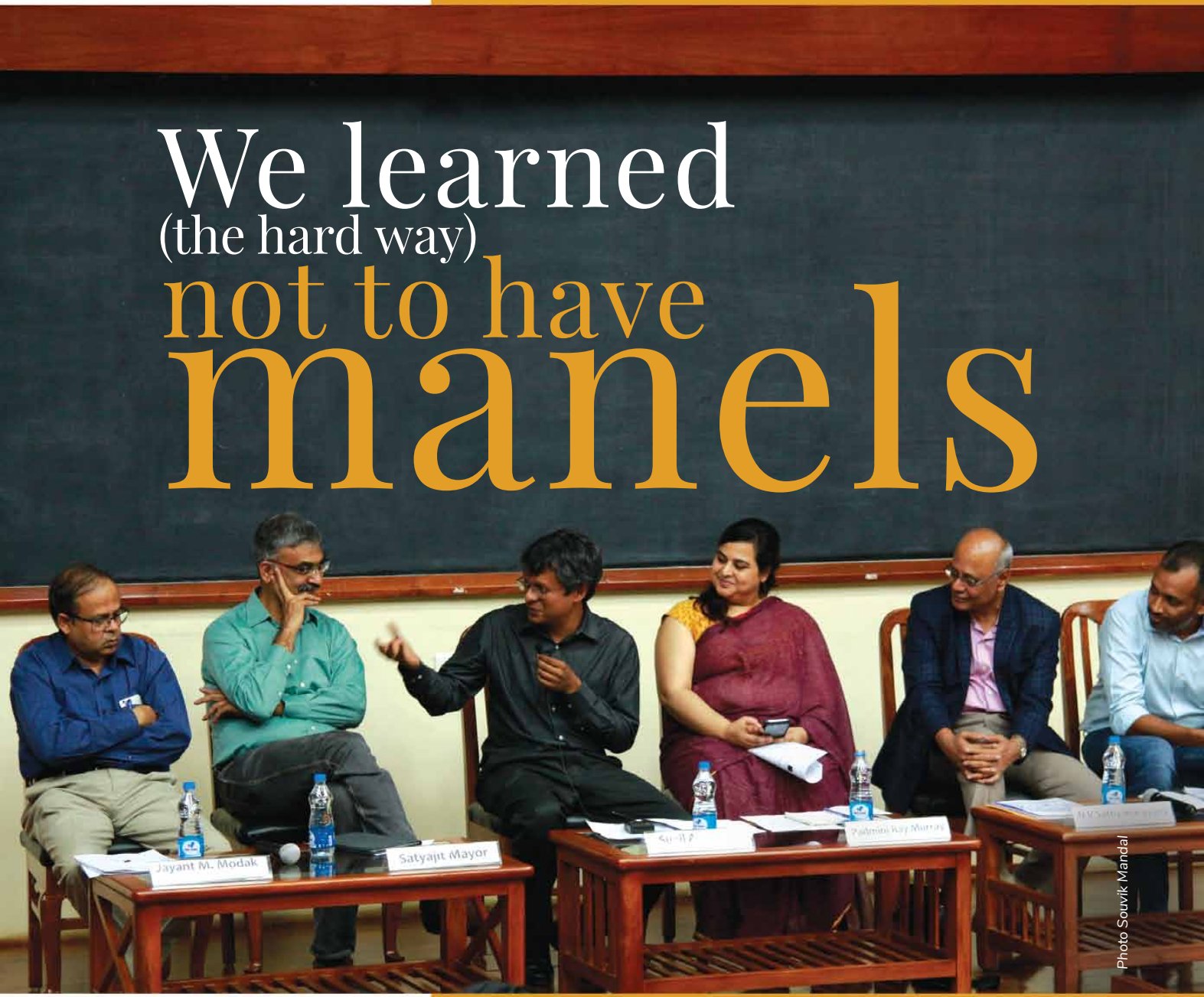


Photo Souvik Mandal

(From left) Jayant M Modak, Satyajit Mayor, Sunil Abraham, Padmini Ray Murray, NV Sathyanarayana, and Madhan Muthu at a panel discussion during International Open Access Week at IISc in 2017.

***B Chagun Basha** is a Science, Technology and Innovation Policy Fellow at IISc's Centre for Policy Research established by the Department of Science and Technology (DST-CPR). While organising an event at IISc, he and his colleagues realised that they hadn't paid much thought to gender inclusivity until it was explicitly pointed out to them that there were no women in their event. That sparked some introspection, as well as actions to ensure that this wasn't repeated. In this interview, he talks about the incident and important lessons from it.*

How did you first hear of the term 'manel'?

It was when I was organising my first event of an academic nature. Every year, DST-CPR marks International Open Access Week by planning activities for the entire week, and having a panel discussion is a major part of it. We bring in experts to sensitise people about topics related to open access and how we can incorporate it in our Institute through a bottom-up approach.

In October 2017, when International Open Access Week came round, we collaborated with six other groups to organise it. We had a poster competition, a panel discussion, and a few other activities like engaging with the student community about open access and how they could play a role in promoting it.

A week before the panel discussion was scheduled, we had confirmed the participation of all our speakers – five male speakers and one female speaker. The female speaker had not been included out of a conscious effort to ensure gender diversity – she happened to be on the list of names we came up with, we had written to all of them, and they had agreed to come. But a few days before the panel discussion, we received an email from her saying that she would not be able to join us.

We didn't think it was a big deal. Instead of six participants we would have five, one of whom would be the moderator. Sunil Abraham of the Centre for Internet and Society (CIS) had already confirmed that he would be the moderator. He sent us an email asking for details of the panelists, so that he could communicate with them and plan and structure the discussion. But when we sent him the details, he immediately got back to us saying that he wouldn't be able to participate in this panel discussion.

I was a little shocked – you can replace a panelist at the last minute, but finding a new moderator to curate a discussion is harder as doing so requires in-depth knowledge of this space and familiarity with open access policies at different levels. I asked Sunil what had happened – why did he have to pull out? He said that CIS had a written policy that was followed strictly: members could not participate in "manels" – a word I was hearing for the very first time. I didn't even catch it properly when we spoke on the phone. Then he explained to me that if there was a panel on which there were only men and no women panelists – which are called "manels" – then people from his organisation avoided them completely.

What happened next?

I realised that as an organiser of an event, I wasn't even thinking about being inclusive. So we requested Sunil to suggest names of women speakers whom we could approach. I realise now that it was not a good thing to do – when somebody points out that there are no women on your panel and for those reasons they are not going to participate, you should try harder to rectify this at your end, and not dump the responsibility for this on the person who pointed it out in the first place. We should have put in genuine effort from our end to learn more about other women in the field whom we could approach for the panel. But at the time Sunil generously agreed and gave us a list with 12 names. We contacted all of them: two people responded, one of whom - Padmini Ray Murray, who was a faculty member at the Srishti Institute of Art, Design and Technology - happened to be in Bangalore and agreed to participate at short notice. We were really thankful for that.

The panel discussion went off smoothly, and at the end we gave a vote of thanks, where we acknowledged our goof-up, thanked Sunil for bringing it to our notice, and we promised the audience sitting in Faculty Hall, which included the Director of NCBS and the Deputy Director of IISc, that we wouldn't run any more manels. We said we would consciously include more women in all events we organised from then on – not just panel discussions but talks, workshops and so on. That's more or less an official decision we took for CPR.

Did you feel like you were being put on the spot at the time?

We would often ask our superiors to suggest names for events or scout for people on our own, but actively thinking about including people of all genders was something we never really did. Now it feels like something that is really important.

And an interesting thing happened after the vote of thanks that year: other people who had been in the audience and worked in other institutes or other departments at IISc came up to talk to us during the tea break. Like us, previously they thought it wasn't important to think about who was being invited as panelists, but they began to see it was important too.

Has that changed how you planned subsequent events?

Two months after that panel discussion, we organised a workshop. On the final day of the workshop, we presented information on how many male and female participants applied, and how many of each we selected (women formed a little over 50 percent of those selected). That was our indirect way of letting people know that we took gender into consideration during our selection process.

In October 2018, when International Open Access Week came around again, we organised a panel discussion as well as an event called the Global Equity Forum for librarians, because they play a key role in making open access a reality at the institutional level. We consciously included women for both events, and not just because they were women. We realised that if you put in a little effort, you can easily find competent people of all genders without having to select people only for representation's sake.

Participants of the Science, Technology and Innovation Policy Workshop held in December 2017.

What about the people you mentioned earlier, who came up after the panel to ask you about including more women – do you know if they ever followed up on it?

Since the 2017 panel, others have made an effort to have equal numbers on men and women in panels too. It's been like a chain reaction – some of those who attended our panel discussion took notice and kept it in mind when they organised events themselves. For now, though, ensuring gender diversity has depended on the efforts of the individual organisers. What happens when they leave and others take their place? I think we need to put forth a policy at an IISc-wide level for events organised on campus so that we can ensure balanced representation of women – not just on stage, but among participants of events like seminars and workshops as well. Leaving it up to personal decisions means that it may not be a sustained process, and that's why we need to work towards having it as a departmental policy or as an institutional policy. Of course we need to push for this as individuals, but we also need the leadership on board in order for this to materialise.

Ensuring equal representation for men and women in public events may seem like a small issue, but it drives bigger issues. Everybody is supportive of gender equality and inclusion of women at some abstract level, but if we really want that to happen, it has to start at small levels and at different stages. That's a key thing we learned from organising the 2017 panel – that it had to start with us. Inclusion in panel discussions and events is just one of the stages at which it can happen. In an academic set-up, dialogue is one way of engaging with a larger audience. You also have events, exams, student participation, and many other such avenues at which it happens, right? We have to address inclusion at all levels. If we have a policy about gender inclusion in events on campus, it could pave the way for policies on gender inclusion in other areas like intake of students, picking members of faculty, picking members of decision-making committees, and so on. We have to start somewhere, and we can't rely on easy excuses not to act. It's a fundamental issue that really needs to be addressed – and maybe then it will become the norm, and open our eyes to the need for other kinds of inclusion as well.

On Teaching

Maria Thaker

Assistant Professor, Centre for Ecological Sciences

Maria Thaker (extreme left) with students from her field course at Agumbe

Maria Thaker and Siddharth Jhunjhunwala reflect on their journeys as teachers after winning the Dr Priti Shankar Teaching Award for 2018 which they received on 15 March this year during the meeting of the Court of IISc

It was 11:30 at night and it was clear that several of the students were not back. Down the main trail, I found two undergraduate (UG) students staring intently at the pink flowers on a *Syzygium* tree and one furiously writing in a notebook by the light of a headlamp. A PhD student stood a few feet back, scanning the area for snakes and expertly identifying the occasional moth or bee that the others missed. They were not ready to return, and so I walked to the river on the other side of the camp. There, the situation was even more impressive. I knew not to turn on my headlamp and it took a few minutes for me to find everyone in the dark. Perched on rocks along the river, the students were still and silent. And then we all heard it, the call of a *Mircrixalus* male. One UG student shone his torch upwards, two PhD students nodded, and someone else recorded the location and time on a rather wet data sheet. I stayed to hear three more frog calls, by which time I understood the clever (and silent!) communication system among the students. I left these young ecologists with whispered instructions to be back at camp by midnight.

Ecology is a science full of discovery and adventure. I could teach ecology without any of us leaving the classroom, but that would be a wasted opportunity.

And so every year since 2013, the UG Biology students travel with me to the Western Ghats. The goal of this trip is to enable *emergent learning*. Without cell phone connectivity or reliable electricity, we spend the weekend developing and testing hypotheses, based entirely on what we see around us. It's unconstrained, curiosity-driven science at its best. What makes this experience so valuable is not just the forest and the bonds we build while collectively removing leeches off our socks. It's the *mixed-level learning*. With PhD students and Instructors as mentors, we organically engage in deep discussions about experimental design, confounding variables, and sample size – all of which are key to training a scientific mind that can look beyond published methods or set experimental protocols. The mixed-level interactions where PhD students learn to teach and mentor, while UG students develop their independence is powerful. I'm hoping that our impromptu conversations about academic ethics, research practices, mental health, and sustainability – issues that we never make time for in the classroom – help build a shared culture for open science, collaboration, and integrity. Therein lies my overarching learner-centric pedagogical approach: *structured and mentored independent learning*.

(Photo: Abhijeet Bayani)

Over the last few years, I've formalised my teaching philosophy and pedagogical approaches. I do this mainly for myself, so that I have clear teaching goals and ways to evaluate the effectiveness of my classes at the end of every semester. Ideally, this should result in me and my courses getting better every year. This introspection takes time and effort. For example, one of my teaching goals is to *provide the tools to be an effective communicator of science*. This means that I need to provide multiple opportunities for learners to communicate, with enough feedback to improve. Thus, students in my courses have exams, but they also write grants, critique and peer review, give several project presentations, and make mini-documentaries. Each of these activities is semi-structured, with a specific target audience in mind: grant committees, scientific peers and the general public. The goal is to convince these audiences that the science is interesting and worth their time (or money).

> *By fostering creativity in the very process of learning, we empower students to be imaginative – a trait that has sparked some of the best discoveries in science*

On the surface, these exercises may sound pointless and lack the rigour of a serious classroom where information is provided, and papers or exams are the sole modes of assessment. But it's time we break the misconception that academic rigour comes in a single form. Let's loop back for a minute to making documentaries. What is the point and where is the learning in this activity? Students must first take the time to observe their environment and find something interesting and curious (discover something new). Then, they must read the relevant primary scientific literature to make sense of their observations (do research) and capture those observations for others to see (record). Finally, they must narrate the story with an informed description (write). All the same steps of a report in a visual form that can be shared with everyone in class. Inevitably, we all learn something new and discover that we are far more creative than we thought we were. By fostering creativity in the very process of learning, we empower students to be imaginative – a trait that has sparked some of the best discoveries in science.

I'll end here by saying that we have all had "good" and "bad" teachers in our lives. It's remarkable how much influence they have to either make us love or hate the subjects they taught. In high school, I met Mr David Hoover, a biology teacher at the American Embassy School in New Delhi. His brilliance in the classroom was only surpassed by his seemingly unlimited time, patience, and mentorship. How many high school biology teachers do you know who would wake up at 5 am and help a student track rodents in the Delhi Ridge? My teaching and mentorship philosophy began with his example.

Siddharth (extreme right) with his students and postdoc during a lab retreat

Siddharth Jhunjhunwala

Assistant Professor, Centre for BioSystems Science and Engineering

On the occasion of Teachers' Day (5 September), the school I studied in asked students from 12th standard to teach a class. I taught 10th standard history for an hour, and all I can recollect about that experience was that the one hour went by quickly. I didn't think much about that day for six years, until I became a teaching assistant in graduate school for a class on Biothermodynamics. In order to prepare for it, I approached Prof John Patzer, who taught the course, for advice on how to handle a class of over 50 students. Two points that were elaborated during that meeting have stayed with me all these years: one, do not proselytise, but rather try to have a discussion with your students, and two, be honest about what you know.

The first piece of advice struck a chord with me immediately. The class I taught in school was to students I knew outside the classroom – I often played cricket with a few of them. Maybe time flew by in that class because I knew the students and was having a conversation instead of trying to instruct them. Since then, I have used the approach of teaching classes through discussions with students rather than merely lecturing.

However, engaging students in discussions is not always easy. Some students are shy and do not want to talk, and others have been brought up in a system that has discouraged talking to the teacher. At IISc, I try to overcome some of these barriers by asking students *directed questions*, which both encourages and gives them the space to engage in a conversation. The directed question approach may seem intimidating, but I attempt to structure my questions more along the lines of "what are your thoughts on this subject", or "what comes to your mind when you hear this term", rather than ask factual questions. My experience using this approach and the anonymous feedback I receive from students at the end of my courses suggest that this brings the students out of their shell and they become more active learners.

But classroom discussions have a way of meandering towards topics that are not necessarily relevant to what needs to be taught. This is where I as an instructor have to step in and nudge the conversation towards the topic of relevance. This is hard, and I am still learning how best to do this without abruptly stopping a dialogue among students.

The second piece of advice I received from Prof John Patzer – about the importance of being honest about what I know and what I don't know – sounded difficult at first but has been easier for me to follow in reality. It begins with an acknowledgement that one can only understand so much about a particular subject, even the one they are teaching. Once that is done, it becomes easier to handle a classroom discussion and address thought-provoking questions from students. In fact, the most fun I have had teaching is when students ask questions that I do not have answers to. It is among the easiest ways to appreciate the limits of my understanding of a particular topic and provides my students and me with an opportunity to re-learn or gain new knowledge. And this, I feel, reinforces the idea that you become an expert in an area only when you teach it.

> *I try to overcome some of these barriers by asking students* directed questions*, which both encourages and gives them the space to engage in a conversation*

The idea of learning through discussions raises the question about the role of a teacher: does the teacher merely act as a facilitator for exchange of ideas, or can they be more than that? Let me attempt to answer the question with an experience I had back in graduate school. I took a self-study class on mucosal immunology, as the topic was of relevance to my research. Graduate school is supposed to be the time when you teach yourself, and that's what I aimed to do. However, with very little prior knowledge of basic immunology, I found mucosal immunology hard to learn by myself. I attended laboratory meetings where students discussed journal articles in this area, and discussed the topic with my colleagues, but I always felt that my understanding of the subject was poor. This became apparent when I attended a lecture on the same topic by a visiting faculty, and then went over videos of pre-recorded lectures (which are now widely available more easily through various sources). Though these lectures did not introduce any new concepts, they put forth the ones presented in the books and journal articles in a way that I found easier to follow. That's when I understood the importance of a teacher, especially in helping the student learn basic concepts in a particular field. I want to emphasise, however, that I do not mean to belittle self-learning, but taking a class with a good teacher does make learning a lot easier.

Photo courtesy: Siddharth Jhunjhunwala lab

Why I talk to scientists about their classic research papers

Ecologist Hari Sridhar has conducted around 140 interviews with scientists about the backstory to well-known scientific papers authored by them

When we read research papers, there's much that we do not know about the studies and their authors. An ecologist sets out to fill the gaps

By Hari Sridhar

In 2016, I began a series of interviews with scientists about the backstory of papers they had written. Scientific papers often present a cleaned up version of science even though the actual process is often messy, and through my interviews I wanted to know more about the not-so-neat bits. I wasn't sure what people would make of my idea, so I started by approaching a biologist called Mandyam V Srinivasan, who studies bee vision in Australia – it seemed less intimidating to do so because he is related to me! And soon after, I interviewed the US-based ecologist Shahid Naeem. They were both generous with their time and encouraging of my plans, and that's where the series began: since then, I've worked on around 140 such interviews, 70 of which are published on my blog, Reflections on Papers Past.

But the idea of doing these interviews formed some years earlier in 2009, when IISc's Centre for Ecological Sciences (CES) was celebrating its silver jubilee and I was asked to give a talk at a symposium that it was organising. I had recently finished my PhD at CES, and it just so happened that around the time, I was chatting with Vidyadhar Atkore, a friend and former classmate of mine who pointed out that everyone gives talks about their research, but what they don't talk about so much is what they actually did – even if it was unintended, or didn't initially work, or had to be discarded. He felt knowing something like that would be really useful for people coming into the field, especially students who might be doing research for the first time. So I thought maybe it would be interesting to talk about one of the papers that I had written during my PhD. By the time of the jubilee, I no longer stood by some of the things that I had said in that paper – if I had written the paper at that later point, I would perhaps have said things differently and interpreted some of the data differently. And that got me thinking more about how we tend to do science, and the importance of peeling back that process.

Photo courtesy: Hari Sridhar

In 2013 I had the opportunity to go to a place called the Institute for Advanced Studies in Berlin. It lets you pursue any crazy idea, and in my application I said that I wanted to treat published papers as if they were manuscripts that had just come in. If I had to write a review of one of them, what would that look like? Within the institute was the College for Life Science, where there were others like me, and while I was chatting about my work with an evolutionary ecologist called Seth Barribeau, he made a valuable suggestion: if I wanted to reach a wider audience, why not pick papers that people knew really well, and do the same kind of exercise with them – ask the authors about their backstory?

> *It is only when you write your first paper that you realise you go through all kinds of problems and failures, and stumble upon so many chance events*

Before I came into research and wrote my first paper, I found reading papers somewhat intimidating: I always felt like there was no way I'd be able to do this kind of work. Everything seemed so well thought-out, like it was done by really smart people who knew exactly what they were doing, and who had very clear results. It is only when you write your first paper that you realise you go through all kinds of problems and failures, and stumble upon so many chance events, but present all of this in a paper where it sounds like everything was in place right from the beginning. Picking really well-known papers by well-known authors to revisit humanises them, in a way. These papers have become monuments in the field, and part of my motivation for doing this project is to say that they are people just like us, and there is so much luck and chance and so many human aspects to these papers.

What I ask about

The idea is to pick what one might call 'classic' papers in ecology and evolution, and so I look for papers that have been really well cited, used as examples of concepts or ideas in textbooks, or have been recognised in some way (for example, if the author won an award for it). So I started with papers in sub-disciplines of ecology that I was familiar with, but I've since tried to pick ones from other sub-disciplines as well.

In my interviews, I am not interested in trying to challenge the validity of the papers; I am more absorbed by how the authors feel about their papers. I have a standard set of questions that I usually ask. Broadly, they are divided into three kinds: one is about the backstory – how the study and the paper came about. I usually ask things like where the idea came from, how the authors came together, what the fieldwork was like, how they chose the journal, what contribution the people mentioned in the 'Acknowledgements' section made, and so on. The second set deals with what impact the paper had on the author's career, how it influenced their research after that, and what the impact of their paper was on the field itself. The third set is to get the author to reflect on what was said in the paper from a contemporary perspective. I pick certain sections in the paper and I ask the authors, "You said this then, what do you think about this now, 30 years later?"

In the early interviews, sometimes I was so focused on getting answers to my set list of questions that I wasn't paying enough attention to what people were actually saying, and so I wasn't able to ask the right follow-up questions. But the more I did it, I realised it was more important to listen carefully and let some of my questions be open-ended.

Evolutionary biologists Peter (left) and Rosemary Grant (right). An interview with them revealed that their daughter had helped complete the fieldwork for a study when Peter had to undergo treatment for cancer.

What I learned

I was really surprised to get so many positive responses, and that so many people were willing to do the interviews in the first place. And I learned a lot about the process of science from these interviews.

When I went into the interviews, I often didn't realise that the authors had written these well-known papers at such varied stages in their careers. One such paper came out of someone's Master's thesis, a large number were written during their PhDs, and some were written while they were postdocs. So I realised that you don't have to be an established professor in order to write a paper with impact.

> *I realised that you don't have to be an established professor in order to write a paper with impact.*

One thing I am really struck by is how so many of the collaborations between foreign scientists that led to these papers were not planned at all. Many of them happen by chance, largely as a result of people meeting at conferences and agreeing to work together. And from this I've learned the importance of having access to a wide network of people in your field – something we don't have as much in India. Funding to attend conferences is also hard to come by, whether they're in India or abroad. Being able to meet and interact with people from different labs doing really good work, and getting to know them personally, would open up so many more opportunities for collaboration.

To me, one of the most important questions that I ask – with some of the richest answers – is about people who are acknowledged for their contribution. It really gives you a sense of how important other people have been to this work: some of them have made really crucial contributions, even if they are minor. When interviewing evolutionary biologists Peter and Rosemary Grant about their paper on character displacement in Galapagos finches, for example, I asked them about the people they acknowledged, one of whom was "KT Grant". That person turned out to be their daughter Thalia, who had been helping them with fieldwork since she was six years old, and who had completed an important part of the fieldwork for this particular study when her parents were unable to travel because one of them was being treated for cancer.

Another thing I've noticed is that many of the papers that I covered had a single author, and were written during that person's PhD. When I've asked how come their supervisors weren't listed as co-authors, all of them said that at the time, their supervisors felt that unless they were involved in all aspects of the work, they should not be authors on the paper. Now it's become very rare to find that PhD students produce single-author studies, not just in India but across the board. And in general, statistics show that the average number of authors has increased quite a bit – from close to one in 1956 to between three and four in the journal *Ecology*.

There have been a few interviews that I enjoyed doing in particular. One was with Nicholas (Nick) Davies, who works at the University of Cambridge and is well-known in the field of behavioral ecology (best known for his work on brood parasitism in cuckoos). I interviewed him about a paper about butterflies that he did soon after his PhD. It was a great interview because he is such a nice person to talk to, he was very generous with his time and has an engaging way of saying things. But it was also because even though the study was a simple one, it's very rare to find one like that today – it involved a lot of natural history work. He described how on one day he just sat in a tree all day long to watch butterflies patrolling in the woods. In terms of what he found and what he said in that paper, he was also very willing to acknowledge that some of those things probably won't hold today.

Nicholas Davies, behavioural ecologist at the University of Cambridge, spoke about the research he did for an old study on butterflies – the likes of which are now rare because of the amount of natural history involved

Paul Dayton, a well-known marine ecologist at the Scripps Institute of Oceanography, was also a delight to interview. Even though it was an email interview, he really took the time to send me detailed and interesting responses. He continued writing to me even afterwards with suggestions for other people I can interview, and he's put me in touch with other potential interviewees as well as people who might support the project.

Archiving the scientific process

What is it that gets cleaned up in a paper, that you don't usually get to see? You may leave out results that are superfluous or do not seem to present straightforward answers at the moment. Sometimes what you come up with is not what you originally mentioned in your proposal. You also may not present things in the sequence in which you actually did them, and chance discoveries are presented as though they were planned all along. This is not entirely a criticism of the way papers are – of course the cleaning up has a function: you want people to be able to quickly evaluate whether your findings and interpretations are valid. For a reader who wants just that from the paper, the format is fine. But as a document that archives the scientific process, it presents a distorted version of how science works. You may present theoretical motivations for why your work is important. But that isn't necessarily the motivation for why you did that work.

Now, with journals going online, I think there is really an opportunity for this to change – for journals to allow people to present these stories of how they actually did their research and why they did it, along with their papers. For now, I've been putting up all material from the interviews I did on my blog. Another way I'd like to put out this material is to take the original papers and annotate them with material from the interviews. Perhaps it's far-fetched to think that journals would actually be willing to do this, but I would like to do this with some papers, at least as a prototype.

I must sheepishly admit that I don't think the way I write papers myself has altered much (also because I've only published one paper since my project began), though one thing I have started doing is to maintain a more careful record of what I am doing in my research, like keeping a journal. I think it's been very useful, and I wish I had done it right from the beginning. Maintaining a daily log helps track things like exactly when an idea came up and changed the direction of your plans, and for my last paper I tried to document that more diligently.

These days, I am more interested in learning about scientists than I am about doing science – I think there's very little work that tries to understand and document the nature of scientific activity, and the process of science itself. In the near future, these are the questions that I would like to pursue: how does science inform and interact with conservation in India? What kinds of science are useful in conservation? What are the motivations of conservation biologists to do what they do? And more generally, what is it like, on a daily basis, to do science? That's what I'd like to find out.

As told to Deepika S

Hari Sridhar is a post-doctoral researcher at IISc's CES, and his primary research interest is social behaviour among members of different species. In addition to research, he teaches community ecology and ornithology at different institutes, helps edit a magazine called Current Conservation, *and conducts interviews on topics related to the making of science.*

Can Cryptography Keep us Safe in an Increasingly Digital World?

Rohini Krishnamurthy

In the second part of our series on cryptography, we dive into why we are experiencing increasing privacy violations

Image courtesy: Succo/Pixabay

In early February this year, an ethical hacker called Victor Gevers revealed that he could track the movements of 2.5 million Chinese Xinjiang Muslims in real-time on a site that belonged to a Chinese surveillance company, SenseNet. There's more: he could also see their personal records such as their names, dates of birth, passport photographs, and employment details. All Gevers had to do was to find a way into the company's cache – which stores data for faster computation – because its website had no proper security mechanisms in place.

Even Quora, Mariott Hotels, British Airways, T-Mobile, Yahoo and the like have had their security compromised. Back home, we've had our very own Aadhaar privacy breach, where users' data has been stolen multiple times, potentially compromising the personal records of almost 1 billion people, including their names, addresses, photographs, phone numbers and email addresses. The World Economic Forum's (WEF) 2019 Global risk report, has ranked this breach the largest data theft in the world.

> *"Some of these leaks are engineered by humans, who find a loophole and exploit it"*

In spite of advances in cryptography – the science of protecting information – why are we seeing increasing security and privacy violations? According to K Gopinath, Professor, Department of Computer Science and Automation (CSA), the factors that make us vulnerable do not always have to do with cryptography. "Some of these leaks are socially engineered by humans, who find a minor loophole and exploit it," he says.

In the case of Aadhaar, according to him, the Unique Identification Authority of India (UIDAI) employs third parties, some of whom may have tampered with the software that powers Aadhaar's Enrolment Client Multi Platform (ECMP). Through ECMP, third parties enrol applicants by collecting personal data and record fingerprint and iris scans, which have time and location coordinates imprinted on them and feed them into the ECMP software. This software, in turn, enrols applicants only after making sure that the timestamps and GPS coordinates on the fingerprint and iris images correspond to each other.

The software does this by merging the applicant's information – photos, timestamps, and GPS coordinates – and binding them. The binding happens through a cryptographic function called hash, which maps the merged information to specific bits, unique to every applicant. This means that no two different applicants can have their attributes reduced to the same number of bits. He explains, "For example, if I hash a book, which maps to say, 384 bits, finding another book which hashes to the same 384 bits is extremely difficult. It is so difficult that it may take thousands of years to be able to do so." When a third party tries to modify an applicant's photo, time stamp or location, the cryptographically secure software will compress the information, but its value will be different from the original, alerting the UIDAI.

Photo courtesy: Biswarup Ganguly/ Creative Commons Licence/Wikimedia Commons

An applicant in the process of being enrolled into Aadhaar

However, a third party with malicious intent can alter the ECMP software to bypass the checks on timestamps and GPS coordinate and create a new fictional identity altogether. By combining the iris and fingerprint images of two different people or by even artificially generating new identities, a stream of "people" with fake identities could be brought into the system. "The system, it seems, accepts any data on the third attempt", says Gopinath. This defeats the very purpose of Aadhaar – to provide each Indian with a unique identity. Reports claim that the compromised software was being sold for as little as Rs 2,500. However, the UIDAI has refuted them.

Some critics argue that people will find a way of gaming the system. “All it takes is to know where to find a loophole,” Gopinath says, “and then somebody can install a software that overlooks, for example, the mismatching time and location, providing fodder for cut-and-paste attacks.”

To install fake software, hackers meddle with a certificate that identifies the authenticity of the software. Certificates build a chain of trust and are ubiquitous: on the address bar of a websites such as those of banks or ecommerce, (“https” in the URL, as opposed to “http”, indicates that the website has a security certificate), or system updates on mobiles and laptops. Certificates assure the user that the information exchanged with the website, including passwords, is safe, while also ensuring that software updates from WhatsApp or Gmail or on mobiles and laptops are coming from authentic sources. Similarly, the ECMP also has a UIDAI certificate that confirms its authenticity. By making changes to the chain of trust in the certificate, hackers can pass off non-authentic software as authentic.

The situation may seem grim when breaches happen despite the security that cryptography provides. Gopinath thinks that the UIDAI should have made their software more secure by designing the whole ecosystem more efficiently in the first place, by carefully monitoring the third parties or service providers who use their software and checking the integrity across the system. Additionally, he says, they should have rolled out a stronger software system that could have prevented service providers from meddling with them. “Take Gmail’s software for example, he says, “they say that Gmail cannot be tampered with, it is probably true because of the software they use.”

The reason for privacy breaches with Aadhaar, according to Gopinath, is that every user has a Unique Identity Number (UID) that is shared with all the service providers such as banks, telecom operators, hospitals, and the like

However, this isn’t UIDAI’s only hurdle. According to several news reports, it has had several data breaches in the recent past, where users’ personal records were not just stolen but also sold for as little as Rs 500. Gopinath thinks that the UIDAI didn’t think through privacy concerns as thoroughly as it should have. The reason for privacy breaches with Aadhaar, according to him, is that a user’s Unique Identity Number (UID) is shared with all the service providers such as banks, telecom operators, hospitals, and the like. There’s another privacy concern: when all information about an individual and their transactions are linked, the government or any a powerful organisation can surveil its citizens as China has been accused of doing.

Facing heat from critics, UIDAI has recently rolled out a new safety feature – Virtual Identity Number (VID) – through which users’ can generate a unique 16-digit number each time they deal with a service provider, similar to the unique OTP that is generated for each online financial transaction we make. So a user can share one VID – generated on the UIDAI website – with a bank and another with a hospital. Though this ensures greater privacy, the onus is on the user to manage and remember each VID. It is akin to remembering passwords, says Gopinath: “If I deal with 27 service providers, I will have to identify the VID submitted to my bank from the 27 different VIDs I have created. I could write them all in a piece of paper or save it in my smartphone. But if I lose the paper or my phone, I lose everything.”

To deal with this problem, Gopinath and his team came up with a security or privacy model, published in 2017, which while providing an equivalent to VIDs, also addresses the issue of “VID” management. Here, the numbers are automatically generated and require no management from users. There are three players involved in this algorithm: credential producers, who generate and manage "VIDs"; credential consumers or service providers; such as banks, telecom operators and users. This method keeps service providers in the dark about users’ whereabouts. “A user has a single credential. It could be PIN number or a password. This credential producer, depending on which service provider you’re talking to, will produce a new ID for you, automatically,” he says.

Another highlight of Gopinath’s model is that it can protect users from governmental surveillance. Users are allowed to approach multiple producers to generate and manage their VIDs. If the establishment manages to control a producer, users can still rely on the others. However, the model has a threshold – it can only guarantee users’ protection until this threshold of producers is breached.

Gopinath was also keen that the model should not shield people who engage in income tax frauds or terrorism. “For example, if someone is interacting with a vendor to buy tonnes of urea, the government should be able to know whether the purchase was for industrial needs or to make bombs.” Therefore his team has installed a feature allowing the government to access user data called a back door, which ensures that if there is a legitimate security concern, the government can obtain a judicial warrant and track users who are under the scanner.

Beyond Aadhaar

Two breaches that rocked Yahoo email took the world by storm, affecting 3 billion users in 2013, and 500 million users in 2014. Towards the end of 2018, Yahoo was asked to pay a compensation of $50 million for the damage the incidents caused to 200 million people. Gopinath ascribes these breaches to human factors. He explains, “When a person sends an email, it passes through several servers before reaching the recipient. So when the email jumps from one server to another, the recipient’s email address, headers and attachments are unlocked. This also means somebody who has access to servers can view your information.”

> *Cryptography doesn’t solve everything because it all boils down to keys and we still don’t know how to manage it*

There is another area of concern for cryptographers. As the world moves towards cloud computing, a platform which stores and processes massive user data, it too has become the target of attacks by hackers. Here, users’ data are managed on a server maintained by service providers such as Google or Amazon. Cloud service providers use several advanced cryptography tools to secure users’ data and yet, the data are vulnerable to theft. As with Aadhaar, hackers meddle with security certificates and leak sensitive information. They could also look for residual information that computers leave behind every time the device is used, called side channels. “If a hacker follows the side channels of a user’s computation, they [hackers] can figure out everything about the user. It is difficult, requires technical expertise, but it can be done,” Gopinath says.

Leaks also happen when a user unwittingly shares information such as the date of birth or mother’s name on social media sites. With this information, hackers can gain access to people’s bank accounts or buy a duplicate SIM under the user’s name.

It also doesn’t help that many software companies gather large amounts of data of large numbers of people, whose behaviour they study and analyse. The data they generate is often used for targeted advertisements or even sold to a third party, who in turn use it to target the user. “Sites such as Facebook or Google have little motivation to protect users’ privacy. They make money by selling users’ data to advertisers,” explains Sanjit Chatterjee, Associate Professor at CSA, who works on developing stronger cryptosystems. For instance, Facebook has been accused of sharing data of its 87 million users with Cambridge Analytica Pvt Ltd, a political consultancy firm. The firm is said to have used the data to sway the 2016 presidential elections in the United States.

Image courtesy: 422737/Pixabay

DVDs were introduced in 1996 and it took only three years for its security to be compromised

The arms race between hackers and cryptographers is illustrated by the rise and fall of DVDs, buttressed by cryptography. Besides their ability to store data, they were designed to check piracy. Because the content in DVDs is stored in bits, people duplicated them and yet they couldn’t play the DVD. This is because DVDs had a software system that latched on to location details, preventing people from using it in places other than its intended location, Gopinath explains. And the device came with a key which can be unlocked only by an authorised user. But it didn’t take long for some people to create another software system that turned a blind eye to location codes. Also, crackers gradually figured out a way to get hold of the key, stored within the device, which eventually stripped DVDs of its security.

While things seem loaded against the user, cryptographers are constantly developing new tools to better protect the interests of the consumer. Chatterjee highlights the example of TOR, which allows the user to browse anonymously. When a user requests to open a website, say an ecommerce site, TOR locks the IP address and the location of the user. Instead of sending the request directly to the ecommerce site, the locked information passes through a series of nodes or checkpoints, before finally reaching the ecommerce website. The browser has no means of tracking user information. Though secure, one major downside to using TOR is its speed, or lack thereof.

But cryptography doesn’t solve everything because it all boils down to keys and we still don’t know how to manage it, says Gopinath. He recalls a famous quote by a computer scientist, Peter G Neumann, who said, “If you think cryptography is the answer to your problem, then you don’t know what your problem is.”

“We only had four boxes of medicines to treat people with”

Kavitha Harish

Photo courtesy: G Ambiga

Ambiga served at IISc’s Health Centre for 28 years

On 14 December 1973, G Ambiga joined IISc’s Health Centre as Staff Nurse, after serving in Tamil Nadu’s Chengalpat Medical College Hospital and the Government Thiruvateeswarar Tuberculosis Hospital. She spent 28 eventful years at IISc, and is known for her outspoken nature and wealth of stories about her experiences working at the Health Centre where she was ‘in-charge’ for 16 years, her time as President of the SC/ST Employees’ Welfare Association, and the famous people she met while working for the Institute – including former Prime Minister Indira Gandhi and Ramakrishna Hegde, the former Chief Minister of Karnataka. In this interview, she shares a few memories of her time at IISc.

What brought you to IISc?

IISc had advertised for the position of Senior Staff Nurse, which required applicants to have experience of five years. Since I had the required experience, I applied and went through the selection process. Though I met the criteria for the post, the Institute offered me the position of Staff Nurse instead. I was disappointed initially. But later, I felt that this was an opportunity to serve a prestigious place, so I took up the job. I continued as Staff Nurse, thinking that I might get promoted to Senior Staff Nurse in a few months or a year. But no, that didn’t happen. I was promoted much later – after 23 years, in 1996!

What did the Institute and the Health Centre look like when you joined? And how has it changed over the years?

Upon receiving my appointment letter, I was excited and I couldn’t wait to join. IISc has a very beautiful campus: it was calm, green, and people were down to earth, especially students and faculty. This campus always looks good to me. Now, of course, we have more buildings and students. But the greenery still makes the campus pleasant.

Back then, the Institute allowed outsiders to enter with visitors' passes. I met Shri Ramakrishna Hegde, who visited the Institute regularly for morning walks, that way. I ran into him several times on the way to my morning shift. Since I lived in the quarters, I used to walk to work. I once asked why he came to Institute for a walk, to which he said, "IISc is such a beautiful place and everyone wishes to come here. It is the only place in the city where you get pure oxygen!"

I once met Shri Ramakrishna Hegde, who used to visit the Institute regularly for morning walks

When I joined Health Centre, it was much smaller: it was only half as big as it is now. TB Subba Rao was the Chief Medical Officer (CMO) at the time. We were all permanent employees then. Only in the last 15 years, the Institute began appointing people under contract or on a temporary basis, which I am against, because a place like this needs permanent staff. The Health Centre is an important part of the Institute and we need dedicated people working there. Students come from all parts of the country and live on campus. It is our responsibility to take care of them.

In those days we had only four boxes of medicine to treat people with. Now I see that the Health Centre has grown very big and looks very neat, with more doctors and facilities. It is cleaner after renovation and I like that they have expanded the in-patient facility for the IISc community.

Is there anything in particular you remember from your time at IISc?

There were many things that were memorable. The Health Centre had barely any facilities then, especially for patients who were admitted. On my first day at work, I wished a patient good morning and asked him a few questions: "Did you sleep well last night? Did you take your medicines the previous night? Did you have breakfast and coffee? How are you feeling?" It was a practice I had picked up at my previous job. Immediately, the patient got angry and shouted at me, asking me why I was asking him so many questions. He later said that he lived near Nelamangala and that his daughter-in-law would be bring him coffee and breakfast by 11 am.

I felt bad, because the Health Centre didn't provide food to patients who were admitted. I later had a discussion with my colleagues because I felt that we should do something about this. And I started arranging for refreshments from my house: I used to bring coffee and tea. We didn't have many patients, only five or six at a time.

I wanted the administration to address this issue, and so I contacted them. I also met with the Director, Prof Satish Dhawan, regarding this. We requested the Institute to provide refreshments to patients admitted in the Health Centre. When we raised this issue, Prof Dhawan was surprised and concerned. Immediately, he visited the Health Centre and checked every facility there. He checked its cleanliness, including towels, drinking water, lab, syringe, handwash area and other things. He asked the officers concerned to immediately replace all these items with good quality materials. And Prof Dhawan asked the Hostel Mess to provide food and refreshment services to the patients admitted in the Health Centre. This was one of his best initiatives. I was touched by his gesture.

Could you tell us more about your interactions with Prof Dhawan?

I felt he took the Health Centre issue seriously. I wondered why the Director, who was also the Chair of ISRO, had come all the way to our Centre, when he could have easily asked the concerned officers to attend to the issue. He also used to visit each department personally. Despite being a busy man, he was concerned about many things in the Institute. Before he retired, he visited all the departments and spoke to all the employees. People remember him for that. He was such a great man. I am lucky to have interacted with him.

Prof Dhawan asked the Hostel Mess to provide food and refreshment services to the patients admitted in the Health Centre

What kind of ailments did you have to deal with at the Health Centre?

Once, a student had come to the Centre complaining of severe stomach ache. The doctors diagnosed him with appendicitis and chicken pox. The student's situation was complicated: we could not send him to any referral hospital as none would take him into the operation theatre because of the chicken pox. After discussing the matter with our Visiting Surgeon, our doctors decided to perform the operation to remove his appendix at the Health Centre itself, and we were asked to arrange for an operation theatre.

But our existing operation theatre was not suitable for surgery. My colleague, Sister Mara, and I both made the room ready: we cleaned, dusted and fumigated the entire room. The doctor appreciated our efforts.

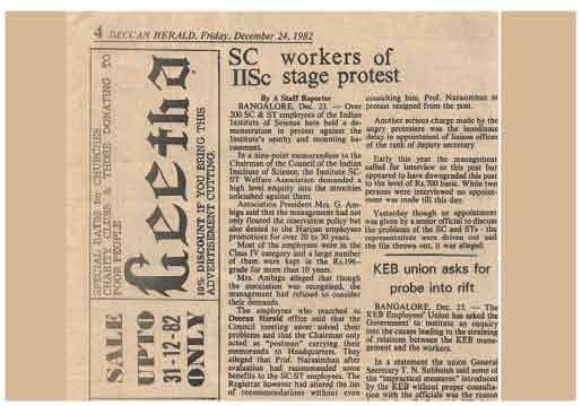
One more incident I want to talk about is an accident that involved two students riding a two wheeler, near IISc's main gate. One student died on spot and the other was seriously injured. He was treated in other hospitals and when he was out of danger, he was nursed at our Centre for three months. We took good care of him, like he was our family member. We brought him liquid food from our homes to feed him.

You were a part of the SC/ST Employees' Welfare Association. Was the Association actively involved in promoting the cause of SC/ST Employees?

Yes, I was a part of the SC/ST Employees Welfare Association, for which I had Prof Dhawan's support. I remember fighting for the cause of these employees. I asked the Institute to provide recruitment and better opportunities for them under the reservation policy based on the Government of India's rules.

I met the Council members during the Council Meeting that happened in the Council Chamber. Prof Dhawan didn't get upset about our protest and allowed us to speak with the Council Members. We handed over a letter stating our demands.

Through the Association, we visited the Prime Minister's office to address the issues of SC/ST employees at IISc, and we had a chance to meet Indira Gandhi. I had to face several difficulties during this period.



DECCAN HERALD, Friday, December 24, 1982

SC workers of IISc stage protest

By A Staff Reporter

BANGALORE, Dec. 23. — Over 200 SC & ST employees of the Indian Institute of Science here held a demonstration in protest against the Institute's security and recruitment.

In a nine-point memorandum to the Chairman of the Council of the Indian Institute of Science, the Institute SC-ST Welfare Association demanded a high level enquiry into the atrocities unleashed against them.

Association President Mrs. G. Ambiga said that the management had not only flouted the reservation policy but also denied to the Harijan employees the promotions for over 20 to 30 years.

Most of the employees were in the Class IV category and a large number of them were kept in the Rs.196-grade for more than 10 years.

Mrs. Ambiga alleged that though the association was recognised, the management had refused to consider their demands.

The employees who reached the Deccan Herald office said that the Council meeting never solved their problems and that the Chairman only acted as "postman" carrying their memoranda to Headquarters. They alleged that Prof. Narasimhan after evaluation had recommended some benefits to the SC/ST employees. The Registrar however had altered the list of recommendations without even consulting him. Prof. Narasimhan is present resigned from the post.

Another serious charge made by the angry protesters was the inordinate delay in appointment of liaison offices of the rank of deputy secretary.

Early this year the management called for interview to this post but appeared to have downgraded this post to the level of Rs.700 basic. While two persons were interviewed no appointment was made till this day.

Yesterday though an appointment was given by a senior official to discuss the problems of the SC and STs - the representatives were driven out said the file throws out, it was alleged.

KEB union asks for probe into rift

BANGALORE, Dec. 23. — The KEB Employees' Union has asked the Government to institute an enquiry into the causes leading to the straining of relations between the KEB management and the workers.

In a statement the union General Secretary T. N. Subbiah said some of the "impractical measures" introduced by the KEB without proper consultation with the officials was the reason

Image courtesy: G Ambiga

A newspaper clipping on the protests

What were those difficulties?

A few administration officers were against us registering the Association and troubled us in many ways to stop our protest. But our team was strong. They also wanted me to resign as President of the Association. I was once attacked when I was going home after my night shift; somebody threw a stone at me and I was hurt. Prof Dhawan came to know about this incident and arranged for security near my house on campus.

Did other members of your family work at IISc too?

Yes, my husband, TK Raja joined the PhD programme in the Department of Electrical Communication Engineering through Bharat Electronics Limited. He was also invited to serve as selection committee member for staff appointments as an external expert.

Photo courtesy: G Ambiga

Ambiga with her husband TK Raja

Did being here change your life in any way?

After meeting many students and watching them being so dedicated towards their studies, I felt the need to study further. I did a Master's in Sociology and other courses such as Nursing Administration, and attended many workshops on rabies.

Photo courtesy: G Ambiga

A group photo of Health Centre staff taken on Ambiga's retirement

I have noticed that once you are a part of the Institute you are recognised and respected. This happens especially when you go abroad. When I visited my elder daughter in the US, I was given special attention from many people. I had several such experiences during my visits abroad.

ABSTRACTS

IISc Photography Club